Partial Caries Excavation

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Regular readers will note that we depart from our normal Critical Appraisal format in this issue of the Journal. This particular Critical Appraisal resembles an expanded Contemporary Issues feature and describes a protocol for partial caries excavation that was recently implemented in the student clinics of the University of North Carolina (UNC) School of Dentistry.

RATIONALE

When a definitive treatment plan cannot yet be determined (e.g., when disease status, treatment outcome, or patient commitment is uncertain), teeth that have large carious lesions but no overt pulpal or periapical pathology should be managed conservatively. In the context of disease control for teeth with large carious lesions, it is generally not advisable to initiate definitive root canal therapy for asymptomatic teeth with a healthy pulp and healthy periapical area.

Therefore, in the disease control phase of the treatment plan, large carious lesions with healthy pulpal and periapical tissues should be managed via *partial caries excavation* (PCE). This procedure is sometimes described as an indirect pulp cap or internal remineralization in the literature. Aggressive complete caries removal that invades the pulp space and forces an immediate decision of definitive root canal treatment or extraction should be avoided. PCE followed by placement of a provisional restoration, or even a definitive restoration if the patient can be monitored adequately, has significant benefits in this context.

For the individual patient, PCE might allow retention of the tooth through the disease control phase without root canal therapy—and thereby avoid the time, expense, and necessary deferral of treatment for other teeth (including those with a better prognosis). It also avoids the problem of performing endodontic therapy on a tooth that might be recommended for extraction later, in the definitive phase of treatment. The complexity and cost of treatment increase several-fold once the pulp is exposed. For many patients in dental schools—and in private practice as well—the cost increase can be a death sentence for the tooth. From a public health perspective, teeth that would otherwise be extracted for financial reasons can be maintained to provide some level of esthetics, function, and preservation of oral health for patients with limited financial resources.

One of the major motivators in implementing this protocol is to assure that large carious lesions are treated as a priority, thus reducing the overall bacterial load and arresting lesion progression—in short, caries control. The philosophy behind the approach is that when the tooth is vital and there are no signs or symptoms of irreversible pulpitis or apical pathology,

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it is preferable to leave and seal partially demineralized dentin from the oral environment and arrest the caries process than to engage in more complex and expensive procedures. When successful, the benefits in reduced cost and postoperative pain are obvious.

There is ample literature to support this approach as being more successful than the insistence upon removing all caries even if it results in exposure of the pulp.[1–31] For example, PCE has been shown to reduce pulp exposures by 98% relative to a traditional one-visit approach where all caries is removed, and by 65%, when a two-visit approach to complete caries removal is taken. Studies further demonstrate that PCE leads to a significant reduction in pulpitis and pulpal necrosis.[26]

CLINICAL PROTOCOL

The PCE protocol described in this paper is a specific UNC adaptation of professionally recognized and accepted tooth-level caries control treatment. It is appropriate to use this protocol when performing disease control phase treatment on any tooth with a large carious lesion (or multiple teeth with moderately large lesions) that is deemed restorable, and for which the pulpal and periapical areas are deemed healthy (no irreversible pulpitis or pulpal necrosis). The appropriate use of the PCE protocol requires a specific form of therapeutic/surgical intervention that is based on a scientific, evidence-based rationale. The protocol involves five distinct steps:

Step 1: Caries control diagnosis and treatment planning. At a diagnosis and treatment planning appointment, any patient who exhibits high caries activity should be considered for treatment using a PCE approach. These patients might present with multiple moderate lesions, several large lesions, or some combination of both. Multiple moderate lesions are a concern because the availability of appointments or financial constraints might result in such a slow pace of treatment that progression to pulpal necrosis is likely.

Any tooth or teeth to be treated with the PCE protocol should be identified. A preliminary assessment of pulpal and periapical health and restorability of teeth should also be made. These teeth should be the top treatment priority. Once these teeth are stabilized, definitive diagnosis and treatment planning can be completed.

Step 2: Definitive assessment of tooth pulp and periapical health. At the restorative appointment, any tooth planned for PCE should receive a definitive pulpal and periapical diagnosis. The PCE protocol is used only for teeth determined to be vital and to have a healthy perapical area. At worst, these teeth would have symptoms consistent with a reversible pulpitis. If the tooth is found to be nonvital, or symptoms are consistent with an irreversible pulpitis, or in the presence of apical periodontitis of endodontic origin, PCE is contraindicated.

Step 3: Assessment of restorability. The restorability of the tooth also is assessed at the beginning of the restorative appointment. Restorability must be definitively confirmed after completion of all peripheral caries removal (i.e., a caries-free dentinoenamel junction [DEJ] should be established around the entire periphery of the cavity preparation). The protocol is used only for teeth that are restorable with a direct restoration (glass ionomer, resin-modified glass ionomer, composite resin, and amalgam) or appropriate foundation and must have a fair to good restorative prognosis. Teeth that are found to be nonrestorable should be extracted.

Step 4: Caries removal and placement of a provisional restoration. Caries is completely excavated peripherally to a sound, caries-free DEJ. Axially and pulpally, caries is excavated to within approximately 1 mm of the pulp. The goal is to stop removing caries when the first of either of these two options occurs: (1) all caries is removed; or (2) all caries is removed except from the axial or pulpal walls, where demineralized dentin still remains and there is approximately 1 mm of remaining dentin thickness. Clinically, it can be very difficult to gauge remaining dentin thickness; when in doubt, the clinician should err on the side of avoiding a pulp exposure.

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The provisional restoration is typically a strong glass ionomer material such as Fuji IX (GC America, Alsip, IL, USA) or ChemFil Rock (Dentsply Caulk, Milford, DE, USA).

Step 5: Postoperative status of the pulp and definitive restoration (follow-up appointment). The treated tooth should be reevaluated later, e.g., at approximately 12 weeks after placement of the provisional restoration. Teeth that are vital and asymptomatic at this visit are restored with a definitive direct restoration (either amalgam or composite). *The glass ionomer provisional restoration is* not *removed to facilitate removal of caries left at the first appointment.* Rather, it is cut back pulpally and axially to serve as a base. Strong evidence indicates that reentering an asymptomatic, vital tooth significantly increases the likelihood of pulp exposure without increasing favorable outcomes.[6,12,22,27]

Reevaluation of the remaining tooth structure prior to placement of a definitive direct restoration sometimes might result in a decision to place a full-coverage restoration. If that is the case, the glass ionomer may be removed to facilitate the removal of any residual partially demineralized dentin and a foundation for a crown is placed. If pulp exposure occurs, the tooth should be treated endodontically. At the follow-up appointment, teeth that still have symptoms consistent with a reversible pulpitis or are found to be necrotic are recommended for endodontic therapy or extraction.

ADDITIONAL CONSIDERATIONS

- The pulpal diagnoses outlined as part of the PCE protocol rely on signs and symptoms of pulp pathology using the best diagnostic tools available. However, *actual* pulpal status is difficult to determine clinically—bacteria and toxins progressing ahead of caries can cause areas of undetectable pulp necrosis or irreversible pulpitis.
- This protocol calls for the use of glass ionomer as the provisional restorative material because the evidence indicates it consistently provides a good seal. Sealing the tooth against microleakage is critical to arresting the caries process. Use of a material other than glass ionomer for the provisional restoration—or placement of a definitive restoration—is permitted at the discretion of the clinician.

Regarding the choice of restorative material, clinicians are encouraged to take a risk : benefit ratio approach. Whereas glass ionomer is inexpensive, can be placed quickly, and can be placed atraumatically, delaying the placement of a definitive restoration increases risk, because it (1) requires patient compliance and (2) incurs additional trauma to the tooth and additional cost to the patient.

- Use of calcium hydroxide (or other liner/base material) after caries excavation and before use of the provisional restoration is not required, but it is permitted at the discretion of the clinician.
- Teeth that are restorable *only* with a full-coverage restoration generally are not appropriate for this approach because of the difficulty of evaluating the tooth for possible failures such as continuing caries activity under the full-coverage restoration. Again, a risk : benefit ratio approach is encouraged. Relative to the potential risks involved in using a PCE approach with a direct restoration, the risk : benefit with a crown is very different. Periodic evaluation of the possibility that the caries process is active is very difficult when a full coverage restoration is present. The cost of rectifying a failure of the PCE approach would involve considerable expense. In a worst-case scenario, it would involve loss of the initial crown, endodontic treatment, placement of a buildup, and a new crown.
- This protocol recognizes that exposures can occur despite admonitions to leave caries rather than expose the pulp. Whenever a carious pulp exposure occurs, the treatment should be consistent with endodontic principles, in which case the tooth is no longer a candidate for the protocol described here.
- The protocol contains provisions for dropouts. It is highly likely that some patients will fail to return for follow-up as specified in the protocol. As these patients return for other care or for loss of the caries

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control restoration, they are treated according to more conventional treatment regimens.

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THE BOTTOM LINE

- Much scientific evidence exists to support the concept of partial caries excavation for treating large caries lesions.
- Selection of teeth for PCE treatment is based on clinical signs and symptoms, with the understanding that the actual status of the pulp cannot be determined with 100% certainty.
- Glass ionomer materials are an excellent choice for provisional caries control restorations in the PCE protocol.
- When placing a definitive restoration, the provisional restoration normally should not be removed completely, as reentering the tooth to ensure complete caries removal has been shown to be counterproductive.[16,27]

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