Treatment of Deep Carious Lesions

SUMMARY

Treatment of deep carious lesions approaching the pulp, traditionally, mandates removing all the infected and affected dentin. Several studies call this approach into question. Electronic databases using selected key words to identify studies relating to partial versus complete removal of carious lesions yielded more than thousand reports but 23 authors judged to be relevant. The results of randomized controlled trials provide evidence of leaving behind the infected dentin, the removal of which would put the pulp at risk of exposure. Several studies have demonstrated that cariogenic bacteria, isolated from their source of nutrition by a restoration, either die or remain dormant and pose no risk to the health of the pulp.

Keywords: Deep Caries; Pulpal Exposure; Pulp Capping, direct

Introduction

Traditional management of deep carious lesions dictates the removal of all infected dentin to prevent further cariogenic activity and provide the mineralized base dentin for restoration. Several studies call this approach into question, such as studies examining partial caries removal\textsuperscript{4}, randomized controlled trials\textsuperscript{52}, studies examining the activity of pulp capping materials\textsuperscript{6,12,53}, and observational studies\textsuperscript{6,54}.

For the practitioners, the treatment of deep carious lesions presents some difficulties when the procedure carries risk of exposing the pulp, because the course becomes less predictable and may require such measures as indirect pulp capping, direct pulp capping, pulpotomy or pulpectomy\textsuperscript{1,3-5,7,9,10}. Choosing among these options can be daunting for the dentist, as well as for the patient, who is advised of the risks and asked to share responsibility in the decision.

The major purpose of this paper was to evaluate the diagnosis, treatment options and prognosis of deep carious lesions when partial removal or complete excavation of the infected dentin was prepared. Several authors have investigated and proposed alternative approaches to preclude or at least minimize the possible complications of the complete excavation of carious dentin close to the pulp\textsuperscript{12-14,26}. One method, a step-wise or 2-step excavation, involves the staged removal of carious tissue. At the initial visit the clinician, when established that the pulp still is vital, partially remove necrotic and infected dentin, which is often soft and can be removed easily with hand instruments\textsuperscript{17,18,20-23}. Than the dentist seals the lesion up with a medicament, such as calcium hydroxide, and places a temporary restoration. At the second visit, a few months after the first visit, in some cases up to 2 years later, the clinician removes all or most of the remaining infected tissue. The rationale for this approach is that by this point any remaining bacteria will become dead, residual infected dentin, as well as a previously affected dentin will become re-mineralised, and reparative dentin will have been generated, making it easier for the dentist to remove any remaining carious tissue.

Conservative or ultraconservative removal of carious tissue, often referred to as “partial caries removal”, is more controversial approach. In this method the practitioner removes most but not all of the infected dentin, seals the cavity (with or without indirect pulp treatment) and proceeds with the restoration. The trade off for avoiding pulpal exposure, leaving behind a layer of infected dentin, is defended by citing the substantial evidence that cariogenic bacteria isolated from their source of nutrition by a restoration of sufficient integrity either die or remain quiescent and thus pulp may stay vital\textsuperscript{11,16,25,27-30}.

It is common to experience difficulties in distinguishing between dentine that should be removed,
and that which should be left. During the course of excavating an extensively decayed tooth, the pulp might be exposed. In this case patient is informed of the possible problem and the treatment options, including a pulp capping, pulpotomy, pulpectomy and root canal therapy. The benefits, prognosis, future treatment needs, and fees are carefully explained. The worst possible scenario happens when the possibility of exposing the pulp during excavation has not been preliminary discussed with the patient. In that case, options, benefits and fees must be discussed with the patient being under stress, who is forced to make a decision. The alternative is for the dentist to make a treatment decision without the patient’s approval and permission. Both alternatives are expensive and time-consuming.

**Consideration and Treatment by Direct and Indirect pulp Capping**

The literature regarding step-wise excavation has reported consistently that residual carious dentin recedes and hardens under temporary restorations in the interim between the initial excavation and re-entry. Kidd stated “why re-enter?” In other words, if the goal is to avoid pulpal exposure, and residual dentin poses no threat to the tooth, why should the patient be subjected to a second excavation?

**Indirect Pulp Capping**

Indirect pulp capping (IPC) is defined as those steps or procedures taken to protect or maintain the vitality of a carious tooth that, if being completely excavated, would result in pulpal exposure. In these cases, the infected dentin, the more bacteria-ridden superficial layer, must be removed to eliminate most of the viable bacteria present in the tooth. Greater understanding of the caries process has led to the distinction between the infected and affected dentine. Stained dentine may be affected by caries (may be slightly demineralised or conversely may be sclerosed) but may not necessarily be infected and, thus, removal of such dentine would be over-preparation with unnecessary loss of tooth structure. Thus, it could be argued that the first definition of an IPC (where stained, demineralised dentine is not removed and a calcium hydroxide lining placed) reflects nothing more than routine practice for pulp protection. The subjacent layer of the affected dentin, although demineralised, does not contain high counts of viable bacteria. It is this layer that is to be left behind after gross caries excavation.

This is a delicate procedure that involves careful judgment by the clinicians. The pulp no longer may respond favourably by re-mineralising the affected layer and producing secondary dentin. Case selection is extremely important. Any tooth that is planned for treatment by basic restorative procedures (amalgams or composites) should be considered a good candidate for the IPC. If extensive tooth preparation is anticipated, it is unwise to utilize an IPC. Analyzing radiographs, the periapical region should have a healthy lamina dura and periodontal ligament space. Patients without spontaneous pain or with mild-moderate pain upon thermal stimulation or mastication may be considered as candidates for IPC. These symptoms usually represent degenerative changes in the pulp which will not respond favourably to IPC.

The procedure consists in achieving adequate anesthesia, isolation, obtaining a proper outline form, complete removal of carious tissue from cavity walls, but limited removal from the pulpal floor and axial wall. Caries should be removed to the level at which a change is noted in dentin consistency (infected to affected layer) or where suspected exposure is imminent. Cavity should be cleaned and dried with cotton pellets. A dressing with calcium hydroxide or zinc-oxide eugenol should be covered by a durable base material and finally permanent restoration.

Although several studies have been completed with regard to progression of caries and prognosis of teeth in which permanent restorations were placed over caries, there is at present insufficient evidence to support this approach. Prognosis of IPC depends on pulp vitality and age of the patient.

**Direct Pulp Capping**

Direct pulp capping (DPC) is defined as dressing of an exposed pulp with the objective of maintaining pulp vitality. Historically, the placement of a medicament or material against a direct pulpal exposure during caries excavation has been considered controversial, and instead, conventional endodontic therapy has been recommended. DPC is a procedure in which a dressing/lining (or restorative material) is placed into direct contact with the exposed pulpal tissue. This is usually carried out following a carious or traumatic exposure. Calcium hydroxide is most commonly used; however some authors have directly bonded resin composite over exposures and mineral trioxide aggregate may be a promise as an alternative (although it is currently relatively expensive).

Although both mechanical and a carious pulpal exposure result in pulp injury and inflammation, the prognosis for a successful DPC is greatly diminished with carious exposure. When the decay has progressed to such an extent that a pulp exposure results during preparation, it means that the pulp has already been chronically inflamed, either partially or totally. This is coupled with invasion of microorganisms associated with the carious exposure, and makes these teeth very poor candidates for direct pulp capping. The traumatic or mechanically exposed pulp possesses a greater adaptive
ability for repair because it has not been previously compromised by inflammation from progressing caries or by the introduction of bacteria and infected dentin.\textsuperscript{37,38,40,43} (Figs. 1 and 2).

If a carious exposure is anticipated, the tooth should be isolated to prevent salivary contamination. Caries should be removed, first in the dentin-enamel junction, then in the lateral walls, and lastly at the deepest part of caries penetration. After pulpal exposure haemorrhage is controlled by pressure with a sterile cotton pellet. Strong or long burst of air should be avoided as this will cause pulpal damage. Calcium hydroxide is placed directly over the exposure site and finally a permanent restoration should be placed (Figs. 3-5).

**Discussion**

One of the most frequently discussed areas among dentists is the maintenance of pulp vitality in carious teeth, particularly by means of pulp capping procedures. It is a complex subject to be examined due to the wealth of contradictory and controversial information concerning pulp-capping.\textsuperscript{9,42,44,45} The opinions of investigators examining the topic are often inconsistent, leaving the concerned clinicians more confused than satisfied.
Weather it is necessary to remove all carious tissue from lesions approaching the pulp? Many practitioners continue to follow the basic principle guiding any surgeon - that one must eradicate the affected tissue from the site of an infection, although there is substantial evidence to the contrary. The conventional treatment paradigm has a long history: GV Black in his classic 1908 text asserted that “it is better to expose the pulp of a tooth than to leave it covered only with softened dentine”. The majority of survey on this subject indicated that all carious tissue should be removed even if the procedure would risk pulpal exposure.

Tooth Development
A younger patient’s tooth with greater blood supply, better defences against insults, and if without previous restoration, it should be a better candidate for IPC than the multi-insulted tooth of the older patient. In teeth with incompletely formed apices, pulp-capping is the recommended treatment procedure following vital pulp exposure. In teeth with mature apices, there are conflicting opinions regarding whether the age is an unfavourable factor in direct pulp-capping. Haskell et al. and Baume have reported that age does not seem to be a factor. However, chances of successful pulp-capping are diminished with age because of decreased blood supply and increased fibrous and calcified deposits in the pulp.

Bacterial Contamination
The presence of bacteria is the most important consideration in predicting pulp-capping success. In the absence of bacteria, pulpal healing results regardless of the severity of the exposure. In contrast, pulp tissue contaminated by microorganisms does not heal.

Size of Exposure
Larger exposures result in more traumatized pulpal tissue, more lacerated blood vessels, greater haemorrhage, and greater pressures, resulting in severe inflammatory reaction.

Control of Haemorrhage
Any haemorrhage must be staunched with sterile cotton pellets because blood coagulum between the pulp and the capping material can reduce the rate of healing by about 50%.

The Condition of the Pulp
The condition of the pulp at the time of exposure is important for success. An inflammation-free pulp possesses a high regeneration potential; if the exposed pulp tissue is contaminated by bacteria before placement of the capping material, failure is the rule.

Selecting the Appropriate Pulp Capping Agent
A paste mixture of calcium hydroxide (CH) powder and sterile anaesthetic solution, Dycal or a paste mixture of MTA and sterile anaesthetic solution, or ProRoot MTA that prevent bacterial leakage should be selected. When using calcium hydroxide for deeper cavities, where it is estimated that less than 2 mm of dentine remains, a preparation liner should be placed in the deepest parts of the preparation for direct pulp capping procedures (to encourage formation of tertiary dentine and minimise risk of future exposure, and to stimulate formation of repair). It should be also used for step-wise caries removal (to encourage formation of tertiary dentine, kill any remaining bacteria and reduce risk of exposure).

Mechanisms of Activity of CH
Since its introduction, CH has been widely used in several clinical situations. Various biological properties have been attributed to CH: antimicrobial activity; tissue dissolving ability; inhibition of tooth resorption; induction of repair and formation of hard tissue.
**Temporary Coverage**  
Depending on the aesthetic and functioning needs of the tooth, the prepared cavity may be restored with a bonded composite resin, amalgam or temporary crown.30,34,35,49-51.

**Success Rate**  
Clinical studies have reported extremely variable success rates after direct pulp capping, ranging from 97.8% after 1.5 years and dropping to 61.4% after 5 years, and only 13% after 10 years, while endodontically treated teeth revealed 93% success after 5 years and 81% after 10 years.3,7,29,31,40,47,49.

**Summary**  
Depending on the clinical setting, vital pulp therapy can be managed with an indirect or direct pulp capping procedure. The determination of which kind therapy should be employed is a decision that must be made by the clinician at the time of treatment.

**Conclusions**  
On the basis of the presented facts, there is substantial evidence that removal of all infected dentin in deep carious lesions is not required for successful caries treatment, provided that the restoration can seal the lesion from the oral environment effectively. Before this concept is fully accepted by dental professionals, additional clinical trials are needed.

**References**

52. Fairbourn DR. Effect of improved Dycal and IRM on bacteria in deep carious lesions. JADA, 1980; 100:547-552.

Correspondence and requests for offprints to:
Prof. Rozarka Budina
Klinika Stomatologjike Universitare
Q.S.U “Nene Tereza”
Tirana, Albania
E-mail: zarkabudina@yahoo.com