ORIGINAL ARTICLE

TO DRILL OR NOT TO DRILL? - CURRENT CONCEPTS AND STRATEGIES OF CARIES EXCAVATION

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ABSTRACT

Historically, caries was regarded as an irreversible infection that required the complete removal of all cariogenic microbes. However, the traditional method of caries management, which involves removing all microscopic organisms from lesions, is no longer applicable. The goal of modern caries treatment is to extend the life of the restoration without removing sound or re-mineralizable dentin. This is frequently based on recent findings that dental caries is a biofilm-based and lifestyle-mediated disease.

INTRODUCTION

Over the past century, dentistry has shown a paradigm shift from the original tenets of GV Black's "extension for prevention" to a "prevention of extension" approach. This is part of an evolution that stresses on a medical, rather than a surgical model for caries management. The introduction and advancement of adhesive dentistry, which encourages the preservation of tooth structure, has aided in this transition.

Carious tissue removal is presently agreed to be best assessed by the hardness of residual dentin.[1] Probes, an excavator, or a bur can all be used to determine hardness. Based on the hardness, dentin can be broadly classified as (Table 1)

DISCUSSION

CARIOUS TISSUE REMOVAL STRATEGIES

Based on the outlined understanding of the disease and the goals of carious tissue removal, a number of removal strategies can be defined, with hardness serving as the criterion for what is removed or left during carious tissue removal.

1. **Non-selective Hard Dentin Removal (*no longer recommended*)**

   Previously known as "Full Removal," this technique removes all softened dentin from the cavity, i.e., carious tissue removal is stopped only when hard dentin remains.[2] This method is no longer recommended, especially for deep carious lesions, due to the negative consequences such as accidental pulp exposure and unnecessary sound tooth structure loss.[1,3,4]

2. **Selective Removal to Firm Dentin**

   Carious tissue is removed from the cavity's periphery until only sound enamel and firm dentin remain, which aids in achieving a tight, effective seal between the restorative material and tooth, extending the material's lifetime. However, firm or leathery dentin is left in the pulpal floor of the cavity.[2] Selective removal to firm dentin is recommended for lesions that are not deep, i.e., do not extend into the inner third or quarter of the dentin or are radiographically or clinically close to the pulp. It is not recommended for deep lesions.

3. **Selective Removal to Soft Dentin**

   When pulp protection is required, soft dentin should be removed selectively in deep lesions. On the periphery, only firm dentin and sound enamel remain (achieving a good seal and maximizing restoration longevity). In the pulpal floor, the goal is to avoid exposure. Carious (soft) dentin is thus left behind. When compared to the previous two techniques, this one reduces the possibility of pulpal exposure.[1,4,5] The sealed cavity slows the progression of the carious lesion by reducing biofilm activity and depriving the bacteria of a source of nourishment.

4. **Stepwise Removal**

   This technique involves the removal of carious tissue in two steps.[6,7,8] In the first step, soft dentin is selectively removed. A temporary restoration is placed, and reactionary dentin continues to develop, remineralization occurs, and bacteria are inactivated over the next 6- 12 months. Following this time, the restoration is removed, and removal to firm dentin is performed in the cavity's center.

The idea behind stepwise removal is that in the first step, pulp exposure is avoided, while in the second step, less carious dentin is removed than would be removed

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Table 1: Classification of Dentin

INFECTED DENTIN	AFFECTED DENTIN	HEALTHY DENTIN
Consistency		
SOFT	**FIRM/LEATHERY**	**HARD**
Contaminated by bacteria, demineralized and irreversibly denatured collagen network	Not yet contaminated by bacteria, remineralizable and reversibly denatured collagen network	Made up of 70% inorganic hydroxyapatite crystals, 20% organic substance and 10% water content
Hardness		
Can easily be removed/scooped out by gentle scraping with a hand instrument	Can be removed with a hand instrument when medium pressure is applied	Can only be removed with burs. When a straight probe is run across the dentin, a scratchy sound called "cri dentaire" can be heard

if excavating to firm dentin was done immediately. The temporary restoration should be made of a material that forms a seal and is long-lasting, such as glass ionomer cement. One of the main complications of stepwise removal is premature failure of the temporary restoration, which jeopardizes the pulp's vitality.[9]

Stepwise removal may pose more pulp exposure risks than selective removal to soft dentin, but it has been shown to pose fewer risks than non-selective removal. For extremely deep lesions, stepwise removal is advised (those involving the inner quarter of the dentin).

5. No Removal at All - Sealing-In Lesions

Based on the logic that lesions can be sealed and therefore arrested, as carbohydrates are no longer available to sealed bacteria for their progression. Moreover, sealing protects the sealed enamel or dentin by installing a diffusion barrier against acids.[10,11] Fissure sealing over non- cavitated occlusal and proximal lesions can be successful, although it is critical that the sealants are maintained.

However, a plastic sealant-based sealant strategy is not appropriate for cavitated, load-bearing carious lesions. The 'Hall Technique,' which involves sealing with more durable materials such as preformed stainless-steel crowns, has been proposed here. This technique is only for primary molars. It entails placing a crown without removing any carious tissue or preparing the tooth. The benefits of this therapy include the fact that it is well tolerated by children, [12,13] that it biologically controls lesion activity, and that it provides a long-term restorative option for the cavity (most other direct restorations have a very limited performance in primary teeth). [14] When compared to conventional restorative treatment, the Hall Technique has been found to be highly effective (involving carious tissue removal and placement of amalgam or glass ionomer restorations).[15]

6. No Removal at All - Managing the Biofilm

Non-restorative cavity control is based on the notion that the primary reason for restorations is to reinstall a cleansable surface that is then amenable to oral hygiene from the patient. Cleansability is achieved by chiseling or drilling away the overhanging enamel or dentin, thereby opening up the cavity. 18 Then, an oral hygiene program is implemented, which includes the application of fluoride varnish on a regular basis. This technique has so far only been used on primary teeth and root surface lesions. Although clearly promising in theory, the limited practice-based data available for primary teeth is not encouraging: the ability to change patients' and, in the case of children, their parents' behavior to keep the cavity clean is limited.[16]

A non-restorative cavity control approach may serve children who are unable to accept any other treatment under certain conditions, such as assurance of optimal supervision, evidence of diet/brushing habit change, careful selection of tooth cavities, and frequent, regular, and well-recorded monitoring of lesion status over time. [16,17,18]

LATEST CARIES-EXCAVATION PROCEDURES

1. Conventional Excavation with Burs

- ***Polymeric burs***

A "plastic" bur made of polyamide/imide (PAI) polymer, with slightly lower mechanical properties than sound dentin, was introduced in an attempt to develop a selective caries-removal rotating instrument. However, it quickly became clear that if the bur came into contact with sound or caries-affected dentin, it quickly dulled and produced undesirable vibration, making further cutting impossible.

- *Ceramic burs*

For the removal of carious dentin, a new line of slow-speed rotary cutting instruments made of ceramic materials is now commercially available. CeraBurs (Komet-Brasseler; Lemgo, Germany) are all-ceramic round burs made of alumina-yttria stabilised zirconia that come in a variety of diameters. The manufacturer claims that, in addition to its high cutting efficiency in infected, soft dentin, using this instrument for caries removal replaces both the explorer and the spoon excavator by providing tactile sensation at the same time, thereby reducing preparation time.[19]

2. Chemo-mechanical Excavation

- *Pepsin-based caries excavation*

As an alternative to the traditionally used sodium hypochlorite, a new experimental gel containing pepsin in a phosphoric acid/sodium biphosphate buffer is being considered (SFC-VIII, 3M ESPE; Seefeld, Germany). The main advantage of this new enzyme-based solution is that it can be more specific than sodium hypochlorite-based agents by digesting only denatured collagen (after the triple-helix integrity has been lost).[20] According to the manufacturer, phosphoric acid dissolves the inorganic component of carious dentin while allowing pepsin access to the organic component of carious biomass to selectively dissolve the denatured collagen. To avoid over excavation, use the SFC-VIII gel in conjunction with a prototype plastic instrument with a hardness between that of sound and infected dentin. Heavily pigmented, arrested dentin caries is known to be more resistant to pepsin digestion, but this does not seem to present a major drawback to the method.[21]

3. Excavation by sono-abrasion

The technique of "sono-abrasion" caries excavation is based on the use of cutting tips coupled to high-frequency, sonic, air-scaler handpieces that are cooled by water. The handpiece oscillates in the sonic range (6.5 kHz), while the tips move elliptically. A maximum torque force of 2-N should be applied; otherwise, the cutting efficiency is reduced due to oscillation damping. Sono-abrasion excavation with diamond-coated tips appears to be as efficient as conventional hand excavation with dental spoons, but takes longer than carbide-bur excavation.[22]

4. Fluorescence-aided Caries Excavation (FACE)

This technique was created as a direct method for clinically distinguishing infected from affected carious dentin. Because several oral microorganisms produce orange-red fluorophores (porphyrins) as byproducts of their metabolism, infected carious tissue will fluoresce, particularly in the red fraction of the visible spectrum, due to the presence of proto- and meso-porphyrins. Continuous visual detection of orange-red fluorescence during caries excavation was thought to be convenient for clinicians in this manner.[23]

Areas exhibiting orange-red fluorescence can be selectively identified and removed with the bur by feeding a slow-speed handpiece with a fiber-optic violet light source (370 to 420 nm) and allowing the operator to use a 530-nm yellow glass filter. Using confocal microscopy, the FACE method demonstrated the highest sensitivity, specificity, percentage correct score, and predictive values for residual caries detection when compared to Caries Detector or the visual-tactile method for establishing the caries removal endpoint.[24]

The FACE method is also very efficient, requiring less time to excavate caries and eliminating the need to change instruments, apply chemical agents, or test the cavity with an explorer. 34 Another significant point is that FACE's increased caries-removal efficacy is not related to increased cavity size or over excavation.

5. Excavation Aided by Laser-induced Fluorescence

Based on the fact that caries-induced changes increase dentin fluorescence at the 655-nm (red) wavelength, a laser-fluorescence device that emits light at this wavelength has been developed to detect "hidden" occlusal carious lesions (DIAGNOdent, Kavo Dental; Biberach, Germany). A photodiode attached to the tip of the handpiece measures fluorescence feedback after initial irradiation, with the intensity of fluorescence at the occlusal surface directly related to the degree of caries progression into dentin.[23]

Based on a diagnostic scale that correlates fluorescence readings with the histological presence of caries, values above 30 are considered a stage of caries progression that necessitates surgical intervention.

6. Laser Excavation

Lasers are now used in dentistry for a variety of purposes, including caries diagnosis, disinfection of periodontal pockets or root canals, photodynamic therapy of oral tumors, soft-tissue surgery, caries removal, and cavity preparation. Erbium lasers have been identified as the most promising in the field of operative dentistry due to their specificity in ablating

enamel and dentin without causing side effects to the pulp and surrounding tissues when the appropriate parameters are used.[25]

CONCLUSION

Caries is not seen as an infection any longer. Carious lesions, even those containing large amounts of bacteria, can be sealed, depriving the bacteria from the dietary carbohydrate nutrition and inactivating them, thus arresting the lesion. New caries excavation techniques, such as the use of plastic and ceramic burs, improved caries-disclosing dyes, enzymatic caries-dissolving agents, caries-selective sono/air abrasion, and laser ablation, have all been introduced. They are all designed to remove or assist in the removal of caries-infected tissue as selectively as possible while remaining minimally invasive by preserving caries-affected tissue. Each technique has a distinct caries-removal endpoint and produces residual dentin substrates of varying natures, resulting in varying receptiveness to adhesive procedures.

Despite these changes, some of Black's original writings remain relevant today: "The day will undoubtedly come when we will be practicing preventive dentistry rather than reparative dentistry."

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