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Review Article

Recent concepts and techniques in dental caries excavation: A systematic review

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ABSTRACT:
Dental caries is one of the most widespread persistent diseases affecting people of all ages. Contemporary caries excavation practices with the concept of minimal intervention have commenced like step wise caries excavation, use of plastic and ceramic burs, caries-detector dyes, enzymatic mediators, sono and air abrasion, FACE, laser technology, etc to preserve the tooth structure, prevent pulpal exposure and also to make treatment patient friendly. The chief predicament, however, is the perceptible deficiency of the methods to discriminate between affected and infected tooth tissue. So, further research is required to overcome this drawback and ensure the use of these various techniques in clinical practice.
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INTRODUCTION

WHO defined caries as "a localized post eruptive, pathological process of external origin involving softening of the hard tooth tissue and proceeding to the formation of a cavity." (2018)

The conventional treatment of carious lesions is essentially by removing them and replacing them with a restorative material. However, the perception of caries has changed: it is now seen as an upshot of ecological disparity in the biofilm constitution and its activity.[1]

PRINCIPLES OF CARIES EXCAVATION

1) Evading distress/pain and dental apprehension.
2) Conserving non-demineralized and remineralizable tissue.
3) Accomplishing a sufficient seal by inserting the marginal restoration onto sound dentin and/or enamel, thereby restricting the lesion and inactivating the residual bacteria.
4) Preserving the pulp health by protecting residual dentin and preventing pulp exposure.
5) Increasing durability of the restoration by eliminating adequate infected dentin for placing a long-lasting restoration of ample mass and pliability.[2]

METHODS OF CARIES EXCAVATION

- **STEPWISE CARIES EXCAVATION**

It is suggested for very deep lesions & entails two steps.

First step involves selective removal of soft dentin that is followed by placement of a temporary restoration. For the subsequent 6 – 12 months, reactionary dentin develops, remineralization occurs and bacteria are inactivated. At this juncture pulp exposure is avoided.

In the second step, restoration is removed and excavation up to firm dentin is done. Here less carious dentin needs to be eliminated than instant removal up to firm dentin.

However, complications like untimely failure of the temporary restoration and probability of pulp exposure are present.

- **CONVENTIONAL EXCAVATION USING BURS**

➢ **CARBON-STEEL OR TUNGSTEN-CARBIDE BURS**

For caries removal, a round bur is recommended with diameters analogous to the size of the carious lesion. Excavation of carious dentin should start from the margin and move towards the center of the lesion in order to curtail the hazard of infection in case of inadvertent pulp exposure.

Scanning electron microscopy (SEM) illustrates a homogeneous smear layer with more or less homogeneous roughness and dentinal tubules clearly hindered by smear plugs.[3]

➢ **POLYMERIC BURS**

Selective caries can be removed by a bur made of a polyamide/imide (PAI) polymer, possessing slightly lower mechanical properties than sound dentin. If the bur comes in contact with sound or caries-affected dentin, it rapidly becomes blunt and produces unwanted vibration, making cutting unfeasible. The blade design helps to remove dentin by locally depressing the carious tissue and moving it forward along the surface until it breaks and is carried out of the cavity. However, it often results in premature and irreversible bur damage.[3,4]

➢ **CERAMIC BURS**

These are slow-speed rotary cutting instruments of high cutting efficiency made of ceramic for elimination of carious dentin. The CERABURS are all-ceramic round burs made of ALUMINA-YTTRIA STABILIZED ZIRCONIA and are obtainable in various diameters.

It replaces the use of both explorer and spoon excavator by concurrently providing tactile sensation & reducing preparation time.[3,4]

- **CARIES DETECTOR DYES**

Dyes are applied for about 10 seconds on tooth structure and washed away. Any intensely stained portion of tooth ought to be removed, generally with slow speed burs or spoon excavators. The dye should be reapplied after eliminating all the discolored dentin to corroborate no residual caries is left in the tooth.[1,4]

Following dyes are used to identify carious enamel:

- ✓ 0.5% basic fuchsin
- ✓ Procion dyes
- ✓ 1% acid red in propylene
- ✓ Methylene blue

- **CHEMO-MECHANICAL CARIES REMOVAL**

➢ **CARIDEX**

It was urbanized by CM Habib & comprises of N-monochloroglycine and aminobutyric acid (GK-101E). It brings about disruption of collagen in the carious dentin that leads to translation of hydroxyproline to pyrrole-2-carboxylic acid.

Caridex was not extensively accepted, probably due to the expenditure, extra clinical time and the colossal delivery system.

➢ **CARISOLV**

Developed by Chriser Hedwards, Lars Strid, Dan Ericson and Rolf Bornstein in 1998, it exploits three amino acids—LYSINE, LEUCINE, and GLUTAMIC ACID along with Sodium hypochlorite (0.5%), Carboxymethyl cellulose, Sodium chloride & Saline solution causing rupture of collagen in carious dentin.

Regardless of its efficiency, Carisolv was not a runaway success because it required widespread preparation of professionals and tailored instruments which augmented its cost.[1]

➢ **PAPAIN GEL**

In 2003, Papacarie was developed in Brazil. It consist of papain, chloramines, toluidine blue, salts, thickening vehicle, which jointly are accountable for Papacarie's bactericidal, bacteriostatic and anti-inflammatory characteristics. It is most active against Streptococcus and Lactobacillus.[1,3]

- **EXCAVATION VIA SONO-ABRASION**

It is centered on the employment of cutting tips together with high-frequency, sonic, air-scaler handpieces under water cooling and requires added time than the carbide-bur excavation technique. It has a propensity to under prepare cavities. Chemical or structural alterations are not seen with petite or even no substantiation of smear layer formation.

- **AIR-ABRASION TECHNIQUE OF EXCAVATION**

It draws on the kinetic energy of abrasive elements like alumina particles having 27-μm diameter to cut tooth structure owing to its lofty cutting efficacy, chemical constancy, stumpy charge, low attraction for water and neutral shade. The chief shortcoming of air-abrasion excavation is that sound dentin is more efficiently removed than carious dentin.

- **CARIES EXCAVATION USING AIR-POLISHING**

It comprises of sodium bicarbonate and tricalcium phosphate (0.08% by weight) for the exclusion of carious dentin at the conclusion of cavity preparation.

- **ULTRASONIC INSTRUMENTATION FOR REMOVAL OF CARIES**

Nielsen et al. devised a magnetostrictive instrument with a 25 kHz oscillating frequency in combination with a thick aluminium oxide and water slurry to cut tooth tissue. It was easier to cut hard tissue that represented affected dentin capable of remineralization, but soft carious dentin seemingly

could not be removed. This restricted the application of this instrument.

- **FLUORESCENCE-AIDED CARIES EXCAVATION ("FACE")**

Orange-red fluorophores are formed as metabolic by-products of oral microflora. Carious tissue incandesces particularly in the red portion of the visible spectrum owing to the existence of proto- and meso-porphyrins. By using a slow-speed handpiece with a fiber-optic violet light source (370 to 420 nm) and a 530-nm yellow glass filter, parts showing orange fluorescence can be easily recognized and removed with a bur. This technique is very proficient and less time consuming. There is also no need to change instruments, put on chemicals or use an explorer to detect caries.[5,6]

- **EXCAVATION ASSISTED BY LASER-INDUCED FLUORESCENCE**

DIAGNOdent consists of a photodiode connected to the tip of a handpiece that calculates the response of fluorescence following primary radiation, where the amount of fluorescence at the occlusal surface is unswervingly correlated to the quantity of dentinal caries. Denominations greater than 30 require operative interventions as it indicates progression of caries. DIAGNOdent value often enhance with nearness to the pulp and also with stained, sclerotic dentin, causing unnecessary removal of tooth structure.

- **EXCAVATION USING LASER EXPERTISE**

Er:YAG irradiation causes expansion of water interstitially locked in the dental hard tissues, thereby causing removal of caries. Whereas, the Er,Cr:YSGG laser system, frequently branded as the "LASER POWERED HYDROKINETIC SYSTEM", carries photons directly into an air-water spray that heads to the target tissue. This event stimulates micro-explosive vigor into water droplets that play a role in the mechanism of caries elimination. Nonexistence of smear layer is a benefit of this modus operandi.[7,8]

- **CARIES REMOVAL BY MEANS OF ENZYMES**

Some enzymes like BACTERIAL ACHROMOBACTER COLLAGENASE helps in removing carious tooth structure, keeping the sound layers of dentin beneath the lesion unaffected. Current researches have utilized a non-specific proteolytic enzyme PRONASE, which originates from Streptomyces griseus, to help remove carious dentin. However, more laboratory investigations are required for corroboration of this technique.[9,10]

CONCLUSION

Various methods eliminate carious tooth structure with differing levels of competence but it is still unspecified if these techniques will differentiate between the soft, outer, necrotic, highly infected zone that needs to be excavated and the inner, reversibly damaged, affected zone which can be remineralized.
If this contrast does not take place, this might lead to over preparation of cavities with diminutive jurisdiction over the quality and quantity of the tissues being removed. There is, therefore, an imperative necessity to review the outcomes of these procedures for their effectiveness and degree of caries removal.

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