**Alternative methods of cavity preparation**

**Introduction**

Black's Guidelines (1893) ( macro retentive cavities) : ●

In 1893 dentists used to do traditional excavation as the material of choice was amalgam, & one of the disadvantages of amalgam that it lacks adhesion to tooth structure, so there were Black's guidelines (extension for prevention, retention, convenience and resistance forms > they used to prepare the cavity regardless the amount of caries, not only remove pathological tooth structure but also extend it to get more retention. ) to avoid displacement of amalgam under occlusal, lateral and oblique forces.

●Adhesive dental materials (1970s)

With the introduction of adhesive dental materials , started from silicate until composite nowadays, we no longer need these macro-retentive forms ( we don’t need grooves, 2mm depth, flat floor or convergent walls ) we just follow the caries because the new materials depend on micro retentive forms .

Now we just follow the caries.

●Minimal invasive dentistry

It's not just about to be conservative in cavity preparation, it's also about to determine if we need the operative treatment or it just needs non operative treatment, shall I give the pt oral hygiene instructions to reinforce the oral hygiene w\o intervention so mineralization occurs Or I have to do some intervention?

If we need to apply the minimal invasive dentistry there are lots of alternative methods to use for caries removal leaving the mineralized tissue, because nothing can replace the natural tooth structure so we need to be very conservative, we are not aiming to reach the natural normal dentin totally because you will never sterilize the cavity & because the affected carious dentin can be re-mineralized so we can leave it behind , only remove soft dentin.

●No definitive diagnostic tool is today available to clinically define the caries-removal end point (no way to tell you how much caries to remove and how much to keep behind) , enabling complete removal of infected tissues without overextending cavity preparation.

How can we assume the cavity now is ready to receive the restorative material?

By 3 indicators: Conventional Clinical Criteria:

1- dry > wet

2- hard > soft

3- stain free > stained

These clinical signs are blunt, not sharp or definitive, we use them roughly to evaluate the cavity if it's clean or not. However they are the only ways available!

The most reliable one is the hardness of the cavity, we rely on it to judge the cavity, we don’t rely on the first criteria (dry mo8abel wet) because studies have shown many recurrent caries that held millions of bacteria but it's dry not wet! So dry cavity doesn’t mean it's clean and no bacteria

Hard vs. soft: hard cavity may contain soft parts with active caries and bacteria and other parts are arrested, but at least hardness ensures good bonding " no one of the 3 criteria is related to the amount of bacteria "

Less hardness > weaker bond > bond failure later on > micro leakage > recurrent caries.

Hardness has nothing to do with the infection but we need it for good bonding later on.

Stain-free vs. stained : this is totally wrong criterion, staining has nothing to do with the infection, staining is a result of "Maillard reaction" : reaction between the carbohydrates produced by bacteria and the proteins in dentin resulting in stained tissue. Stained areas (areas of Maillard reaction) are more resistant to acid attacks.

**Cavity preparation**

Does all carious dentin need to be removed prior to restoration placement?

 NO, why?

Caries was arrested when cavity margins were properly sealed-

There was a British study ,where they removed soft dentin using excavator then closed over caries .. after 10 years ,, only few cases developed caries,, most of the cases were arrested ,, they concluded that **seal is the deal .**

Why did that happen? They found that the cariogenic bacteria (in a well-sealed cavity) will lose the source of nutrients and will be converted into normal commencals bacteria, not pathogenic > arrested caries.

We don’t follow this principle in our clinic, because we don’t have ideal material to seal 100%.

**Dentin lesions**

1- superficial infected dentin: remove it ( it does not bond, it harbors all the bacteria and it contains denaturated dentin "hopeless dentin" )

2- gradual transition layer: it has infected and affected dentin.

3- deep affected dentin: has less than 0.1% of bacteria present in the first layer (superficial infected dentin) and this dentin is not destructed.

 **Note**:

●denaturated dentin: broken from within

●De-mineralized dentin: contain less minerals , with fluoride or glass ionomer it could be re-mineralized.

However, mechanical excavation techniques ( excavator & burs) can't differentiate between these layers.

 **Methods of cavity preparation:●**

**1- Conventional excavation with burs**

-using tungeston carbide or diamond burs

-round slow speed

- start from periphery to the centre (from DEJ inwards)

-check with probe if there is any softness

-these burs are efficient ( I achieve what I want In a reasonable time )

- burs however tend to over excavate

- thick smear layer potentially reduce the bonding effectiveness , so we need etching to remove smear layer .( smear layer formation is one of the disadvantages of burs)

**2- Polymeric burs**

-In attempt to develop selective caries removal rotating instruments

-Plastic burs made of polyamide\imide polymers

-cannot remove sound dentin, only soft dentin)

The available commercial burs consisted of polymers with particular hardness of 50 KHN which is higher than the hardness attributed to carious dentin and lower than the sound dentin.

( Affected dentin hardness is 70-90 KHN and carious (infected) dentin hardness is 0-30 and the burs hardness is 50 KHN.)

Advantages:

1- removes only soft infected dentin

2- reduce the need for local anesthesia (the pt will not feel that much pain when removing carious infected dentin)

 Disadvantages:

1- they become dull quickly

2- residual caries (reduced bond strength)

**3- Ceramic burs**

-Made of Alumina yttria stabilized zirconia

-High cutting efficiency in infected soft dentin

-Replaces both the explorer and excavation spoon ( By Simultaneously providing tactile sensation (l2nhm slow speed)) so no need to check the cavity with the probe .

**Caries disclosing dyes ( Caries Detector)**

0.5% basic fuchsin in propylene glycol base (red solution) when applied on a tooth it enters carious the areas of infected carious dentine ( inside opened dentinal tubules ) giving red color, we remove the red colored areas only .

Later they found that the basic fuchsin is carcinogenic material, so they replaced it by 1% acid-red in propylene glycol base ( acid- red instead of basic fuchsin)

This depends on large molecules entering de-mineralized areas > red color > remove it .

By this we ensure we are removing only de-mineralized dentin not sound dentin.

However, we have 2 problems here:

1- the molecules may enter de-mineralized but not denaturated areas (areas that might re-mineralize ) so I am not conservative as much as I want

2- DEJ also hypo-mineralized and will appear in red color.

So the problem with this disclosing agent is it's not related to infection , it's related to de mineralization.

Staining is not related to denaturated collagen fibers nor to bacteria or bacterial by-products, it depends on hardness and mineralization.

**4-Chemo-mechanical excavation**

-Sodium hypochlorite base agent

-The first attempt to develop a chemical solubilizer that will selectively act on carious dentin resulted in sodium hypochlorite solution buffered with amino acid containing mixture of amino butyric acid and sodium chloride and sodium hydroxide .

-because sodium hypochlorite is very aggressive they buffered it using amino acids & they came up with : Carisolv & Caridex solutions.

●Mix this solution for minutes > apply it on the tooth > do agitation using brush > wash > all infected dentin is resolved and removed.

●So .. chemicals plus mechanical brushing = chemo-mechanical excavation

●This solution removes everything except the collagen fibers( which contain minerals ) collagen fibers that are de-mineralized will be removed. However, they found that this solution removes also the partially de-mineralized layer > not conservative as much as we want (minimal invasive dentistry)

**Caridex**

Need of a specific apparatus to deliver the solution into the cavity -

Short shelf-life-

 -Longer treatment time

higher treatment cost-

**Carisolve**

-Sodium hypochlorite with amino acid mixture

Longer treatment time-

-Great amount of residual bacteria was also detected at the DEJ where direct access of the gel and the hand instruments is difficult. (you need to do good cavity using burs to provide access for the gel to reach all carious areas ) , residual bacteria here is not that important because we are not going to sterilize the cavity.

**5- Pepsin-based caries excavation**

-A new experimental gel consisting of pepsin in a phosphoric acid\sodium bisphosphate buffer

-Pepsin is an acidic enzyme in the stomach, it acts (digests) only on denaturated destructed collagen in dentin, it's self limiting does not act on de-mineralized (not destructed ) collagen .

-Trypsin has the same advantage of pepsin, but pepsin is not active unless it's in an acidic media , so acidic media (carious dentin) with pepsin in a 5 minutes will give the result , trypsin gives the same result but after 24 hours because it doesn't work in acidic media.

-Collagenase acts on denaturated dentin and on de-mineralized dentin but not on mineralized sound areas.

Sodium hypochlorite is more aggressive than these 3 enzymes.-

-The main advantage of this new enzyme – based solution is that it can be more specific by digesting only denaturated collagen (after the triple-helix integrity is lost) than sodium hypochlorite-based agents.

-No burs,pain, anesthesia or discomfort , but it's costy and needs access for the gel to reach every part in the cavity.

**6- Excavation by sono-abrasion**

-Caries excavation by sono-abrasion is based on the use of cutting tips coupled to high-frequency, sonic, air-scaler handpiece under water cooling .

It's like a scaler but the tip is cutting. -

Tendency to under prepare carious cavities -

Little or no evidence of smear layer formation -

- Efficient ( more time needed than conventional bur excavation), it's better than spoon excavator but not efficient as the burs.

**7- Air-abrasion excavation**

-Air-abrasion systems for cavity preparation use the kinetic energy of abrasive particles (Aluminum oxide ) to cut tooth structure, in a less invasive way, while rounding off internal and cavo-surface angles to the direct benefit of the subsequent adhesive restoration.

-These particles sometimes remove sound dentin and leave carious dentin! It's not reliable.

-Sound dentin is more efficiently removed than carious dentin by these particles, because carious dentin has a softer consistency so the particles energy is absorbed during the impact reducing the cutting ability.

-It forms smear layer (less than burs) but still we need acid etching to remove it .

**8- Fluorescence aided caries excavation (FACE)**

-Based on that oral microorganisms produce orange-red fluorescence as by-products of their metabolism (under microscope) this orange-red appear under the red fraction of visible light (not in clinic)

-This system is sensitive, specific and reliable but cannot be done in clinic , only under laboratory conditions

**9- Excavation aided by laser-induced fluorescence (Diagnodent)**

-Laser fluorescence device that irradiates at 650 nm wavelength has been developed to diagnose hidden occlusal carious lesions.

It's diagnostic rather than excavation method.-

-It gives light and this light is transferred into numbers , values above 30 should be considered a stage of caries progression.

However, it reads hypo calcifications , not related to bacteria , it reads calculus and water makes readings wrong

**10- Laser-excavation**

-Erbium lasers have been pointed as the most promising operative dentistry, specificity in ablating enamel and dentin without side effects but it costs not less than 50000 JDs

Advantages:

- more conservative

- antibacterial

- less pain

- no need for anesthesia

- more patient comfort

- no vibration

Disadvantages:

- more time for cavity preparation, it produces heat and might cause pulp necrosis so you need to work slowly

- its effectiveness in removing carious dentin is questionable

- expensive

- lack of tactile sensation

Note: Ozone: O3 , not considered as excavation method , it's antibacterial method

**Methods of excavation requirements (in general )**

- avoid pulp irritation or exposure and maintain pulp vitality

- conservative and avoid over preparation.

- more selective in caries removal

- efficient (needs less time ) , sensitive (remove only carious dentin) and specific (does not remove sound dentin)

- preserve re-mineralizable tissues

- patient comfortable

- inexpensive