Operative Dentistry

Lecture (7) Dr. Raghad Noori

Caries Diagnosis and Treatment

Caries is a dynamic process of demineralization and remineralization of dental hard tissue which may result in progression, regression (reversal), or arrest (stabilization) of the lesion. When demineralization (loss of minerals "hydroxyapatites crystals") outgain remineralization (gain of minerals), caries progresses which occur in case of frequent eating (which lead to continuous reduction in pH of oral environment) and inadequate use of fluorides.

❖ Caries detection and diagnosis:

Caries detection involves determining whether or not clinical signs of caries are present at one point in time.

Caries diagnosis is the determination of activity and causes of the caries lesion in addition to caries detection.

Caries detection process can be performed by mixing of information obtained from:

1- Clinical examination
2- Use of caries diagnostic aids
3- Communication with patient
4- Knowledge about caries process

➢ Aim of detection of early caries lesions

The aim of detection of early carious lesions is to limit the progression of caries as early as possible and monitor caries lesion activity. Early caries is a reversible disease and can be prevented by prevention of demineralization and promotion of remineralization by an effective prophylactic intervention which employed to reverse or arrest the lesion before the need for restorative intervention.

➢ Methods of caries detection

The conventional caries detection methods are visual and radiographic examinations. Visual examination of early caries lesion can be seen either as a white or as a brown/black spot lesion. There are noncavitated and cavitated stages of progressed dental caries that can be identified and described using clinical signs.

Detection of carious lesions with visual examination must be performed while the teeth are:

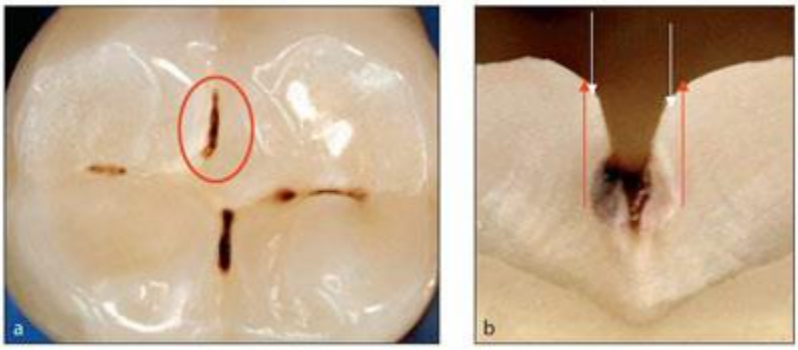
1. Clean tooth: cleaned from plaque by a probe or a prophylactic cleaning.

2. Dry tooth: dried with air-water syringe for more than 5 seconds, because removing water from the porous tissue enables the dentist to gauge how far through the enamel a lesion has progressed.
3. Magnification and lighting: Use of magnification devices such loupes or operating microscope can improve caries detection by 50%.

❖ Caries detection in different types of lesions:

1. Pit & fissure lesions:

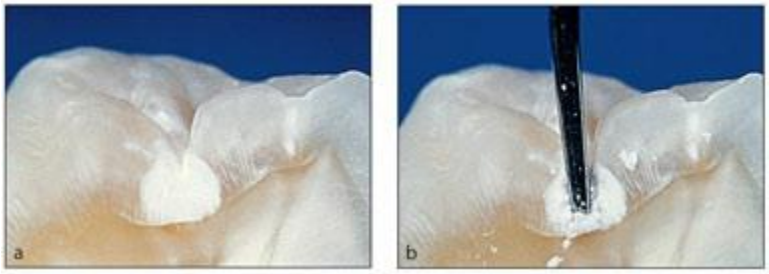
- Detection of these lesions most often performed by visual inspection. Good lightening & dry clean teeth. It appears that any sign of visible cavitation in the occlusal surface corresponds to the progression of the lesion into the dentin. Opaque, matte texture of enamel adjacent to the stained pits and fissures may indicate the presence of active caries underneath the pit and fissure. When there is no caries underneath, discoloration will remain within the confines of the pit and/or fissure.



-Bite-wing radiographs can detect only large occlusal lesions. Small lesions can't be detected with bitewing radiographs because of the large amounts of surrounding sound enamel.



-Tactile examination of fissures with sharp probe is unreliable method because the explorer can damage a white spot lesion by breaking through intact surface zone & cause a cavity which will trap dental plaque & encourage lesion progression.

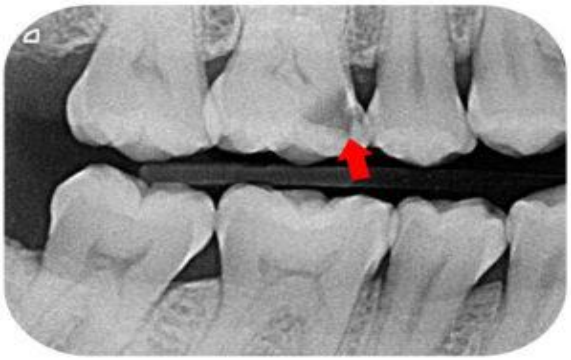


2. Lesions involving proximal surfaces:

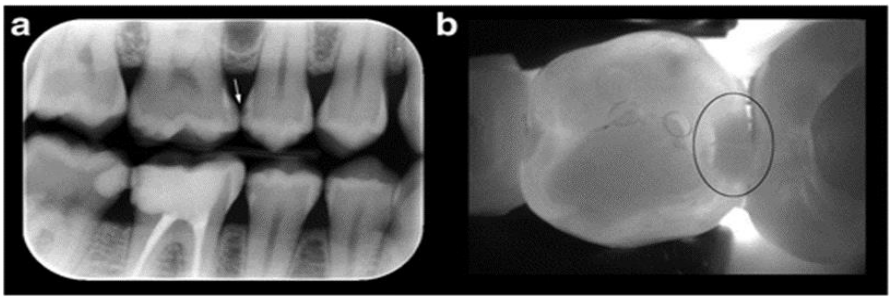
-Extensive active proximal lesions can be revealed by shadowing or grayish discoloration of the undermined occlusal enamel ridge.



-Bitewing radiographs are the most effective method for evaluation of the proximal smooth surfaces for evidence of demineralization because these areas are not readily assessed visually or tactilely when there is contact between proximal surfaces. The radiograph should be assessed to determine penetration of the lesion either into enamel, DEJ, outer half or in the inner half of dentin. However, the bitewing radiograph still cannot distinguish between cavitated and noncavitated proximal lesions.



-Fiberoptic transillumination techniques have proven useful in detection of proximal caries lesion. In these techniques, a fine light is transmitted through the contact area. Lesions appear as a dark shadow; however, it is difficult to determine penetration of lesion into enamel or dentin.



-The use of orthodontic separator has been advocated in some cases to allow the dentist to see more clearly & gently feel for a break in the enamel surfaces.

3. Lesions in smooth free surfaces (buccal and lingual):

lesions in enamel of smooth free surfaces of the crown usually located close to the gingival margin and characterized by chalky matte, whitish/ yellowish surfaces.



4. Root surfaces:

Root surfaces exposed to the oral environment, usually due to gingival recession, are at risk for caries and should be examined visually and tactilely. Discoloration of such areas (light brown, dark brown, or black discolored area on the root surface or at the cementoenamel junction) is common and usually is associated with remineralization. Generally, the darker the discoloration, the greater the remineralization. On the other hand, active, progressing caries shows. little discoloration and is primarily detected by the presence of softness and cavitation.



New Caries Detection Methods

The conventional caries detection methods, visual and radiographic examination, cannot quantitatively measure the continued changes in mineral status of the caries lesion. The development of several new devices and detection methods is promising. Most of these devices claim to detect and monitor caries activities based on the change in the reflectance, transmission, fluorescence, electrical conductance/ impedance properties of enamel following demineralization.

➢ **Reasons for employing new caries detection methods are:**

• Early lesion detection as well as hidden occlusal lesions detection.
• Objective and quantitative lesion assessment (for monitoring purposes).
• Visualization of the caries process.
• Avoiding of potentially harmful ionizing radiation.

Electronic caries monitors: Sound tooth structure should possess limited or no conductivity whereas, carious enamel should have measurable conductivity that will increase with increasing demineralization (Tooth demineralization due to caries process causes increased porosity of tooth structure. This porosity contains fluid containing ions). Conductivity from the occlusal surface to a ground electrode is measured with a probe.

The only drawback is the fact that it is time consuming to use in a routine full-mouth examination. (for example: CarieScan system it is a handheld, battery-operated device).

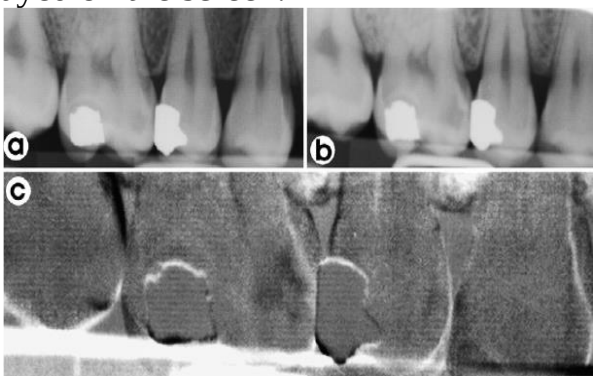




Direct digital radiographs: for caries detection. This system use a wire-based sensor that contains a computer chip inside a protective casing, the sensor is connected to a computer by wire. The sensor is placed in the patient's mouth, when this sensor hit by x-ray the information is transmitted directly to the computer and displayed as an x-ray image on the computer screen. The use of digital radiography permits image manipulation and reduces the amount of radiation required to obtain a diagnostic image. Darkroom is not required; instant image is viewed. Capability for tele-transmission.



Digital Subtraction radiography: Used for detection of recurrent caries. The basis of subtraction radiology is that two radiographs of the same object can be compared using their pixel values. any differences in the pixel values must be due to change in the object. Two standardized radiographs produced with identical exposure and geometry. The reference and the subsequent image for comparison. The reference image is displayed on the screen.



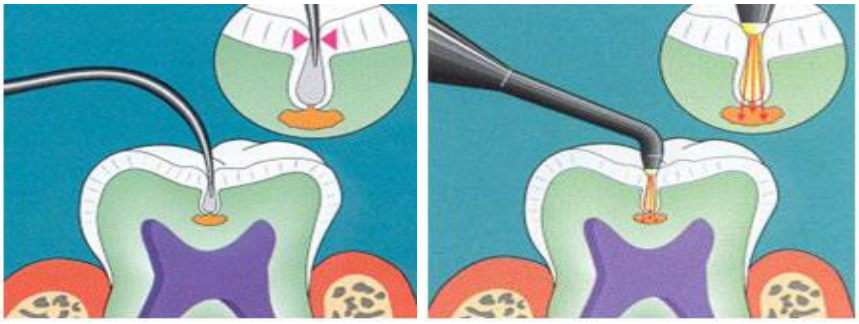


Intra-Oral camera for caries detection and for patient motivation.

Magnification using Loupes, and Dental Microscope.

Infrared Laser Fluorescence (DIAGNOdent)

It can be used for detection of caries on occlusal and smooth surfaces. The principle is that when Diode laser with 655nm wavelength is irradiated on dental surface, it is absorbed by metabolites of caries lesion bacteria and these metabolites emit a red fluorescence. This fluorescence reflected by the dental surface is indicated as a number between 0 and 99 on the screen of the device. The **higher** the number the more is the caries, however, DIAGNOdent is used as a complementary tool beside visual examination for diagnosis of occlusal caries.



- **Advantage:**

It is most useful in confirming the presence of caries in suspicious fissure and detecting deep dentinal caries (hidden caries). It is non-invasive method for caries detection. However, it is not used for the detection of recurrent caries or to detect proximal caries.

Due to this limitation, a new version of the method was designed and introduced, named DIAGNOdent pen, this new version permits the assessment of both occlusal and proximal surfaces.

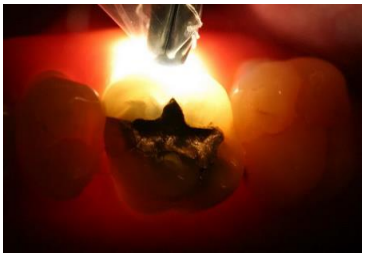


<u>Fiber-optic transillumination</u>

Fiber-optic transillumination (FOTI) as a caries detection technique is based on the fact that carious enamel has a lower index of light transmission than sound enamel. The intact tooth absorbs very little light allowing it free passage. In contrast areas of caries absorb and scatter light thus appear as dark shadow. This method is mainly used to determine proximal caries as well as cracks.

- **Advantages:**

1. Lesions which cannot be diagnosed radiographically can be diagnosed.
2. No radiation hazard.
3. Comfortable to the patient.



- **Disadvantages:**

1. FOTI is not possible in all locations of carious lesions.
2. Cannot detect small lesions.

DEXIS CariVu is a brilliant new approach to caries detection combining FOTI with a digital camera which allow immediate imaging and detection of early lesions and can be used on proximal and occlusal lesions.

- **Contraindication**

- Large fillings
- Crown
- Subgingival caries
- Calculus or discoloration can lead to light scattering can be shown like a shade.

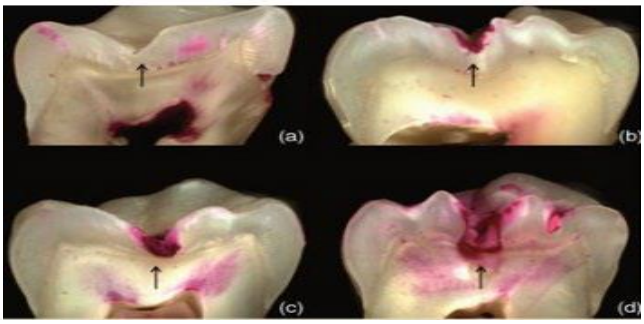


Caries detector dyes

Various dyes such as silver nitrate, methyl red have been used to detect carious sites by change of color.

These dyes aid the dentist in differentiation of infected dentin. These dyes enhance the visual recognition of caries by selectively staining the infected demineralized dentin which should be removed during preparation leaving the inner affected dentine (demineralized but not infected) that should be kept and not removed because it could be remineralized.





❖ Caries activity

Caries lesion can be active or inactive (arrested) lesions. Clinical criteria used to assess the activity of a specific caries lesions in enamel or root are **as follow:**

1- Appearance: color and luster
2- Texture: roughness and hardness (soft, leathery, firm and hard).
3- Translucency (opaque vs Semitransparent).
4- Presence of plaque (covered by plaque versus plaque free)
5- Cavitation (probing the cavity in enamel reveal either hard or soft base).

Active lesions can be arrested at any stage of its development, if plaque free condition is maintained. If the lesion is arrested, no treatment is required except for esthetic or functional reasons. If the lesion is active, treatment is needed to arrest lesion progression and must include preventive measures. It may also include restorative dentistry. Table 1 shows the clinical appearance of active and arrested caries lesions according to the type or site of the lesion.

Table 1: The clinical appearance of active and arrested caries lesions according to type or site of the lesion

Type of lesion	Active	Arrested
Occlusal lesion	- Matte or Frosted surface, plaque covered white spot lesion. - Cavitated lesion; include micro cavities to cavities involving dentine which is visible on bitewing radiograph.	- White or brown spot lesion with shiny surface.
proximal	-Lesion appears on radiograph -Lesion appears on radiograph with persistent gingival inflammation despite patient attempt to remove plaque by flossing. -Lesion not presents at previous examination	- Successive, reproducible bitewing radiograph shows no lesion progression deeper.
Smooth surface	- White spot lesion close to gingival margin that may have frosted, plaque covered surface - Cavitated, plaque covered lesion with or without exposed dentine, if dentine is exposed & soft, then the dentine is heavily infected with bacteria.	- Shiny white or brown lesion & lesions are not plaque covered. - Cavitated lesion; dark brown with hard dentine at their base, are not plaque covered & away from gingival margin.
Root surface lesion	- Lesion close to gingival margin, plaque covered. - Dentin is soft or leathery in consistency	- Lesion far from gingival margin, not plaque covered. - As hard as surrounding healthy root surface.

❖ Caries Prevention

Caries preventive treatment is a complex process involving multiple interrelated factors because of the nature of caries disease which is a multifactorial disease. ***Self-applied preventive measures*** (by patients) such as maintaining of good oral hygiene "brushing and flossing", diet containing sucrose and carbohydrate control, and fluoride toothpastes; all these measures can affect carious lesion initiation (prevention) and also remineralization of the incipient carious lesion specially in smooth surfaces to arrest the carious lesions. If the lesion is arrested, it requires no restorative treatment.
Professionally applied measures (by dentist) such as pit and fissure sealant and fluoride varnish. Fluoride varnishes applied on the surface of the tooth to form calcium fluoride globule deposit because they contain a high level of fluoride (5% NaF, 22,600 ppm F), this deposit can slowly release fluoride and calcium over time to make tooth surface more resistible for acid demineralization. Pit and fissure sealant is the most effective method in preventing pit and fissure caries because they prevent caries by preventing the growth of bacteria that promote decay in pits and fissures in teeth.

❖ Caries treatment

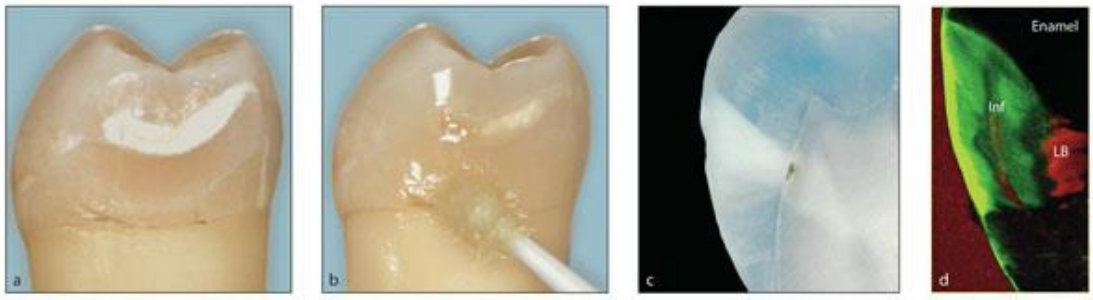
1- Treatment of noncavitated lesions
Non cavitated lesions on occlusal and proximal surfaces of the tooth can be treated by self-preventive measure in addition to the application of occlusal and proximal sealants.

When active fissure caries has been diagnosed or if a high risk has been established, sealants may be indicated. Sealants have advantages of preventing progression of active dentin lesions (there is ample evidence that caries lesions do not progress as long as the fissure remains sealed), no cutting of tooth structure needed thus preventing irreversible intervention and its use prevent development of new lesions on other sites of the fissure.

On proximal surfaces, Active caries lesions have been treated by application of either adhesives or fissure sealants after temporary tooth separation, However, proximal sealing techniques are as complex to apply and time-consuming as proximal restorations.

A new approach to treat active non-cavitated non-proximal and proximal smooth surface lesions that extend radiographically into inner half of enamel or the outer third of dentin by ***lesion infiltration technique (e.g. ICON caries infiltrant) .*** In this technique, a protective low viscosity light curing resin applied on the lesion to occlude the lesion pores and create a diffusion barrier to reduce progression

of lesion by changing the cariogenic environment of the lesion and stabilize the fragile structure of the lesion.



2- Treatment of cavitated lesions

Once caries has produced cavitation of the tooth surface (i.e., the lesion is active and there is a dentin involvement), preventive measures are usually inadequate to prevent further progression of caries, because plaque stagnate in non-cleansable cavities and enhance lesion progression, therefore cavity preparation and restoration are needed. However, the most important reason for placing a restoration is to aid plaque control and attempt should be made to select the most conservative treatment option to prevent iatrogenic damage during cavity preparation such as damage of proximal surfaces of adjacent teeth. Indications of restorative treatment are: sensitivity of the cavitated tooth to hot, cold and sweetness, non-cleansable deep occlusal and proximal caries lesion extending into dentin, lesion endangering the pulp, disability of patient to provide home care, loss of proximal contact, unesthetic appearance of the tooth. Once the pulp is dead partially or completely; root canal filling become necessary to avoid tooth extraction.

➢ *New Technologies for Caries Removal and Cavity Preparation (Minimal Invasive cavity preparation)*

1. Air abrasion: air abrasion removes tooth structure (enamel and dentin) using a steam of aluminum oxide particles generated from compressed air. The abrasive particles strike the tooth with high-velocity and remove small amount of tooth structure.

- **Clinical application of air abrasion includes:**

- Detection of pit and fissure caries.
- Removal of superficial enamel defects.
- Cleaning fissures and surface preparation for sealant preventive resin restoration.
- Small class I and V preparation.

- **Advantages:**

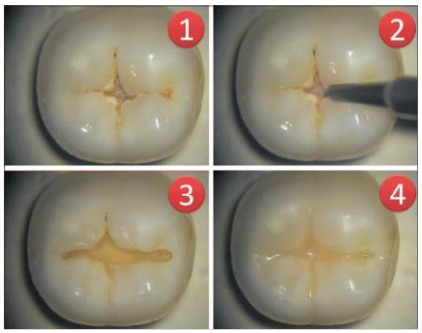
1- No heat, pressure, vibration and sound

2-Reduce need for anesthesia
3-Minimal cutting of tooth structure
4-Dry operative field
5-Reduce risk of micro-crack and chipping of tooth structure

- **Disadvantages:**

1-Air jet can cause sensitivity
2-Not recommended for deep cavities
3-Only composite resin can be used after air abrasion cavity preparation.
4-Lack of tactile sensation
5-Impair indirect vision
6-Cause damage to dental mirror





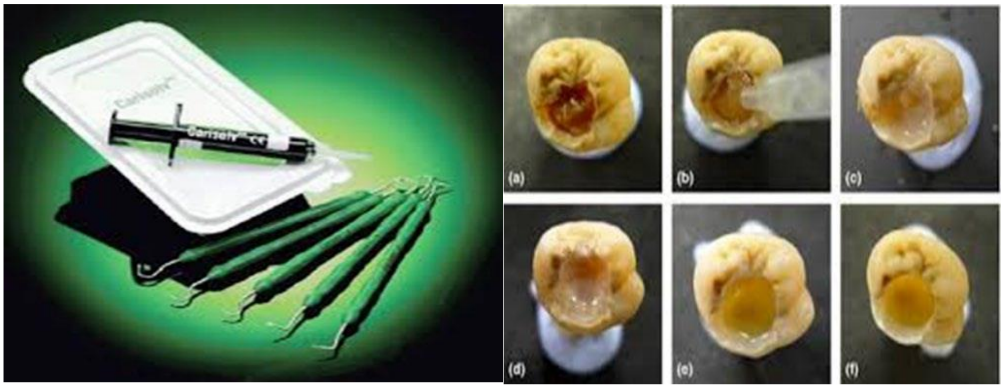
2. Chemo mechanical method: this method involves the application of an isotonic solution on tooth tissue, softening the caries and facilitating its removal using specially design hand instrument. This reduces the removal of sound tooth structure, the cutting of open dentinal tubules, pulpal irritation and pain compared with conventional rotary method using burs. Examples: Carisolv.

- **Advantage:**

1- Reduce the need for L.A (reduce cost and anxiety).
2- Conservation of tooth structure (no cavity over preparation).
3- Reduce risk of pulp exposure
4- No noise, vibration and heat
5- The most important advantage is the selective removal of caries infected dentin and leaving the caries affected dentin.

- **Disadvantage:**

1- Time consuming
2- Still need for hand instrument
3- Expensive
4- only can be used with composite resins (no amalgam restorations).
5- limited shelf life



3. Laser devices: Lasers are used to remove decay within a tooth and prepare the surrounding enamel for receipt of the filling. It based on the ablation mechanism in which hard dental tissue is removed by phoptovaporization of water within the tooth which create high pressure act in destroy and remove selective area of the tooth. direct water steam is important to reduce heat buildup.

- **Advantages**

1- Comfortable and eliminate need for L.A
2- No vibration or noise
3- Conservation of sound tooth structure
4- Increase surface area available for bonding of composite restorations
5- Ideal for children and adult
e.g. Er:YAG laser device, and laser-powered hydrokinetic system (LPHKS).



4. Smart bur (Smartprep)

The Smartprep bur is a polymer that safely and effectively remove decayed dentin, leaving healthy dentin intact.

The polymer instrument is self-limiting and will not cut sound dentin unless applied with great force, and then it will only wear away, rather than cut the healthy dentin. The self-limiting polymer is unlikely to mechanically expose dentinal tubules and unlikely to cause patient discomfort. In many cases, no local anesthesia is required for patient comfort. It is used with low speed handpiece, single patient use.

- **Advantage:**

1.Less chance for iatrogenic pulp exposure
2.Minimal removal of sound tooth structure

- **Disadvantage:**

1. According to studies, it has been concluded that this technique leaves large amount of decayed portion unexcavated.
2. Expensive
3. Chance of damage if the bur touches enamel or sound dentin during or after preparation



5. Ozone treatment

The ozone delivery system is a device that takes in air and produces ozone gas. The ozone is then delivered via a hose into a disposable sterile cup. The ozone gas is refreshed in this disposable cup at a rate of 615 cc/minute changing the volume of gas inside the cup over 300 times every second. The cup forms a seal around the lesion being treated so that ozone cannot leak into the oral cavity.
Around 20-40 seconds of ozone application have been shown to penetrate through carious dentin to eliminate any live bacteria, fungi, and viral contamination. This treatment eliminates cariogenic organisms as well as priming the tissues for remineralization.

- **Advantage**:

1- Non-invasive, painless method
2- do not cause allergy
3- microorganisms do not develop resistance to ozone
4- decrease treatment time (20-120 sec per lesion)
5- the studies shows that 75-100% of ozone treated lesions become harder during l year period

