ALAYEN IRAQI
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COLLAGE OF DENTISTRY

الفرع العلمي: فرع POP

المادة: Prevention

المحاضرة: Diagnosis of dental caries

رقم المحاضرة: 3

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Diagnosis of dental caries

Diagnosis is identifying a disease from its signs and symptoms. Diagnosis is a decision process that rests with the clinician and is informed by, initially, detection of a lesion and should be followed by an assessment of the patient's caries risk, which may include the number of new caries lesions, past caries experience, diet, presence or absence of favorable or unfavorable modifying factors and qualitative aspects of the disease such as color and anatomical location. The problem of diagnosis is related to sensitivity versus specificity.

Sensitivity: It is the probability of a positive finding when disease is present. Specificity: It is the probability of a negative finding when disease is absent.

Detection systems of caries

These detection systems are aimed at augmenting the diagnostic process by facilitating either earlier detection of the disease or enabling it to be quantified in an objective manner. All diagnostic methods have inherent errors and it is just not possible to separate disease from no disease and active from arrested lesions. A useful visual description of the benefits of early caries detection was provided by using the metaphor of an iceberg as shown in figure, it can be seen that traditional methods of caries detection result in a vast quantity of undetected lesions. There isa clinical argument about the significance of these lesions; it was believed that only a small percentage will progress to more severe disease, however, it is undisputed fact that all cavitated lesions with extension in pulp began their natural history as an early lesion.

- Visual and tactile examinations
- Radiographic techniques
- Electrical current measurement (electronic resistant method)
- Fiber Optic Transillumination (FOTI and DiFOTI) (Enhanced visual techniques)
- Fluorescent techniques
- Other techniques like Dyes, Ultrasound techniques, Photo-thermal Radiometry.

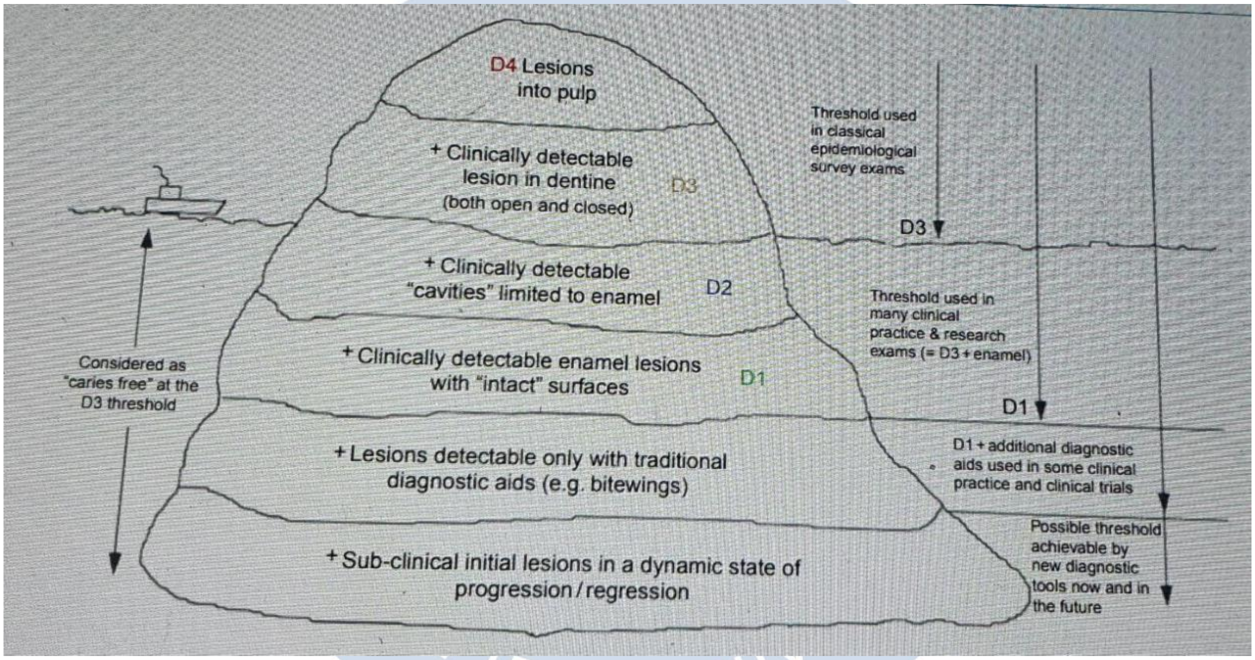

Figure shown the" iceberg" of caries and the influence of detection system.

Visual and tactile examinations

The vast majority of carious lesions are detected by dentists using visual methods. The International Caries Detection and Assessment System (ICDAS) is one that advocates a careful and thorough assessment of the dentition following cleaning and drying; it can prove to be a useful and reliable system in detecting early lesions. Visual inspection, the most widespread caries detection system, is subjective.

Assessment of features such as color and texture are qualitative in nature. These assessments provide some information on the severity of the disease.

They are also limited in their detection threshold, and their ability to detect early, noncavitated lesions restricted to enamel is poor. Carious lesions come in various sizes, surface features and colors. The use of accompanying tactile examination is not recommended because rigorous probing of lesions can lead to cavitation and deep bacterial invasion. The use of a blunt probe, ideally a periodontal probe, can be used to detect differences in surface roughness. Detection of initial caries by sharp probe may lead to cavity formation which reducing the chance of remineralization of intact surfaces. Tactile examination using explorers allows for detection of roughness, soft floors, frank cavitation, white spot lesion as non cavitated. Good dryness is recommended while detection of initial lesion. A clinical caries examination performed according to these principles takes about 5– 10 min, depending on the caries status of the patient. Caries on proximal contact area is difficult to be examined by inspection and probing. Dental floss can be used as a convenient method. The floss will be torn if caries is present. Examination with floss can be misled by dental calculus. Different types of separators can be used as orthodontic rubber rings for several days as diagnostic aids. The effectiveness of a visual–tactile caries examination depends strongly on the caries diagnostic level used. When non-cavitated diagnoses are included in the classification, the diagnostic yield of the visual–tactile caries examination is greater than that of radiographic examination. Visual and tactile examinations are quick and easy to perform as well as does not need expensive equipment.

Radiographic techniques

Radiographic examination (traditional and digital) can be helpful in locating proximal caries and undermining caries and secondary caries. It can also be used to assess the proximity of caries to pulp chamber. It is non-invasive technique in caries diagnosis. Periapical and bite-wing radiographs are commonly used for clinical assessment of caries. Using bite-wing radiographs raise the sensitivity of the diagnosis if obvious dentin caries activity to be detected but can be inaccurate if diagnosing enamel occlusal caries activity. Radiolucency on hard tissue due to demineralization is identified as carious lesion. Digital radiography has offered the potential to increase the diagnostic yield of dental radiographs, it also offers a decrease in radiographic dose and thus offer additional benefits than diagnostic yield. Digital images can also be archived and replicated with ease. Using digital radiographs offers a number of opportunities for image enhancement, processing, and manipulation. One of the most promising technologies in this regard is that of radiographic subtraction, which has been extensively evaluated for both the detection of caries and also the assessment of bone loss in periodontal studies. Miss diagnosis by radiograph can occur as a result of superimposition, angulation of cone, difficulty of film position.

The degree of caries risk should be reassessed individually by considering the number of new lesions, and progression of existing lesions, as well as other relevant risk factors. The interval to the next bitewing examination is adjusted accordingly. Intervals shorter than 1 year are seldom indicated. A 6-month interval is, however, advocated if several approximal dentin lesions are left unrestored.

Electrical current measurement

Every material possesses its own electrical signature. For example, when a current is passed through the substance the properties of the material dictate the degree to which that current is conducted. Conditions in which the material is stored or physical changes to the structure of the material will have an effect on this conductance. Caries can be described as a process resulting in an increase in porosity of the tissue, enamel or dentine. This increased porosity results in a higher fluid content than sound tissue, and this difference can be detected by electrical measurement by decreased electrical resistance or impedance. The Electronic Caries Monitor (ECM) device employs a single, fixed-frequency alternating current, which attempts to measure the „bulk resistance" of tooth tissue. A number of physical factors also will affect ECM include the temperature of the tooth, the thickness of the tissue, the hydration of the material, and the surface area. A major advantage of ECM is to present objective readings which have the potential for monitoring lesion progression, arrest, or remineralization. A further application of electronic monitoring of caries is that of Electrical Impedance Spectroscopy (EIS). Unlike ECM which uses a fixed frequency (23 Hz), EIS scans a range of electrical frequencies and provides information on capacitance and impendence among others. This process provides the potential for more detailed analysis of the structure of the tooth to be developed, including the presence and extent of caries

Fiber Optic Transillumination (FOTI and DiFOTI)

The basis of visual inspection of caries is based upon the phenomenon of light scattering. Sound enamel is comprised of modified hydroxyapatite crystals that are densely packed, producing an almost transparent structure. The color of teeth, for example, is strongly influenced by the underlying dentin shade. When enamel is disrupted, for example in the presence of demineralization, the penetrating photons of light are scattered (that is, they change direction, although do not lose energy), which results in an optical disruption. In normal, visible light, this appears as a 'whiter' area called white spot. This appearance is enhanced if the lesion is dried; the water is removed from the porous lesion. Water has a similar refractive index (RI) to enamel, but when it is removed and replaced by air, which has a much lower RI than enamel, the lesion is shown more clearly.

This demonstrates the importance of ensuring the clinical caries examinations are undertaken on clean, dry teeth. Fiber-optic transillumination (FOTI) is a diagnostic method by which visible light is transmitted through the tooth from an intense light source, for example from a fine probe with an exit diameter of 0.3–0.5 mm. If the transmitted light reveals a shadow when the tooth is observed from the occlusal surface this may be associated with the presence of a carious lesion. The narrow beam of light is of crucial importance when the technique is used in the premolar and molar region. For optimal performance the probe should be brought in from the buccal or lingual aspect at an angle of about 45 degrees to the approximal surfaces pointing apically, while looking for dark shadows in the enamel or dentin. Shadows are best noticed when the office light is switched off. Although transillumination is a simple, fast and cheap supplementary method well known to most practitioners for diagnosing approximal caries in the anterior teeth, the fiber- optic method has never become broadly accepted for detection of lesions in approximal surfaces in the premolar and molar regions. The sensitivity has been shown to vary between 50 and 85%, with higher values for dentin lesions than for enamel lesions. Although the specificity of the method has also been reported to be high, over 95%, it remains to be documented that FOTI adds substantially to the clinical caries examination for detecting lesions. FOTI is used to detect lesion in anterior area, it is adjuvant to visual and radiographic examination but its limitation as failure sometimes in the detection of very small lesions.

Digital Imaging Fiber Optic Transillumination (DIFOTI) is used for detection of both incipient and frank caries in all tooth surfaces, fractures, cracks and secondary caries around restoration. This is a digitized and computed version of the FOTI. DIFOTI uses white light to transilluminate each tooth and to instantly create high-resolution digital images of the tooth. It is based on the principle that carious tooth tissue scatters and absorbs more light than surrounding healthy tissue. Decay near the imaged surface appears as a darker area against the more translucent brighter background of surrounding healthy anatomy.

Fluorescent techniques

Quantitative Light-induced Fluorescence Technique (QLF)

QLF is light emission phenomenon of biological structure. The autofluorescence of dental tissue decreases in demineralization of the tissue. Quantitative light induced fluorescence devices use high-intensity halogen lamp (blue light 488 nm) to stimulate the tooth to emit the fluorescence in green spectrum. This reflected light is detected by spectrum and recorded in computer and demineralization is quantified. QLF is a visible light system that offers the opportunity to detect early caries and then longitudinally monitor its progression or regression. It may also be able to image plaque, calculus and determine if a lesion is active or not and predict the likely progression of any given lesion. Fluorescence is a phenomenon by which an object is excited by a particular wavelength of light and the fluorescent (reflected).

QLF has inability to detect or monitor interproximal lesions and is limited to measurement of enamel lesions several hundred micrometers depth.

Laser fluorescence - DIAGNODent

It is another device employing fluorescence to detect the presence of caries. Using a small laser, the system produces an excitation wavelength of 655 nm, which produces a red light. This is carried to one of two intra-oral tips: one designed for pits and fissures, and the other for smooth surfaces. The tips both emits the excitation light and collects the resultant fluorescence.

The device doesn't produce an image of the tooth, it displays a numerical value. The device is aimed in detection of occlusal and smooth surface lesions. The threshold between occlusal caries limited to enamel and caries into dentin was found to be around 18 under humid conditions. Clinically visible white spot lesions are measurable with this device. However, very initial lesions, with no fluorophores from bacteria present, are not captured by the DIAGNOdent. The same registration under dry conditions led to higher cut-off point. The intensity of the fluorescent light is displayed as a number ranging from 0 to 99, with 0 indicating a minimum and 99 a maximum of fluorescent light.

A new version of the method was designed named DIAGNODent pen permits assessment of both occlusal and proximal surfaces. The device works on the principles of the old version but the design is different. After excitation, the tip collects the fluorescence and translates it into a numerical scale from 0-99.

For both DIAGNOdent devices, careful tilting on occlusal surfaces around the spot to be measured is crucial for adequate detection.

Photo-thermal Radiometry (PTR)

PTR is based on the use of combined levels of luminescence and heat released by a tooth that has been excited by a laser. The system is based on the theory that demineralized areas of the tooth will respond to this excitation in different ways than to “sound” areas, and therefore a map of demineralization can be established. A particular benefit of this technology is that the manufacturers claim that the use of pulsed lasers will enable a depth profile of a lesion to be determined.

Ultrasound techniques

The principle behind the technique is that sound waves can pass through gases, liquids, and solids and through the boundaries between them. Images of tissues can be acquired by collecting the reflected sound waves. In order for sound waves to reach the tooth, they must pass first through a coupling mechanism.