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Diagnosis of dental caries

Tooth caries is chronic, progressive, and bacterial diseases. The main characters of tooth caries are the changes in color, shape, and quality of tooth hard tissue. The typical pathological changes have important reference value for caries diagnosis. At present, the methods for dental caries diagnosis are mainly based on clinical inspection and X-ray examination. However, it is difficult to identify early caries which is in the hidden area of the tooth. Prevention is at its most effective when detection is early within the natural history of the dental caries. The failure to detect early caries, leaving those detectable only at the deep enamel, or cavitated stage, has resulted in poor results and outcomes for remineralization therapies. Therefore, the ability to monitor early lesions and determine if they have indeed arrested or stabilized is also key to ensuring that effective prevention can become commonplace in general dentistry.

Diagnosis is a decision process 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 and past caries lesions, diet, presence or absence of modifying factors (salivary flow, mutans streptococci counts, oral hygiene), and qualitative aspects of the disease such as color and anatomical location. These detection systems are therefore aimed at augmenting the diagnostic process by facilitating either earlier detection of the disease or enabling it to be quantified in an objective manner. The problem of diagnosis is related to sensitivity versus specificity.

Detection systems of caries

- 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 (PTR).

Visual and tactile examinations

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. The vast majority of carious lesions are detected by dentists using visual methods. 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. 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.

Benefits of visual and tactile examinations

- Is quick and easy to perform.
- 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.

Electrical current measurement

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.

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 takes advantage of these optical properties of enamel and enhances them by using a high intensity light that is presented through a small aperture in the form of a dental handpiece. Light is shone through the tooth, and the scattering effect can be seen as shadows in enamel and dentine, with the device's strength the ability to help discriminate between early enamel and early dentine lesions. Generally, the decayed area shows dark shadow. 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.

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.