Update in Caries Diagnosis

Jenny Smits, AAS, RDH
University of Michigan E-Learning Program
482 Oral Diseases: Prevention & Management

University of Michigan Dental Desktop Support
12/16/2009
Introduction

Dental caries, a chronic communicable disease, is experienced by more than 90% of all adults in the United States. In recent years, reduction in caries rates have been noted – in fact 20% of the population has 60% of the total caries diagnoses, making some people more susceptible to the development of caries than others. Specifically, those who are minorities, homeless, migrants, children with disabilities, and those of lower socioeconomic status all have a higher prevalence of caries diagnosis. The occlusal fissures have shown to be the most prone tooth surface for the development of carious lesions, especially in children and adolescents. With such a high percentage of people being affected by caries and a high percentage of them being located on the occlusal surfaces, a surface easily accessed by dental professionals with visual and tactile examination, an update in caries diagnosis has been researched and developed to decrease these issues.

Another concern with current caries detection and diagnosis is the variation seen among dentists for such diagnosis. With litigations seen more often these years than ever before, it is important that dentists’ diagnoses can have reproducibility among other dentists, along with similar decision-making preventive and reparative therapy recommendations that are given to patients. Through an update in caries diagnosis, specifically with development of modern tools, these aids can assist in decreasing the variations currently seen among practicing dental professionals.

Etiology

The direct cause of the development of caries is multifactorial, with the inclusion of factors such as saliva, bacteria, sugar, fluoride levels, and past dental and medical histories all playing a role. The demineralization process, which may or may not result in caries, occurs as bacteria in the oral cavity (present in dental plaque) metabolizes sugar and produces acid. When exposed to this acid for prolonged amounts of time, hard, yet permeable, tooth structures begin to demineralize as calcium and
phosphate are taken from the tooth structure resulting in white spot lesions.\textsuperscript{2} Unless the white spot lesion becomes cavitated, remineralization of the tooth structures can occur by reversing this process.\textsuperscript{2} Increasing fluoride levels can assist in the reversal of this process by returning calcium and phosphate to the tooth structure; saliva can also reverse this process by buffering the acidic levels in the oral cavity.\textsuperscript{2} This process of demineralization and remineralization is episodic unless the demineralized area becomes cavitated, in which case restorative therapy is needed.

While the oral cavity is composed of hundreds of different microbiota, specific strains of bacteria have been linked to the development of carious lesions. While early lesions present with \textit{Streptococcus mutans}, later stages of carious lesions are associated with strains of lactobacilli, a bacterial species that is able to produce lactic acid and tolerate the acidic living environments.\textsuperscript{2,7} More recently, \textit{Candida albicans} have been associated with caries development in children and young adults as they are able to: tolerate acidic levels, adhere to saliva-coated hydroxyapatite, and adhere to collagen.\textsuperscript{7} Introduction of these bacterial strains, along with other odontopathogens, may be transferred to infants at an early age of only 6 months from salivary exchange with their mothers.\textsuperscript{2} This exemplifies the fact that caries is an infectious, communicable disease.

**Patient Assessment**

Early diagnosis of caries gives dental professionals the opportunity for effective dental care.\textsuperscript{8} Not only is early detection important, but obtaining an accurate and correct diagnosis is equally as critical. Effective techniques and tools are necessary in order to apply suitable preventative methods or restorative procedures.\textsuperscript{5} Features that are important for each method should include effectiveness, validity, and reproducibility.\textsuperscript{5} There are numerous detection methods available, from conventional to modern tools.
Conventional methods include the traditional visual and tactile detection of caries as well as the use of dental radiographs. The use of explorer instruments is a method of visual and tactile detection of dental decay which relies on the “catch” of the explorer tip in order to discover occlusal caries. Disadvantages of this conventional method include the transfer of cariogenic microorganisms from one tooth to another via the explorer tip and potentially damaging the integrity of the enamel surface on the tooth due to the use of operator pressure. This tactile attempt of diagnosis can actually encourage conditions for dental caries to develop. Additionally, questions of legitimacy arise with use of conventional tactile methods that criticize variations of pit and fissure morphology from patient to patient, the sharpness of the explorer tip, and variations in the amount of pressure exerted by the clinician. Visual and tactile methods of detection are not the only conventional techniques used in dentistry today. Diagnostic adjuncts can be utilized and should be highly specific and sensitive, both of with the visual examination cannot demonstrate alone.

Radiographs remain popular conventional tools for the detection of proximal carious lesions. However, there is a disadvantage of this technique as well. Dental radiographs cannot detect white spot lesions on the enamel surface. There needs to be approximately 30-40% of mineral loss on the tooth surface before the incipient lesion is even visible to the clinician radiographically. Various deficiencies with these conventional techniques make it difficult for the dental professional to diagnose early enamel lesions and occlusal caries. When our goal as dental professionals is early diagnosis of carious lesions, these conventional techniques may need the use of adjunct tools for proper detection.

Patient assessment should also include, along with visual, tactile and radiographic examination, a thorough clinical examination identifying whether or not any cavitations and/or white spot lesions are present, salivary flow, past dental history and plaque accumulations. While talking with the patient, the clinician should also assess their exposure to fluoride, dietary habits and daily home care practices.
All of these factors can adversely result in demineralization of the tooth structures. By gathering this information from the patient and through clinical examination, the dental hygienist is better able to provide patient-centered care with therapeutic recommendations and specific education geared towards the patient’s needs. Education on proper home care techniques, sugary and acidic dietary habits, sources of fluoride are all topics that should be discussed with the patient. If, through this assessment, the patient appears to be at a moderate to high-risk for developing caries, clinical adjuncts should be utilized in order to monitor the patient’s tooth structures with proper documentation for clinician’s to follow through the coming months.

**Intervention/Management**

The field of dentistry exhibits the necessity for new diagnostic tools to help improve patient care.\(^3\) There are numerous methods of caries detection that have become available within the past years. Although some skepticism still lingers, scientific advances in caries diagnosis have led to improvements in prevention and treatment.\(^3\) A modern technique doesn’t necessarily mean latest technology. Modern tools of caries diagnosis involve accepted adjuncts in contemporary dental research and practice on the foundation of evidence from research.\(^10\) First we will begin by discussing one of the most prevalent and talked about adjunct, laser fluorescence.

Laser fluorescence (commonly known as the instrument DIAGNOdent or Laser fluorescence pen [LFpen]) is a laser (light) based instrument that was made to aid in the detection and quantification of carious lesions on smooth and occlusal tooth surfaces.\(^9\) This adjunct consists of two different probes available for use. Probe A is used for occlusal decay detection and probe B is used for smooth surface caries detection.\(^10\) A light travels through an optic fiber to a handheld probe with a fiber optic eye that can be used as a bevel on the tooth surface.\(^5\) Prior to reading areas of interest, the clinician must first use the probe on a non carious lesion to provide a baseline measurement.\(^4\) The operator then positions
the probe on the tooth surface, rotates around its vertical access to ensure that the tip of the laser has
picked up fluorescence from all slopes of the fissure/surface walls, and read the highest value.\(^4\) When a
carious lesion is present, a red fluorescent light is significantly higher in reading as opposed to a sound
structure reading.\(^4\) Determining whether or not caries are present on a tooth surface is determined
using cut off points given from Lussi, et al.\(^4\) A higher reading means that a carious lesion is more wide
spread as opposed to a smaller reading, where decay is not as wide spread. The suggested cut off points
lie on a scale that is useful in the diagnosis of carious lesions. Readings between 0-20 does not
necessitate active care or preventative measures. Higher numbers such as 21-29, Lussi et al
recommends preventive or operative care to help restore the tooth. Finally, for a reading of 30 and
above, operative care is advised.\(^4\)

An in vitro study was performed by the Department of Pedodontics Preventive Dentistry in
collaboration with the Department of Oral Pathology on the effectiveness of the DIAGNOdent. This
study took place at Manipal College of Dentistry, Manipal.\(^9\) Their results shown that even though this
adjunct device had exceptional specificity and sensitivity, in some of their cases teeth were over scored.\(^9\)
Additionally, another study performed by the Department of Restorative Dentistry in Germany as well as
the Department of Preventive, Restorative, and Pediatric Dentistry in Switzerland had found false
negatives with laser fluorescence.\(^5\) In this case, some occlusal caries were hidden into the dentin, with
the surface of the tooth macroscopically intact.\(^5\) Therefore, even though laser devices have
demonstrated applaudable results, this technology should be used in conjunction with visual inspection
(i.e. radiographs, tissue examination, etc) to avoid false positive readings.\(^4\)

Another modern adjunct that uses light waves is the optical coherence tomography (OCT)
imaging technology. OCT provides high resolution morphologic images of depth on the tooth structure.\(^8\)
Sound enamel will cause scattering of the light at the tooth surface with high intensity as opposed to a
cavitated lesion, in which the scattering will decrease depending on the caries’ depth.\(^8\) However,
diverging from this scattering concept are incipient or white spot lesions. These areas of early decay will produce a higher light back-scattering at the tooth surface which indicates porosity caused by the demineralization.\textsuperscript{8, 11} One disadvantage of this method is that this tool cannot be used on structures previously restored or that present with staining due to inaccurate readings.\textsuperscript{11} OCT adjuncts are only capable of penetrating 2-4mm below the surface of the tooth, therefore are only applicable to near-surface lesions.\textsuperscript{8} Although developments of OCT prototype hand pieces have shown clinical relevance in the detection of carious lesions, no in vivo studies have been reported; therefore, further studies are needed before becoming a sole diagnostic technique.\textsuperscript{11}

Ultrasound caries detectors (UCD) utilize sound waves, which are longitudinal or pressure waves, which have the capability to travel through solids, liquids, and gases. The UCD’s use these waves to identify carious lesions based on the sonic conductivity comparing sound and echoes of cavitated enamel.\textsuperscript{12} Changes in sonic conductivity suggest a difference between healthy, sound enamel and an area of demineralization.\textsuperscript{12} Novadent is an example of an UCD tool. This tool includes a system that includes an ultrasonic pulser-receiver controlled by a personal computer, with a handheld probe attached to apply to the tooth in question.\textsuperscript{12} The screen will reveal the acoustic reflection of the surfaces and reveal whether or not the area is cavited.\textsuperscript{12} This is a quick and easy tool to use in the dental setting, however further studies are needed to evaluate this tools reciprocity and accuracy.\textsuperscript{11}

Another modern technique that is still under heavy research and development is the multi-photon imaging technique. This technique utilized a probe that emits infrared photons (beam) directly on the tooth surface.\textsuperscript{11} An image will display on a screen that will show sound tooth structure, which fluoresces strongly, and areas weakened by carious lesions which will fluoresce to a lesser extent.\textsuperscript{11} Therefore, the image provided will display a cavitated lesion in a darker form compared to a brightly fluorescing tooth.\textsuperscript{11} Currently, however, this technique has only been performed on extracted teeth and needs further development of equipment to be efficient in the private practice setting.\textsuperscript{11}
Prevention

Although many caries diagnosis technologies, as well as conventional methods, can be useful for caries detection, prevention should always be the first choice. Community water fluoridation decreases the incidence and prevalence of dental caries when patients consume drinking water.\(^8\) This method is accepted by over 90 professional health organizations both at the national and international levels.\(^8\)

Additionally, sealants are another option for prevention of caries. Sealants are tooth-colored plastics that prevent bacteria and food accumulation in the pits and fissures of the molar and pre-molar surfaces, therefore preventing dental decay.\(^3\) Finally, assessing the patients risk according to amount of plaque buildup, dietary habits, fluoride exposure, and salivary flow will allow the clinician to educate risk levels and modes of prevention such as proper home care, etc.\(^3\)

Conclusion

As G.V. Black said, “The day is surely coming...in which we will be practicing preventive dentistry, rather than reparative dentistry.”\(^13\) To assist in shifting the focus towards preventative therapy, early recognition of demineralized tooth structures is necessary to arrest the demineralization process sooner and provide therapies to increase remineralization. With the development of multiple clinical adjuncts, which should be used in conjunction with radiographs and clinical exams, detecting early enamel changes has been made easier and has provided a more standardized caries diagnosis across varying dentists. Although many of the described adjuncts to cavity detection showed promising results, more studies are needed to show acceptable sensitivity and specificity.\(^4\) Therefore, it is advisable for dental professionals to use caution with these tools and implement conventional methods such as visual, radiographical, and tactile inspection as well for caries detection.
References: