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Original Research

Diagnosis and Prevention Strategies for Dental Caries

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ABSTRACT:
Dental caries is one of the oldest and most common diseases found in humans. With the recent shift from the surgical model, which emphasized restorative treatment, to a medical model of disease management, newer strategies emphasize disease prevention and conservation of tooth structure. For early detection and monitoring of caries, rather than waiting until a cavity is formed and restorative treatment is needed, devices such as DIAGNOdent, Digital Imaging Fiber-Optic Transillumination, quantitative light-induced fluorescence, and the Electronic Caries Monitor have been introduced. For caries prevention, oral hygiene measures, fluoride application, pit-and-fissure sealants, the use of xylitol, the development of a dental caries vaccine, and the role of the primary caregiver for infants are briefly discussed.
Key Words: Dental caries, Prevention, Diagnosis, Detection, Risk assessment

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INTRODUCTION

Dental caries is one of the oldest and most common diseases found in humans. While there have been continuous efforts to reduce its prevalence, it is still widespread, especially in lower socio-economic classes [1]. Traditional caries management strategies adopted a surgical model of treatment: after removing the decay, a more geometrically perfect cavity is created and filled with the most compatible and artificial material. This surgical model eventually created bigger and bigger cavities as secondary dental caries progressed even after restorative treatment, subsequently requiring re-treatment, until eventually the tooth was lost. With the shift from the surgical model to a medical model of disease management, the newer strategies emphasize disease prevention and conservation of tooth structure. This review briefly discusses the etiology of and current detection and prevention methods for dental caries.

ETIOLOGY

Dental caries is a multifactorial disease caused by host, agent, and environmental factors. Mutans streptococci (MS) is the primary etiologic agent of dental caries. Through adhesion, MS attaches to the dental pellicle and breaks down sugars for energy to produce lactic acid, causing an acidic environment around the tooth. As a result, demineralization of the enamel and, subsequently, the dentin occurs [2]. Factors involved in the dental caries process include the tooth, bacteria in the form of a dental plaque, and a diet containing sugar. The quantity, quality, and frequency of sugar intake have a definitive influence on the incidence and prevalence of caries. Four main factors are associated with dental caries etiology. These factors are bacteria, time, susceptible tooth surface, and fermentable carbohydrates [25, 26]. Along with these factors, there are certain behavioral and sociodemographic factors that are likely to increase the risk of caries. These include poor oral hygiene, age, improper tooth brushing habits, plaque, and sugar-containing drinks [27].

The oral cavity of human is considered as a complex ecosystem which has both acid-producing and acid-tolerant bacteria. Almost 700 different bacterial species have been known for human oral cavity [28, 29, 30], and nearly 200–300 species have been identified for dental plaque [31] using different culture-dependent and culture-independent techniques. S. mutans is considered as the main organism responsible for human dental caries. Certain factors like ability to form biofilms, tolerance of frequent and rapid environmental fluctuations, and metabolizing carbohydrates are considered to be responsible for the virulence of these bacteria [32,

33]. In addition, the mutans is also associated with bacterial endocarditis, inflammation of heart valves. Synthesis of the extracellular polysaccharides by S. mutans from sucrose through glucosyltransferases (GTFs) is considered another important virulence factor that causes caries in humans [34]. This not only facilitates the adhesion and accumulation of the organism on the tooth surface but also provides protection against host immune defenses along with provision of increased resistance against antibiotics and gene expression [35]. This combination of virulence properties allow the mutans to colonize the surface of tooth and modify the nonpathogenic to highly cariogenic dental biofilm that ultimately leads to caries formation [36].

DETECTION AND PREVENTION OFDENTAL CARIES

More emphasis is being placed on dental caries prediction and caries risk analysis than mere detection of cavities which require immediate filling. While in the past, the cavities were filled at their earliest detection, now the indications for restorative treatment have narrowed; rather than restorative treatment, plaque control measures are employed to promote remineralization and reversal of the dental caries process.

1. CARIES DIAGNOSIS

Traditionally, dental caries were detected by visible color and texture change, tactile sensation using a dental explorer, and radiographs. However, radiographs are not useful for detecting early enamel caries, and, using these methods, it is difficult to monitor the progress of dental caries and quantify its reversal. Recently, several new technologies have emerged to help diagnosis, especially of early lesions, which can help reverse the process before cavity filling is needed.

DIAGNOdent uses laser fluorescence technology to measure bacterial products in caries lesions, and it may be sensitive enough to detect early demineralization [3]. The intensity of fluorescence is displayed with a numerical value from 0 to 99. Digital Imaging Fiber-Optic Transllumination (DIFOTI) uses fiber-optic light to produce an image, which may be useful for detecting initial areas of demineralization, cracks, or fractures, and provides a quantitative characterization of the caries process [4]. Quantitative light-induced fluorescence (QLF) uses the ability of human enamel to show fluorescence under certain conditions. Demineralized enamel shows reduced fluorescence due to scattering, as the fluorescence is attributed to the cross-links between structural proteins [5]. The Electronic Caries Monitor (ECM) measures the changes in electrical impedance between sound enamel and demineralized tooth structure, as normal teeth have lower electrical conductivity compared to demineralized teeth [6]. Currently, there is no device available that accurately diagnoses whether the caries lesion is active and in need of intervention, and the dentist cannot rely solely on such equipment for treatment planning. Therefore, the dentist should also consider the overall caries risk and the susceptibility of individual patients.

2. CARIES RISK ASSESSMENT

Past caries experience, current caries index, oral hygieneures such as the use of fluoride toothpaste and mouth rinse, calculus deposit, deep pits and fissures, MS level, snacking habits, and salivary flow may all help assess individual caries risk and predict dental caries progression. These factors should be considered in deciding whether preventive measures should be taken or restorative treatment is necessary.

3. PREVENTION METHODS

1) Oral hygiene: Since dental caries do not progress without the bacteria present in dental plaques, daily plaque removal by brushing, flossing, and rinsing is one of the best ways to prevent dental caries and periodontal disease. Proper brushing and flossing methods may be taught at the dental office during routine check-ups.

2) Fluoride application: Fluoride prevents dental caries by inhibiting demineralization of the crystal structures inside the tooth and enhancing remineralization. The remineralized surface is resistant to acid attack. In addition, fluoride inhibits bacterial enzymes [7]. Methods of fluoride application include water fluoridation, fluoride tooth paste, fluoride mouth rinse, dietary fluoride supplements, and professionally applied fluoride compounds such as gels and varnishes.

3) Pit and fissure sealants: The majority of dental caries in young children occur in pits and fissures. Pits and fissures are more susceptible to dental caries because the anatomy favors plaque accumulation; these areas are often too narrow for any oral hygiene measures to be effective. By filling such irregularities with flowable restorative material, the area becomes less morphologically susceptible [8]. This is especially recommended in young patients with erupting teeth and adults with a high caries index.

4) Xylitol: Sucrose is a well-known cause of dental caries, and higher sucrose intake increases the risk of dental caries. However, it is impossible to eliminate sugar from the modern diet. Therefore, sugar substitutes have been developed to reduce caries risks. Xylitol is one of these sugar substitutes. Xylitol has a sweet flavor comparable to sugar, and it is not only non-cariogenic, but also anti-cariogenic. It keeps sucrose molecules from binding with MS, thereby blocking its metabolism. It also reduces the adhesion ability and number of MS [9]. The anti-cariogenicity of xylitol is affected more by the frequency of intake than by the amount consumed.

5) Vaccine: As dental caries is an infectious microbiologic disease, there have been attempts to develop a vaccine. Some vaccines against MS in the form of proteins, recombinant or synthetic peptides, or protein-carbohydrate conjugates, as well as those based on DNA, have been successful experimentally, and an immune intervention can be undertaken by blocking the receptors which are necessary for the colonization of MS or by inactivating glucosyl transferases. However, none of these vaccines have appeared on the market thus far [10,11] due to difficulty in inducing and maintaining high levels of antibodies in oral fluids; research is still ongoing for clinical applications.

6) Role of the primary caregiver in children: As dental caries is an infectious disease, the primary caregiver of infants (most often the mother) can transmit caries-causing microorganisms to a child, resulting in the colonization of MS in the infant's oral cavity. In fact, there is a direct relationship between MS levels in parents and their children [12]. Therefore, efforts to reduce the MS level in the parent, including maintaining oral hygiene and undergoing dental treatment when necessary, are also important for prevention of dental caries in young children.

CONCLUSION

Despite the advancements in dental caries detection and prevention, it is still a common infectious disease. Even with recent dental caries research, most clinical practice is still based on treating the disease by restorative treatment once it is detected, rather than on prevention. Future education and clinical research efforts should continue to emphasize early detection and caries prevention.

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