CRIMSON PUBLISHERS
Wings to the Research

Modern Research in Dentistry

ISSN 2637-7764

Mini Review

X-Ray Free Techniques Used for Detection of Dental Caries

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Submission: August 20, 2018; **Published:** October 05, 2018

Abstract

Modern dentistry focused on prevention, and the idea of "extension for prevention" must be replace with the procedures for a minimal invasive cavity preperation techniques. For this new approach for dentistry. Conventional or the traditional methods have failed to detect early incipient caries effectively. New diagnostic methods are still under research and seems to be very effective for early detection of caries in the near future. Advanced detection methods based on optical properties (fluorescence and transillumination) are seems to be the most potent methods for the detection of early carious lesions.

Introduction

Dental caries is a complex chronic disease that cannot be easily detected in early stages. Visual examination using mouth mirrors, probes, and conventional radiography were the diagnostic methods commonly called traditional methods [1-3]. The occlusal, approximal, and smooth surfaces at the gingival margins of teeth are available areas where plaque can accumulate easily and undisturbed to form a dental caries [4]. Current studies have shown a pathway in caries prevalence from occlusal surfaces at younger ages to approximal surfaces with advancing age [5-7]. It is easy for clinicians to check the occlusal surface but the approximal surfaces cannot be visualized directly due to the presence of neighboring teeth. Therefore, after clinical visual examination, clinicians commonly prefer to check the signs of caries in bitewing radiographs. Several studies reported that traditional radiographic methods have high specificity (Sp) and low sensitivity (Sn) for detection of approximal caries [8-13]. Our aim is to provide a short overview of the X-RAY FREE new simple transillumination techniques used for the detection of caries on approximal surfaces.

Fiber-optic transillumination (FOTI) and digital imaging fiber optic transillumination (DIFOTI)

FOTI is a simple technique that uses a narrow beam of white light to transilluminate the tooth. The principle of FOTI is that transillumination of areas with disrupted enamel crystals in demineralized tooth tissues results in dark shadows due to changes in the light scattering and absorption of light photons [3,14]. DIFOTI is based on the same principle as FOTI, and uses visible light (wavelength range between 450 and 700 nm) to transilluminate the tooth along with a charge coupled device (CCD) camera [15,16]. FOTI is a valid technique for diagnozing approximal caries so it may have been expected that clinicianswould have detected more carious lesions than standard examination alone. FOTI as a diagnostic tool was particularly good for children and regular patients with few fillings,an advantage over x-rays for children and patients who had radiographs six months ago. This may have prompted the taking of radiographs to confirm FOTI findings. In contrast, some clinicians used FOTI to confirm the appearance of caries found on radiographs [17].

DIFOTI offers several advantages over bitewing radiography, including elimination of radiation hazard associated with bitewing radiography, , reduced patient discomfort as no intra-oral films or sensors are used, and higher Sn than radiography for early caries detection. However, the disadvantages of DIFOTI are as follows: it has not been proven that DIFOTI can objectively quantify lesion size, depth, volume and mineral content; DIFOTI cannot differentiate between carious lesions and developmental defects such as fluorosis; it does not determine caries activity; and the higher Sn value might lead to higher false positive values, which might lead to over-treatment [18-20]. Transillumination systems are widely accepted by clinicians as a valid method for detection of approximal caries in anterior teeth as well as dentin-involved caries in posterior teeth.

Near-infrared transillumination (NIRTI) and Near-infrared digital imaging transillumination (NIDIT)

This method uses the same principle of transillumination as FOTI and DIFOTI. Instead of using visible light, this device uses a near-infrared (wave length: 780 to 1310nm) light to transilluminate the tooth. NIDIT is the digital system consists of a CCD sensor to capture the images, connected to a computer, special software, and elastic arms containing a near-infrared light source that transmits light through the gingiva, alveolar bone, root of the tooth, and up to the crown. The image displays from the occlusal surface [21,22]. The demineralized enamel contains increased amount of water, than the sound enamel. Loss of water in enamel also reduces its transparency at all NIR wavelengths This stuation significantly affects the contrast between the sound and demineralized enamel [23]. NIDIT can eliminate the patient ionizing radiation exposure. Therefore,this system could also be beneficial to pregnant or pediatric patients, and in situations where radiography may not be available [24,25]. It is also suggested that NIRTI images showed reliability and the enamel caries surfaces were better identified than on dental radiographs [26-28].

Optical coherence tomography (OCT)

OCT is a new non-invasive, non-irradiative imaging technique that uses infrared light to produce a real time cross-sectional image of a tissue. It constructs images from the back-scattered light of a transilluminated tissue, based on the differences in the optical absorption and scattering properties of the tissue. OCT has been used in several clinical applications including in medical examinations and dentistry. OCT in dentistry can be used for early caries detection,tooth crack diagnosis, and assessment of marginal integrity of existing restorations [29,30]. We need more studies to focus on the efficacy of this system

Laser fluorescence (LF)

LF caries detection is based on the principle that when a red light (wavelength 655nm) is applied to a tooth, the caries-related changes in the tooth tissues lead to an increase in fluorescence. Clean and healthy teeth produce little or no fluorescence, while carious teeth produce fluorescence proportional to the degree of caries [31]. A systematic review of LF concluded that LF has a higher tendency to produce false-positive diagnoses. It is not advised to use as a primary diagnostic method [32].

Ultrasound

The use of diagnostic ultrasound in dentistry was first reported more than 50 years ago. For caries detection, ultrasound is based on the differences in sonic conductivity between sound and demineralized enamel [33]. Although the ultrasonic caries detection device showed hopeful results, to use in clinics, we need more studies to focus on the efficacy of this system [34].

LED fluorescence

This method detects differences in the reflection and refraction of infrared energy from red light-emitting diode (LED). The presence of a carious lesion will lead to changes in these properties. Another fiber optic cable serves as a photodetector that transmits the captured light to a microprocessor, which compares the signals to defined parameters. It is concluded that LED fluorescence was not adequate for approximal caries detection, perhaps due to loss of signal during signal transduction through the occlusal part of the lesion [35].

Conclusion

The transillumination methods showed a high harmony compared with traditional methods (clinical examination and bitewing radiographs). Caries detection reliability using the transillumination device images showed a high intraexaminer agreement. Transillumination showed to be a reliable method and as effective as traditional methods in caries detection. The NIR transıllumination may lead to a reduced usage of radiographic bite-wings for detecting proximal and occlusal dental caries..

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How to cite this article: Hikmet S, Berk K. X-Ray Free Techniques Used for Detection of Dental Caries . Mod Res Dent. 3(2). MRD.000560.2018.
DOI: 10.31031/MRD.2018.03.000560

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DOI: 10.31031/MRD.2018.03.000560