X-Ray Free Techniques Used for Detection of Dental Caries

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Abstract

Modern dentistry focused on prevention, and the idea of “extension for prevention” must be replace with the procedures for a minimal invasive cavity preparation 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 have 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 diagnosing approximal caries so it may have been expected that clinicians would 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 soft-
ware, 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 situation 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 carious [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 which 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 transillumination may lead to a reduced usage of radiographic bite-wings for detecting proximal and occlusal dental caries.

**References**

1. Wilder Smith P, Holtzman J, Epstein J, Le A (2010) Optical diagnostics in the oral cavity: an overview. Oral Dis 16(8): 717-728.

2. Mohanraj M, Prabhu VR, Sendhil R (2016) Diagnostic methods for early detection of dental caries-A review. Int J Pedod Rehabil 1(1): 29-36.

3. Demirölçü N, Solak H (1988) Transillumination in dentistry. A Ü Dental Hek Fak Derg 15(11): 19-21.

4. Zero DT, Zandonà AF, Vail MM, Spólnik KJ (2011) Dental caries and pulpal disease. Dent Clin North Am 55(1): 29-46.

5. Mejeà I, Källèstål C, Stenlund H, Johansson H (1998) Caries Development from 11 to 22 Years of Age: A Prospective Radiographic Study Prevalence and Distribution. Caries Res 32(1): 10-16.

6. Mejeà I, Stenlund H, Zelezny Hombl & C (2004) Caries incidence and lesion progression from adolescence to young adulthood: a prospective 15-year cohort study in Sweden. Caries Res 38(2): 130-141.

7. Martignon S, Chaururia N, Ekstrand KR (2010) Caries status and proximal lesion behaviour during a 6-year period in young adult Danes: an epidemiological investigation. Clin Oral Invest 14(4): 383-390.

8. Gimenez T, Piovesan C, Braga MM, Raggio DP, Deery C, et al. (2015) Visual inspection for caries detection: a systematic review and meta-analysis. J Dent Res 94(7): 895-904.

9. Schwendicke F, Tzschoppe M, Paris S (2015) Radiographic caries detection: a systematic review and meta-analysis. J Dent 15(8): 924-935.

10. Milleman PA, Van Der Weele LT (1990) Accuracy in radiographic diagnosis: Dutch practitioners and dental caries. J Dent 18(3): 130-136.

11. De FA, Rosito DB, Toigo E (1992) Diagnosis of approximal caries: radiographic versus clinical examination using tooth separation. Am J Dent 5(5): 245-248.

12. Pitts NB, Rimmer PA (1992) An in vivo comparison of radiographic and directly assessed clinical caries status of posterior approximal surfaces in primary and permanent teeth. Caries Res 26(2): 146-152.

13. Hintze H, Wendel A, Danielsen B, Nyvad B (1998) Reliability of visual examination, fibre-optic transillumination and bite-wing radiography, and reproducibility of direct visual examination following tooth separation for the identification of cavitated carious lesions in contacting approximal surfaces. Caries Res 32(3): 204-209.

14. Friedman J, Marcus MI (1970) Transillumination of the oral cavity with use of fiber optics. J Am Dent Assoc 80(4): 801-809.

15. Schneiderman A, Elbaum M, Shultz T, Keem S, Greenbaum M, et al. (1997) Assessment of dental caries with digital imaging fiber-optic transillumination (DIFOTI): In vitro Study. Caries Res 31(2): 103-110.

16. Bin-Shuwaish M, Yaman P, Dennis J, Neiva G (2008) The correlation of DIFOTI to clinical and radiographic images in Class II carious lesions. J Am Dent Assoc 139(10): 1374-1381.
17. Davies GM, Worthington HV, Clarkson JE, Thomas P, Davies RM (2001) The use of fibre-optic transillumination in general dental practice. Br Dent J 191(3): 145-147.

18. Peers A, Hill PJ, Mitropoulos CM, Holloway PJ (1993) Validity and reproducibility of clinical examination, fibre-optic transillumination and bite-wing radiology for the diagnosis of small approximal carious lesions: An in vitro study. Caries Res 27(4): 307-311.

19. Neuhaus KW, Ellwoodm R, Lussi A, Pitts NB (2009) Traditional lesion detection aids. Monogr Oral Sci 21: 42-51.

20. Young DA, Featherstone JD (2005) Digital imaging fiber-optic transillumination, F-speed radiographic film and depth of approximal lesions. J Am Dent Assoc 136(12): 1682-1687.

21. Söchtig F, Hickel R, Kühnisch J (2014) Caries detection and diagnostics with near-infrared light transillumination: Clinical experiences. Quintessence Int 45(6): 531-538.

22. Staninec M, Lee C, Darling CL, Fried D (2010) In Vivo Near-IR Imaging of Approximal Dental Decay at 1,310 nm. Lasers Surg Med 42(4): 292-298.

23. Usenik P, Bürmen M, Fidler A, Pernuš F, Likar B (2014) Near-infrared hyperspectral imaging of water evaporation dynamics for early detection of incipient caries. J Dent 42(10): 1242-1247.

24. Kühnisch J, Söchtig F, Pitchika V, Laubender R, Neuhaus KW, et al. (2016) In vivo validation of near-infrared light transillumination for interproximal dentin caries detection. Clin Oral Investig 20(4): 821-829.

25. Berg SC, Stahl JM, Lien W, Slack CM, Vandewalle KS (2018) A clinical study comparing digital radiography and near-infrared transillumination in caries detection. J Esthet Restor Dent 30(1): 39-44.

26. Maia AMA, Karlsson L, Margulis W, Gomes ASL (2011) Evaluation of two imaging techniques: near-infrared transillumination and dental radiographs for the detection of early approximal enamel caries. Dentomaxillofac Radiol 40(7): 429-433.

27. Lara Capi C, Cagetti MG, Lingström P, Lai G, Cocco F, et al. (2017) Digital transillumination in caries detection versus radiographic and clinical methods: an in vivo study. Dentomaxillofac Radial 46(4): 20160417.

28. Kühnisch J, Söchtig F, Pitchika V, Laubender R, Neuhaus KW, et al. (2016) In vitro validation of near-infrared light transillumination for interproximal dentin caries detection. Clin Oral Investig 20(4): 821-829.

29. Huang D, Swanson EA, Lin CP, Schuman JS, Stinson WG, et al. (1991) Optical coherence tomography. Science 254(5035): 1178-1181.

30. Shimada Y, Sadr A, Sumi Y, Tagami J (2015) Application of optical coherence tomography (OCT) for diagnosis of caries, cracks, and defects of restorations. Curr Oral Health Rep 2(2): 73-80.

31. Lussi A, Hibst R, Paulus R (2004) DIAGNODent: an optical method for caries detection. J Dent Res 83(1): 80-83.

32. Bader JD, Shugars DA (2004) A systematic review of the performance of a laser fluorescence device for detecting caries. J Am Dent Assoc 135(10): 1413-1421.

33. Marotti J, Heger S, Tinschert J, Tortamano P, Chuebouf F, et al. (2013) Recent advances of ultrasound imaging in dentistry-a review of the literature. Oral Surg Oral Med Oral Pathol Oral Radiol 115(6): 819-832.

34. Matalon S, Feuerstein O, Calderon S, Mittelman A, Kaffe I (2007) Detection of cavitated carious lesions in approximal tooth surfaces by ultrasonic caries detector. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 103(1): 109-113.

35. Neuhaus KW, Cucchi P, Rodrigues JA, Hug I, Emerich M, et al. (2015) Diagnostic performance of a new red light LED device for approximal caries detection. Lasers Med Sci 30(5): 1443-1447.

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