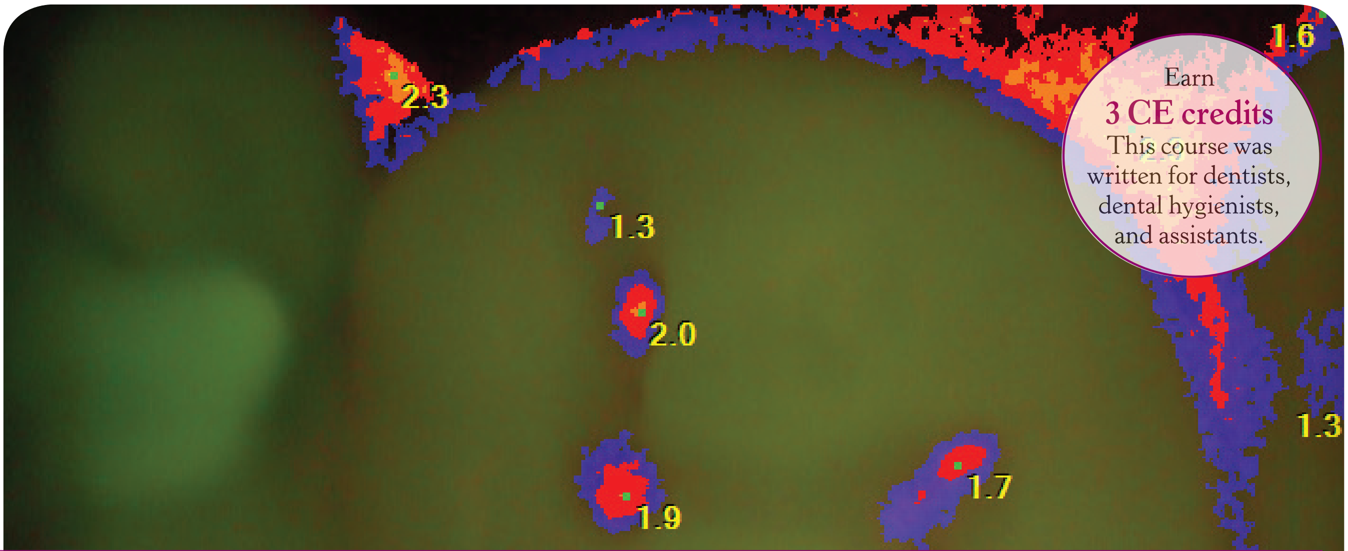

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Light Assisted Caries Detection: 21st Century Technology

A Peer-Reviewed Publication
Written by Ian Shuman DDS, MAGD, AFAAID

Abstract

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Educational Objectives

At the conclusion of this educational activity participants will be able to:

1. Discuss the limitations of manual and radiographic diagnostics for caries identification.
2. Describe the current equipment needed for caries diagnosis.
3. Access and restore carious lesions in a minimally invasive manner.
4. Describe cavitated and non-cavitated carious lesions.

Author Profile

Ian Shuman DDS, MAGD, AFAAID maintains a full-time general, reconstructive, and aesthetic dental practice in Pasadena, Maryland. Since 1995 Dr. Shuman has lectured and published on advanced, minimally invasive techniques. He has taught these procedures to thousands of dentists and developed many of the methods. Dr. Shuman has published numerous articles on topics including adhesive resin dentistry, minimally invasive restorative, cosmetic and implant dentistry. He is a Master of the Academy of General Dentistry, an Associate Fellow of the American Academy of Implant Dentistry, a Fellow of the Pierre Fauchard Academy. Dr. Shuman was named one of the Top Clinicians in Continuing Education since 2005, by Dentistry Today.

Author Disclosure

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Abstract

Due to the current limitations inherent in diagnostic tools for caries detection, the presence of potentially undiagnosed and untreated carious lesions concealed beneath seemingly innocuous pits and fissures is a concern for both clinicians and researchers. In response to this need, recent technological advancements in various scientific disciplines have generated new diagnostic tools.

Discussion

The traditional tools used for caries diagnosis are no longer considered the gold standard. Research has demonstrated that traditional methods and techniques for caries detection and diagnosis are inaccurate.[1-3] Visual examination, probing with an explorer, and radiographs do not offer a complete representation of teeth that may be carious. The primary reason is due to the non-cavitated carious lesion phenomenon. Dentin caries can result in visually non-cavitated lesions, which present clinically intact enamel over the bodies of these lesions.[4]

The Non-Cavitated Carious Lesion

Historically, dental caries has been synonymous with the presence of cavitation. However, that paradigm is changing thanks to advancements in both the understanding of caries development and diagnostic modalities. The progress of caries can now be quantitatively and qualitatively measured and the clinical stages of the disease process that precede cavitation can be recognized and documented. There are a number of reasons and causes for the non-cavitated carious lesion also known as "Occult Caries" or "Hidden Caries".[5,6] This phenomenon may be due in part to natural anatomic defects in the enamel surface,[7] especially pits and fissures.[8] Often seen are diffuse opacities, which may be thin bridges of non-cavitated enamel overlying carious dentin. One implication may be due to over-fluoridation, which hardens the outer enamel surface, but does not penetrate sufficiently to prevent caries from occurring in the deeper layers of enamel and dentin.[9-11]

In response to these observations, The International Caries Detection and Assessment System (ICDAS) presented a new paradigm for the measurement of dental caries[12] that was developed based upon the insights gained from a systematic review of the literature on clinical caries detection systems.[13-18] That review found that while new caries detection criteria measured different stages of the caries process, there were inconsistencies in how the caries process was identified and measured.[19]

Visual Exam

It is difficult to determine whether a lesion is active or arrested simply by looking at the lesion. [20] In a study by Assaf et al., it was determined that the visual/tactile method, with or without diagnostic adjuncts can diagnose cavitated lesions efficiently, but not non-cavitated lesions.[21]

Explorer

Physical diagnostic methods such as the use of an explorer for probing into pits and fissures will only reveal a "catch" if the defect is large enough to accommodate the explorer tip or soft enough to allow probing. In 1924, G.V. Black recommended treatment that would foreshadow the future of diagnosis and treatment of non-cavitated carious lesions: "A sharp explorer should be used with some pressure and if a very slight pull is required to remove it, the pit should be marked for restoration even if there are no signs of decay."[22] Dr. Black knew that a sharp explorer was not ideal for caries diagnosis. A new explorer has an average tip diameter of 30-40μm.[23] After repeated use, the tip will dull to an average diameter of approximately 150μm. A physically undetectable enamel pit, fissure, or defect smaller than 30μm can accommodate a large bacterial population; therefore, caries detection by means of explorer examination is no longer considered a completely reliable diagnostic method.[24-26] In addition, a false positive probing can result from the shape of the fissure, force of application, path of explorer placement and as mentioned, sharpness of the explorer.[27]

Caries-Staining Dyes

Chemical detection using caries-staining or caries-detection dyes lack accuracy. These dyes are most useful for detecting remaining caries following the initial preparation of a lesion. There also is a wide variation in the efficacy of the different caries dye materials currently available.[28] Ideally, caries-detector dyes should stain only in a manner that permits proper discrimination between healthy and diseased tooth structures.[29] Currently, none of the available caries-detection dyes is caries specific. Therefore, their routine use may lead to a profound degree of over-treatment.

Radiography

Another traditional diagnostic tool, intraoral radiography, does not always reveal the presence of occlusal lesions because of the amount of healthy tooth structure surrounding the lesion, the small size of many lesions, and the variables in image quality related to radiographic exposure and development.[30,31] Decay is difficult to detect in radiographs unless the lesion is larger than 2-3mm deep into dentin, or one-third the bucco-lingual distance. A systematic review was conducted by Schwendicke et

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al.,[32] aimed at evaluating the accuracy of radiographic caries detection for different lesions at different locations. Radiographic caries detection is highly accurate for cavitated proximal lesions, and seems also suitable to detect carious dentin lesions.

For detecting initial lesions, more sensitive methods should be considered in populations with high caries risk and prevalence. Radiographic caries detection is especially suitable for detecting more advanced carious lesions, and has limited risks for false positive diagnoses. For groups with high caries risk and prevalence, alternative detection methods with higher sensitivity for initial lesions might be considered. A more quantifiable, accurate diagnostic method is required. In response to this growing need, recent technological advancements in various scientific disciplines have generated new diagnostic tools.

Modern caries detection using light

Because all teeth are translucent, they have specific optical properties[33] and caries detection using a light source is not a new concept. In 1922, Dr. William John Cameron published his work: Diagnosis By Transillumination: A Treatise On The Use Of Transillumination In Diagnosis Of Infected Conditions Of The Dental Process. (1922)[34] In it, he states, that this use of transillumination provides one of the most valuable aids in operative procedures. It can be used effectively for the detection of interproximal caries and intercoronal caries. Caries will at once evidence themselves by a distinct discoloration in the crown of the tooth covering the area affected or filled.

Transillumination is but one diagnostic technique that uses light for detecting hidden caries. Light source technology and result interpretation and recording has evolved to include laser caries detection through fluorescence, light emitting diode spectroscopy, fiber-optic transillumination, and optical coherence tomography among others.

Fiber Optics

Detection of a carious lesion is based on changes in scattering and absorption of light photons traveling through the carious lesion which can be observed by the clinician as a dark shadow. An intense light using fiber-optic technology greatly enhances detection ability. Methods using this intense light source are referred to as FOTI (fiber-optic transillumination) or DIFOTI (digital imaging fiber-optic transillumination), which operates under the same principle as FOTI but allows for the saving of digital images of the transilluminated tooth. In the literature, most studies have focused on transillumination as a method to replace radiographs with varying performance.[35-39]

One device, the Microlux Transilluminator® (Addent, Danbury, CT) is used for detecting anterior and posterior caries.[40] Using a 2 or 3mm light guide, it also helps to visualize crown fractures, root canal orifice, and root fractures. The fiber optic probe is placed adjacent to the oral structure under examination and the passage of the light through the tissue is proportional to the translucency of each material. Caries, calculus, cracks, and the orifice of root canals do not transmit as much light as healthy enamel or dentin and appear darker.

Laser

There are a number of different devices for detecting caries through the use of lasers.[41] The most popular devices detect caries through the use of fluorescence. Normal healthy tooth structure produces little or no fluorescence. Carious tooth structure will fluoresce proportionate to the degree of caries. Some of these early devices were highly sensitive to caries but had a low specificity. This low specificity meant that these devices would measure the fluorescence of anything. However, with contemporary advancements in laser technology, that specificity has improved and caries can be diagnosed in a more precise manner.

One of the first laser devices to detect caries was the Diagnodent®. (Kavo, Alsip, IL) This unit employs a 655 nm laser that detects the fluorescence of decay in teeth on virgin smooth surfaces, and pit and fissures areas. A value is produced along with an increasing audio tone and digital readout indicating the presence of non-healthy tooth structure as well as other materials such as calculus and plaque.

Other devices (The Canary System®, Quantum Dental Technologies, Toronto, Ontario, Canada) use lasers that are absorbed in the tooth with luminescence conversion providing information on the presence and extent of tooth decay below the tooth surface. Another caries detection device uses Optical Coherence Tomography (OCT)™, which images both the teeth and periodontium. (Lantis Laser Inc., Denville, NJ).[42] Cross-sectional images are then displayed allowing the device to detect decay associated with restorations.

LED (Light Emitting Diode)

LED technology has been used for caries detection. Midwest Caries I.D.™ (Dentsply, York, PA), measures the caries reflection signature for smooth surfaces, pits and fissures, and interproximal surfaces using LED. It is based on the concept that healthy tooth structure is more translucent than decalcified structure. The light reflected from the decalcified structures allows the device to distinguish between healthy and less translucent structures. A simple red and green indicator light and an alternating beeping sound indicate the presence or lack of caries. Other artifacts, present in or on the tooth, can interfere with detection.

LED Based Spectroscopy

Spectroscopy is the study of objects based on the spectrum of color they emit, absorb, or reflect. Certain bacteria are able to synthesize fluorescent compounds called porphyrins and can therefore be detected by sensitive fluorescence measurements in the red spectral region.[43] Fluorescence of dental caries (and dental plaque) in the red spectrum is caused by oral bacteria such as Bacteroides and Actinomyces odontolyticus. This phe-

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nomenon occurs in a wide range of bacteria and is not specific to bacteria involved in the pathogenesis of caries. Localized in human skin, the porphyrin-producing bacterium Propionibacterium acnes is responsible for acne vulgaris. High concentrations of the porphyrin-producing bacterium Pseudomonas aeruginosa have been found in biopsies of oral squamous cell carcinoma and exhibit red fluorescence. Based on studies by König, et al., it is apparent that the spectral characteristics of bacterial fluorescence can be used in the diagnosis and treatment of a variety of diseases. In fact many researchers have gone so far as to destroy bacteria by exciting the porphyrins contained within them through photo-targeting these metabolites with spectrum specific light. [44-46]

Caries Identification Using LED Based Spectroscopy

Caries detection utilizing a device that emits auto-fluorescent light and evaluates the fluorescing porphyrin byproducts of cariogenic bacteria such as Streptococcus mutans, Bacteroides, and Actinomyces odontolyticus.[43] is also available (The Spectra System™, Air Techniques, Melville, NY). **(Figure 1)**

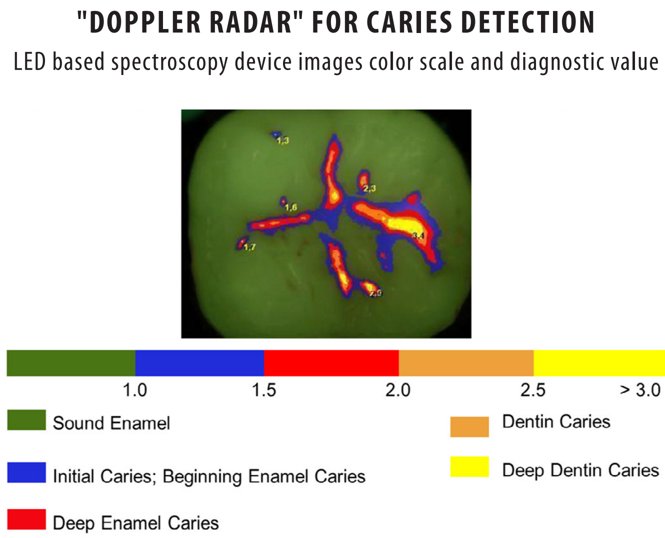
Using a 405nm LED, the device emits an auto-fluorescent light that is absorbed differently by various objects on and within a tooth. Porphyrin producing cariogenic bacteria have a unique spectral response to auto-fluorescence, producing a red color.[47] In contrast, healthy tooth structure will fluoresce green. In a study by Lennon et al.,[48] it was determined that red fluorescence is well suited to detection of the bacteria that cause dentin caries.[49] This has been substantiated and repeatedly demonstrated in numerous studies. [50-53]

The fluorescing substrate in and/or on the captured image of a tooth is converted to both colors and numbers via live video feedback. A graphic display showing varying colors on the tooth

Figure 1.

is produced. For patient education, this has often been referred to as a "Doppler radar" type image, especially useful for immediate comprehension of familiar technology often used by weather reporters. Next to each color variance is a quantitative numerical display. **(Figure 2)** One of the benefits of this device is that the graphic image can be saved to imaging software and the patient's chart, enhancing the ability to monitor the development of caries and chart the progression of remineralization of tooth structure over time. In addition, the visual image provides the patient with an interactive point of reference. This is a powerful tool that allows the patient to co-diagnose their caries, understand the problem, and often initiate the dialogue regarding treatment.

Figure 2.



This technology has been demonstrated to be highly effective. **(Figure 3)** In a study by Buchalla, emission spectra from noncavitated enamel caries with different degrees of discoloration under a wide range of excitation wavelengths were compared. [54,45] Freshly extracted human molars with white spot, light discolored and dark discolored, brown spot enamel caries were selected. Rectangular blocks were cut from the carious area and a corresponding sound area of the same tooth. Emission spectra were recorded from carious lesions and the corresponding sound areas using a fluorescence spectrophotometer at excitation wavelengths from 360 nm up to 580 nm in steps of 20 nm. Emission spectra of all types of carious lesions were shifted towards longer wavelengths (red shift) when compared to the spectra of the corresponding sound enamel. The red shift was highest for dark brown spot lesions and lowest for white spot lesions. Distinct fluorescence bands within 600-700 nm typical for porphyrin compounds were strongest for excitation wavelengths from 400 to 420 nm and present in most of the lesions investigated.

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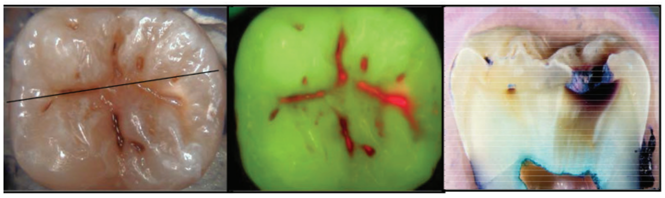
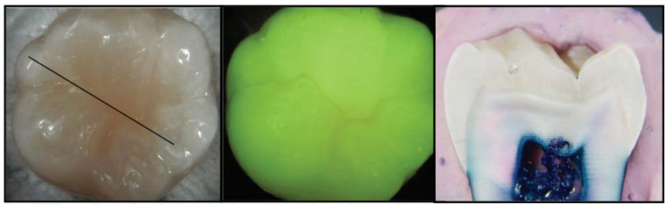
Figure 3.



Photos of a sample with a carious lesion. left: Intraoral camera, middle: Fluorescence camera system, right: Cut view of the same tooth.



Photos of a sample without a carious lesion. left: Intraoral camera, middle: Fluorescence camera system, right: Cut view of the same tooth.

Case Report: Non-Cavitated Carious Lesion

The patient, a 35-year-old male presented for initial examination. Existing carious lesions were charted, however there were several areas in the occlusal pits and fissures that were not cavitated to the point where an explorer would stick. A lower right second premolar exhibited such signs. **(Figure 4)** These areas of discoloration are common, yet many are not properly diagnosed. After polishing and then drying the occlusal surface, the LED spectroscopy device was used to obtain more in-depth information regarding the status of caries presence. **(Figure 5)** The areas of concern were accessed using a minimally invasive bur (Fissurotomy Bur™, SS White, Lakewood, NJ) **(Figure 6)** and the site was reevaluated for the presence of remaining caries using the LED caries detection device . **(Figure 7)** These areas were additionally confirmed with an explorer and were confirmed to be soft, carious dentin. The caries was carefully removed **(Figure 8)** using a round bur on a slow speed handpiece at 250 rpm, and the site reevaluated with the same device.

Figure 4.

Figure 5.

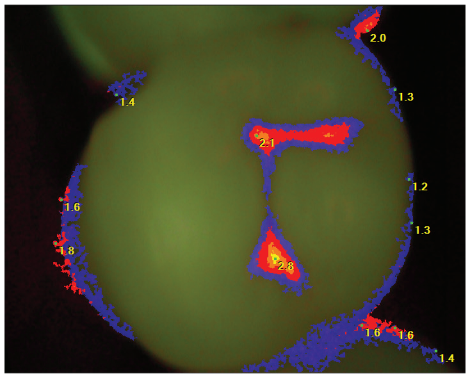


Figure 6.

Figure 7.

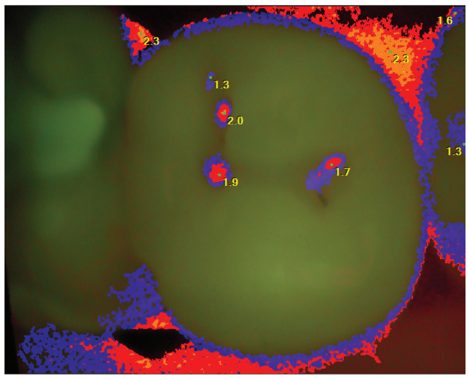


Figure 8.

Figure 9.

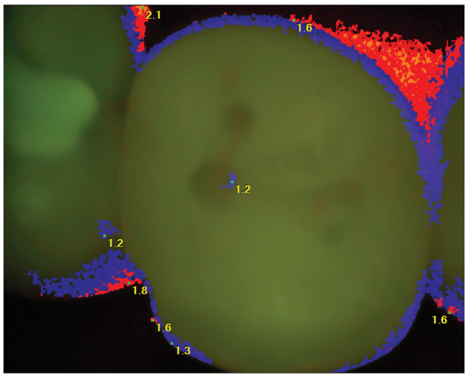


Figure 10.

(Figure 9) Showing no signs of any further lesions, confirmed with an explorer the cavity preparation was restored. **(Figure 10)**

Conclusion:

With technology able to now detect the undetectable, caries diagnosis and treatment has evolved from the need for "extension for prevention" to a minimal intervention model. This advancement in caries management has been further strengthened by the advancements in adhesion dentistry, which together encourage preservation of tooth structure. Despite these changes, the ultimate goal lies with the prediction of GV Black: "The day is surely coming.... when we will be engaged in practicing preventive, rather than reparative, dentistry."[55]

Bibliography

1. Hefferren JJ. A review of approaches to the detection of dental caries. Council on Dental Materials and Devices. J Am Dent Assoc 86(6): 1358-1364, 1973.
2. Seow WK. Clinical diagnosis of enamel defects: pitfalls and practical guidelines. IntDentI47(3):173-182, 1997.
3. Anderson RI. Has occlusal caries become more difficult to diagnose? Br Dent J 165(1):9, 1988. 4.
4. Stahl J, Zandona AF. Rationale and protocol for the treatment of non-cavitated smooth surface carious lesions Gen Dent. 2007 Mar-Apr;55(2):105-11.
5. Chong MJ, Seow WK, Purdie DM, Cheng E, Wan V. Visual-tactile examination compared with conventional radiography, digital radiography, and Diagnodent in the diagnosis of occlusal occult caries in extracted premolars. Pediatr Dent. 2003 Jul-Aug;25(4):341-9.
6. Weerheijm KL, van Amerongen WE, Eggink CO. The clinical diagnosis of occlusal caries: a problem. ASDC J Dent Child. 1989 May-Jun; 56(3):196-200.
7. Carvalho JC, Silva EF, Gomes RR, Fonseca JA, Mestrinho HD. Impact of enamel defects on early caries development in preschool children. Caries Res. 2011;45(4):353-60.
8. Ekstrand KR, Bjørndal L. Structural analyses of plaque and caries in relation to the morphology of the groove-fossa system on erupting mandibular third molars. Caries Res. 1997;31(5):336-48.
9. Mackay TD, Thomson WM. Enamel defects and dental caries among Southland children. N Z Dent J. 2005 Jun;101(2):35-43.
10. Angelillo IF, Romano F, Fortunato L, Montanaro D. Prevalence of dental caries and enamel defects in children living in areas with different water fluoride concentrations. Community Dent Health. 1990 Sep;7(3):229-36.
11. Vignarajah S. Dental caries experience and enamel opacities in children residing in urban and rural areas of Antigua with different levels of natural fluoride in drinking water. Community Dent Health. 1993 Jun;10(2):159-66.
12. Ismail AI, et al. International Caries Detection and Assessment System (ICDAS) Coordinating Committee. ICDAS II p.2 15/06/2012
13. Gomez J, Tellez M, Pretty IA, Ellwood RP, Ismail AI. Non-cavitated carious lesions detection methods: a systematic review. Community Dent Oral Epidemiol. 2013 Feb;41(1):54-66.
14. Chesters RK, et al. An abbreviated caries clinical trial design validated over 24 months J Dent Res. 2002 Sep;81(9):637-40.
15. Fyffe HE, Deery C, Nugent ZJ, Nuttall NM, Pitts NB. Effect of diagnostic threshold on the validity and reliability of epidemiological caries diagnosis using the Dundee Selectable Threshold Method for caries diagnosis (DSTM). Community Dent Oral Epidemiol. 2000 Feb;28(1):42-51.
16. Ekstrand KR, Ricketts DN, Kidd EA. Occlusal caries: pathology, diagnosis and logical management. Dent Update. 2001 Oct;28(8):380-7.
17. Ekstrand KR, Christiansen ME. Outcomes of a non-operative caries treatment programme for children and adolescents. Caries Res. 2005 Nov-Dec;39(6):455-67.
18. Ricketts DN, Ekstrand KR, Kidd EA, Larsen T. Relating visual and radiographic ranked scoring systems for occlusal caries detection to histological and microbiological evidence. Oper Dent. 2002 May-Jun;27(3):231-7.
19. Oliveira RS, Zenkner JE, Maltz M, Rodrigues JA. Association between two visual criteria in assessing non-cavitated caries lesion activity on occlusal surfaces of permanent molars. Clin Oral Investig. 2015 Mar;19(2):565-8.
20. National Maternal and Child Oral Health Resource Center and Ohio Department of Health www.ohiodentalclinics.com/curricula/sealant/mod3_2_2.html, 2009
21. Assaf AV, Meneghim Mde C, Zanin L, Pardi V, Pereira AC, Ambrosano GM. Influence of diagnostic adjuncts to the measurement of caries prevalence at different caries thresholds.. Int Dent J. 2003 Dec;53(6):485-90.
22. Black GV. Operative Dentistry. 1924; 1(7) 32.

23. Phillips RW: Skinner's Science of Dental Materials, ed 9. Philadelphia, W.B. Saunders, 1991.
24. al-Sehaibany F. The use of caries detector dye in diagnosis of occlusal carious lesions. Clin Pediatr Dent 20(4):293- 298,1996.
25. Penning C, et al. Validity of probing for fissure caries diagnosis. Caries Res 26(6):445- 449, 1992.
26. Lussi A. A comparison of different methods for diagnosis of fissure caries without cavitation. Caries Res 27(5). 409-416, 1993.
27. Caries diagnosis – SlideShare www.slideshare.net/drkskumar/caries-diagnosis-10066187 Nov 7, 2011
28. Styner D, Kuyinu E, Turner G. Addressing the caries dilemma: detection and intervention with a disclosing agent. Gen Dent 44(5):446-449, 1996.
29. McComb D, Caries-Detector Dyes - How Accurate and Useful Are They? Canadian Dent Assoc 2000; 66:195-8
30. Christensen GJ. Dental radiographs and dental caries: a challenge. J Am Dent Assoc 127(6):792- 793, 1996.
31. White SC. Clinical and historical predictors of dental caries on radiographs. Dentomaxillofac Radiol 24(2): 121-127, 1995.
32. Schwendicke F, Tzschoppe M, Paris S. Radiographic caries detection: A systematic review and meta-analysis. J Dent. 2015 Feb 24.
33. Rechmann P1, Rechmann BM, Featherstone JD. Caries detection using light-based diagnostic tools. Compend Contin Educ Dent. 2012 Sep;33(8):582-4,
34. Cameron WJ. Diagnosis By Transillumination: A Treatise On The Use Of Transillumination In Diagnosis Of Infected Conditions Of The Dental Process. Cameron's Publ. Co., 1922 Chicago IL.
35. Vaarkamp J, ten Bosch JJ, Verdonschot EH, Bronkhoorst EM. The real performance of bitewing radiography and fiber-optic transillumination in approximal caries diagnosis. J Dent Res. 2000;79(10):1747-1751.
36. Schneiderman A, Elbaum M, Shultz T, et al. Assessment of dental caries with Digital Imaging Fiber-Optic Transillumination (DIFOTI): in vitro study. Caries Res. 1997;31(2):103-110.
37. Bjelkhagen H, Sundström F, Angmar-Månsson B, Rydén H. Early detection of enamel caries by the luminescence excited by visible laser light. Swed Dent J. 1982;6(1):1-7.
38. Sundström F, Fredriksson K, Montán S, et al. Laser-induced fluorescence from sound and carious tooth substance: spectroscopic studies. Swed Dent J. 1985;9(2):71-80.
39. König K, Flemming G, Hibst R. Laser-induced autofluorescence spectroscopy of dental caries. Cell Mol Biol (Noisy-le-grand). 1998;44(8):1293-1300.
40. Davies GM, Worthington HV, Clarkson JE, Thomas P, Davies RM. The use of fibre-optic transillumination in general dental practice. Br Dent J. 2001 Aug 11;191(3):145-7.
41. Jablow M. Caries detection in the 21st century -- sharpening our diagnostic abilities. Dentistry IQ 2015
42. Lenton P, Rudney J, Chen R, Fok A, Aparicio C, Jones RS. Imaging in vivo secondary caries and ex vivo dental biofilms using cross-polarization optical coherence tomography. Dent Mater. 2012 Jul;28(7):792-800.
43. Karsten K, et al. Advances in Laser and Light Spectroscopy to Diagnose Cancer and Other Diseases. The International Society for Optical Engineering. Proc. SPIE 2135, 129 (May 19, 1994)
44. Nikolaos S, et al. Phototargeting Oral Black-Pigmented Bacteria. Antimicrob. Agents Chemother. April 2005 vol. 49 no. 4 1391-1396
45. Henry CA, et al. Sensitivity of Porphyromonas and Prevotella species in liquid media to argon laser. Photochem. Photobiol. 1995. 61:410-413.
46. König K, et al. Red light kills bacteria via photodynamic action. Cell. Mol. Biol. 2000. 46:1297-1303.
47. Volgenant CM, van der Veen MH, de Soet JJ, ten Cate JM. Effect of metalloporphyrins on red autofluorescence from oral bacteria. Eur J Oral Sci. 2013 Jun;121(3 Pt 1):156-61..
48. Lennon AM, Buchalla W, Brune L, Zimmermann O, Gross U, Attin T. The ability of selected oral microorganisms to emit red fluorescence. Caries Res. 2006;40(1):2-5.
49. Buchalla W. Comparative fluorescence spectroscopy shows differences in noncavitated enamel lesions. Caries Res. 2005 Mar-Apr;39(2):150-6.
50. Buchalla W, Lennon AM, Attin T. Comparative fluorescence spectroscopy of root caries lesions. Eur J Oral Sci. 2004 Dec;112(6):490-6.
51. Zezell DM, Ribeiro AC, Bachmann L, Gomes AS, Rousseau C, Girkin J. Characterization of natural carious lesions by fluorescence spectroscopy at 405-nm excitation wavelength. J Biomed Opt. 2007 Nov-Dec;12(6)
52. Karlsson L. Caries Detection Methods Based on Changes in Optical Properties between Healthy and Carious Tissue. International Journal of Dentistry. Volume 2010
53. Borisova EG, Uzunov TT, Avramov LA. Early differentiation between caries and tooth demineralization using laser-induced autofluorescence spectroscopy. Lasers Surg Med. 2004;34(3):249-53.
54. Loguercio AD, et al. Does active application of universal adhesives to enamel in self-etch mode improve their performance? J Dent. 2015 Apr 20.
55. Wolff MS, Allen K, Kaim J. A 100-year journey from GV Black to minimal surgical intervention. Compend Contin Educ Dent. 2007 Mar;28(3):130-4

Author profile

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Author Disclosure

Dr. Shuman has no commercial ties with the sponsors or the providers of the unrestricted educational grant for this course.

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Questions

1. A new explorer has an average tip diameter of:
   a. 10-20µm
   b. 20-30µm
   c. 30-40 µm
   d. 40-50µm

2. A false positive probing can result from the:
   a. Shape of the fissure
   b. Force of application
   c. Path of explorer placement
   d. All of the above

3. The International Caries Detection and Assessment System review found that while new caries detection criteria measured different stages of the caries process, there were inconsistencies in how the caries process was:
   a. Identified
   b. Measured
   c. Located
   d. Both a and b

4. According to several studies, one possible cause of non-cavitated lesions may be due to:
   a. Well water
   b. Recession
   c. Over-fluoridation
   d. None of the above

5. Historically, dental caries has been synonymous with the presence of:
   a. Candida albicans
   b. Cavitation
   c. Balancing contacts
   d. All of the above

6. The non-cavitated carious lesion is also known as:
   a. Occult caries
   b. Shadow caries
   c. a and d
   d. Hidden Caries

7. Dentin caries can result in visually non-cavitated lesions, which present as clinically intact:
   a. Dentin beneath enamel bridges
   b. Enamel and dentin
   c. Enamel over the body of the lesion
   d. None of the above

8. Thin bridges of non-cavitated enamel overlying carious dentin may present as:
   a. Diffuse opacities
   b. Green phosphorescence
   c. A violet isthmus
   d. All of the above

9. Which of the following determined that the visual/tactile method, with or without diagnostic adjuncts can diagnose cavitated lesions efficiently, but not non-cavitated lesions?
   a. Farley
   b. Hartman
   c. Assaf
   d. Radner

10. After repeated use, an explorer tip will dull to an average diameter of approximately:
    a. 50µm
    b. 100µm
    c. 150µm
    d. 200µm

11. Chemical detection using caries-staining or caries-detection dyes:
    a. Lack accuracy
    b. Are highly accurate
    c. Offer a definitive diagnosis
    d. Are inaccurate 98% of the time

12. Decay is difficult to detect in radiographs unless the lesion is larger than:
    a. 2mm to 3mm deep into enamel
    b. 1mm to 2mm deep into enamel
    c. 1mm to 2mm deep into dentin
    d. 2mm to 3mm deep into dentin

13. Which of the following conducted a systematic review aimed at evaluating the accuracy of radiographic caries detection for different lesions at different locations?
    a. Berkowitz
    b. Raider
    c. Shipman
    d. Schwendicke

14 Some laser devices detect caries through the use of:
    a. Fluorescence
    b. Optical mirroring
    c. Trans-evaluation
    d. Bioluminescence

15. Some of the early laser devices were highly sensitive to caries but had:
    a. High gravity
    b. Low specificity
    c. A defined gradient
    d. An average median

16. Low specificity meant that these early laser devices would measure the fluorescence of:
    a. Specific dentinal anomalies
    b. Enzymatic viral byproducts
    c. a and b
    d. Anything

17. There are now caries detection devices that image both the teeth and periodontium using:
    a. Optical Coherence Tomography
    b. Infrared Coherence
    c. Sonography
    d Refractive Guided Telemetry

18. The LED based spectroscopy caries detecting device uses an LED at a wavelength of:
    a. 680nm
    b. 820nm
    c. 405nm
    d. 360nm

19. Porphyrins fluoresce differently than other tooth structures and restorations and will produce which of the following colors?
    a. Red
    b. Green
    c. Violet
    d. Indigo

20. One compound emitted from caries-producing bacteria that is detected with fluorescence is:
    a. Lactin
    b. Casein
    c. Oxydoreductase
    d. Porphyrin

21. A visual image of their tooth can provide the patient with an interactive point of reference and is a powerful tool that allows them to:
    a. Codiagnose
    b. Understand the problem
    c. Request treatment
    d. All of the above

22. Over-fluoridation hardens the outer enamel surface, but does not penetrate sufficiently to prevent caries from occurring in the deeper layers of:
    a. Enamel
    b. Cementum
    c. Dentin
    d. Both a and c

23. Using the LED based spectroscopy caries detection device, healthy tooth structure will fluoresce:
    a. Lavender
    b. Green
    c. Red
    d. Cobalt blue

24. Which of the following researchers determined that red fluorescence is well suited to the detection of bacteria that cause dentin caries?
    a. Lennon
    b. Green
    c. Lynch
    d. Martin

25. Normal healthy tooth structure produces:
    a. Little or no fluorescence
    b. High fluorescent values
    c. Little or no phosphorescence
    d. High phosphorescent values

26. According to a review by McComb, the routine use of caries staining dye:
    a. Is an excellent method for removing caries
    b. Should be completely avoided
    c. Is a definitive diagnostic tool
    d. May lead to a profound degree of over-treatment

27. Radiographic caries detection is highly accurate for all but which of the following lesions?
    a. Cavitated proximal lesions
    b. Carious lesions within the dentin larger than 2-3mm
    c. Non-cavitated lesions
    d. Highly advanced caries lesions

28. Diagnostic techniques that use various forms of light to detect hidden carious lesions include:
    a. Transillumination
    b. Lasers
    c. LED spectroscopy
    d. All of the above

29. Which of the following researchers studied the effect of metalloporphyrins on red autofluorescence from oral bacteria?
    a. Chase
    b. Volgenant
    c. Martin
    d. Short

30. LED caries detection is based on the concept that:
    a. Decalcified teeth are more translucent than healthy teeth
    b. Health teeth are opaque
    c. Healthy teeth are more translucent than decalcified tooth structure
    d. None of the above

Notes

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Notes

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ANSWER SHEET

Light Assisted Caries Detection: 21st Century Technology

Name: ______ Title: ______ Specialty: ______

Address: ______ E-mail: ______

City: ______ State: ______ ZIP: ______ Country: ______

Telephone: Home (   ) ______ Office (   ) ______

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Educational Objectives

1. Discuss the limitations of manual and radiographic diagnostics for caries identification.
2. Describe the current equipment needed for caries diagnosis.
3. Implement the materials and steps required to access carious lesions in a minimally invasive manner.
4. Be able to restore a tooth using a variety of composite bonding agents and resins.

Course Evaluation

1. Were the individual course objectives met?

Objective #1: Yes No   Objective #2: Yes No

Objective #3: Yes No   Objective #4: Yes No

Please evaluate this course by responding to the following statements, using a scale of Excellent = 5 to Poor = 0.

2. To what extent were the course objectives accomplished overall?	5	4	3	2	1	0
3. Please rate your personal mastery of the course objectives.	5	4	3	2	1	0
4. How would you rate the objectives and educational methods?	5	4	3	2	1	0
5. How do you rate the author's grasp of the topic?	5	4	3	2	1	0
6. Please rate the instructor's effectiveness.	5	4	3	2	1	0
7. Was the overall administration of the course effective?	5	4	3	2	1	0
8. Please rate the usefulness and clinical applicability of this course.	5	4	3	2	1	0
9. Please rate the usefulness of the supplemental webliography.	5	4	3	2	1	0
10. Do you feel that the references were adequate?		Yes		No		
11. Would you participate in a similar program on a different topic?		Yes		No		

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______

13. Was there any subject matter you found confusing? Please describe.

______

14. How long did it take you to complete this course?

______

15. What additional continuing dental education topics would you like to see?

______

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4.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	19.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
5.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	20.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
6.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	21.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
7.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	22.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
8.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	23.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
9.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	24.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
10.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	25.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
11.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	26.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
12.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	27.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
13.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	28.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
14.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	29.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
15.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	30.	Ⓐ	Ⓑ	Ⓒ	Ⓓ

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