



Quick Tips

Quantifiable Caries Detection, Minimally Invasive Tooth Preparation, and Esthetic Restorations



Ian E. Shuman, DDS, FAGD
Private Practice

Associate Clinical Editor
Profitable Dentist Newsletter
Phone: 416-766-5104
Fax: 410-766-4416
E-mail: ishumandds@erols.com

During the past several decades, research has demonstrated that traditional methods and techniques for caries detection and diagnosis are inaccurate.¹⁻³ Physical diagnostic methods such as the use of an explorer for probing into pits and fissures will only reveal a "catch" if the diameter of the defect will accommodate its tip (Figure 1). A new explorer has an average tip diameter of 30 μm to 40 μm .⁴ After repeated use, the tip will dull to an average diameter of approximately 150 μm . A physically undetectable enamel pit, fissure, or defect smaller than 30 μm can accommodate a large bacterial population; therefore, caries detection by means of explorer examination is no longer considered a completely reliable diagnostic method.⁵⁻⁷

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 radiographic quality as related to radiographic exposure and development.⁷⁻⁹ Chemical detection using caries-staining dyes also are not completely accurate. These dyes are most useful when a suspicious area has been debrided of organic material or after a lesion has been initially excavated and the clinician is attempting to locate residual caries.

There also is a wide variation in the efficacy of the different caries dye materials currently available.¹⁰

Caries Detection: The Solution

Because of 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. A more quantifiable, accurate diagnostic method is required. In response to this need, recent technological advancements in laser science have generated a new diagnostic tool—the DIAGNOdent (KaVo America).

Since 1998, the DIAGNOdent has allowed very small carious lesions to be detected at an early stage and be treated in a highly conservative, minimally invasive manner.¹¹⁻¹⁸ The device is simple to use and highly accurate in detecting changes in healthy tooth structure.

DIAGNOdent: How It Works

Because of the slight, natural variances in healthy tooth structure fluorescence, a zero baseline specific to each patient should be established.¹⁹ Before scanning the tooth surfaces, select a healthy tooth surface and calibrate the unit to that tooth, establishing the zero baseline. Place the probe tip on the suspect tooth surface (of which plaque and debris has been removed), and it will accurately measure tooth fluorescence up to 2-mm deep.

When the unit's laser light is shone into the tooth surface, the tooth structure fluoresces and its information is transmitted to a circular bank

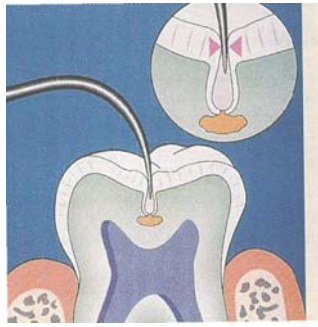


Figure 1-A new explorer cannot probe lesions smaller than its own diameter (30 μm), making physical examination of caries inexact.



Figure 2-The red diode laser light is shone into a tooth surface free of

plaque and debris. The tooth structure fluoresces, and the fluorescence is transmitted to a circular bank of detectors.



Figure 3-Tooth No.20 with darkly stained pits and fissures.



Figure 4-The DIAGNOdent is calibrated to the patient's baseline by placing the laser tip against healthy tooth structure.



Figure 5-The central-occlusal pit measures 35, indicative of caries.

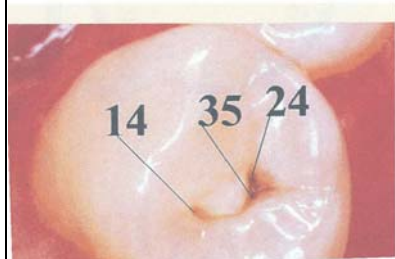


Figure 6-Laser fluorescence measurements of tooth No. 20.



Figure 7-The tooth is isolated with a rubber dam assembly and the lesion is prepared with air abrasion.



Figure 8-A. caries-staining dye highlights any remaining caries.



Figure 9-Complete caries removal.

of detectors (Figure 2). This quantifies the reflected laser light energy (fluorescence) and displays the measurement in both a numerical form and an audible sound. The sound is useful because it makes the clinician aware of a suspicious area without having to avert his or her eyes from the tooth. It may be even more important to patients, who can be told of the significance of this sound as it relates to the presence of carious lesions.

The following case study demonstrates how DIAGNOdent is used for caries diagnosis before the tooth is restored using a minimally invasive simplified restorative technique that minimizes the need for occlusal adjustment.

Case Report

Tooth No.20 showed darkly stained pits and fissures and was suspected of having an occlusal carious lesion (Figure 3). To obtain an accurate reading with the DIAGNOdent, all organic debris had to first be removed- an extremely important step because organic, noncarious material will read as a false positive and a healthy tooth could be treated unnecessarily. To safely remove the debris, sodium bicarbonate and water was sprayed on the tooth surface with a PROPHYflex handpiece (IkaVo America) and then rinsed and dried.

Table 1—Correlation of DIAGNOdent Values to Possible Course of Action

DIAGNOdent Values	Possible Course of Action*				
	No Action	Preventive Therapy	Record & Monitor	Sealant	Preparation
0-5	•				
5-10	•	•			
10-15	•	•	•	•	
15-20		•	•	•	
20-25		•***	•	•	•**
25-30		•***	•	•	•**
30+		•***			•

**Taken from Lussi.^{14,23}*

***In unusual cases of virulent disease, preparation may be a course of action when a value between 20 and 30 is recorded.*

****Regardless of course of action taken to treat a specific lesion, preventive therapy may be indicated based upon caries risk.*



Figure 10—Using the total-etch technique, 40% phosphoric acid is applied to the entire preparation for 10 seconds.



Figure 11—A single-component bonding agent is applied to the preparation, scrubbed into the restorative-bearing surface for 10 seconds, and light-cured.



Figure 12—The cavity preparation is restored with a hybrid flowable composite resin.



Figure 13-Any excess flowable resin is removed. The remaining resin is "burnished" to the occlusal table of the preparation using a resin applicator brush saturated with a highly unfilled resin before light-curing.

DIAGNOdent Detection

The DIAGNOdent was calibrated to the patient's baseline by placing the laser tip against healthy tooth structure (usually the facial of an upper central incisor) (Figure 4). The tip was then placed in the occlusal of tooth No.20 and each pit and fissure was measured and recorded (Figure 5). For this case, the highest DIAGNOdent numerical measurement depicting caries-35- was reached when the central-occlusal pit was measured, indicating carious penetration to dentin (Figure 6). Table 1 indicates the numerical output of the DIAGNOdent in regard to the presence of caries and possible courses of action, based on the findings of Lussi.^{14,19,20}

Preparation

After determining the necessity to treat the carious lesions in tooth No.20, a minimally invasive technique was used for cavity preparation. The tooth was isolated with a rubber dam assembly and the lesion was prepared with an air-abrasion system (PrepStar™, Danville Engineering) (Figure 7). A caries staining dye (Caries Finder G™, Danvill Engineering) was used to highlight any remaining caries to be removed (Figures 8 and 9).



Figure 14-The completed restoration displays a high degree of esthetics and durability.

Etching

The preparation was irrigated with copious amounts of water to remove any residual aluminum oxide powder and blotted dry. A 40% phosphoric acid gel (Onyx L/G™ Black Etch, Centrix, Inc.) was applied to the entire preparation using the total-etch technique (Figure 10). After 10 seconds, the etchant was rinsed from the tooth, and it was irrigated again with copious amounts of water to ensure complete etchant removal. The preparation was blotted dry, and a single-component bonding agent (EXCITE, Ivoclar Vivadent) was applied to the preparation in several coats, scrubbed into the restorative-bearing surface (Figure 11), gently air-dried, and light-cured.

Final Restoration

Because of the intricate shape and under-cuts present in the preparation, a restorative material was required that would have the ability to flow into the irregularities of the preparation, maintain a high degree of strength, and low wear rate, and display excellent esthetics.

In this case, a flowable hybrid composite resin (Tetric ® Flow, Ivoclar Vivadent) was chosen. A transparent shade was selected to blend with the surrounding tooth structure (Figure 12), and it was placed into the preparation in 2-mm increments before it was light-cured.

After the final increment was placed, all excess flowable composite was removed (Figures 13 and 14). The remaining flowable resin was "burnished" to the occlusal margins of the preparation using a resin applicator brush saturated in a resin-bonding agent (Heliobond™, Ivoclar Vivadent) before it was light-cured. Removing excess restorative material and "burnishing" the remaining flowable resin allows for sculpting of the final flowable layer, prevents the unnecessary step of gross occlusal adjustment, and provides for a final sealed layer at the restorative-occlusal interface.

The presence of potentially undiagnosed and untreated carious lesions concealed beneath seemingly innocuous pits and fissures is a concern for both clinicians and researcher

Conclusion

In the past, early caries detection and treatment have been demonstrated to be an effective and desirable method for maintaining optimal oral health.²¹⁻²³ Early caries diagnosis an intervention, minimally invasive tooth preparation without anesthetic, and a restoration that uses an esthetic, durable, and historically strong material that seals the occlusal interface from future tooth degradation or damage can be accomplished. This triad of early lesion diagnosis, minimally invasive preparation, and restoration is now an integral component of oral health care and promises to create a bright future for both patients and clinicians.

References:

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. *IntDent* 47(3):173-182, 1997.
3. Anderson RI: Has occlusal caries become more difficult to diagnose? *Br Dent J* 165(1):9, 1988.
4. Phillips RW: *Skinner's Science of Dental Materials*, ed 9. Philadelphia, W.B. Saunders, 1991.
5. al-Sehaibany F: The use of caries detector dye in diagnosis of occlusal carious lesions. *Clin Pediatr Dent* 20(4):293- 298, 1996.
6. Penning C, van Amerogen JP, Seef RE, et al: Validity of probing for fissure caries diagnosis. *Caries Res* 26(6):445- 449, 1992.
7. Lussi A: A comparison of different methods for diagnosis of fissure caries without cavitation. *Caries Res* 27(5): 409-416, 1993.
8. Christensen GJ: Dental radiographs and dental caries: a challenge. *J Am Dent Assoc* 127(6):792- 793, 1996.
9. White SC: Clinical and historical predictors of dental caries on radiographs. *Dentomaxillofac Radiol* 24(2): 121-127, 1995.
10. Styner D, Kuyinu E, Turner G: Addressing the caries dilemma: detection and intervention with a disclosing agent. *Gen Dent* 44(5):446-449, 1996.
11. Ando M, Hall AF, Eckert GJ, et al: Relative ability of laser fluorescence techniques to quantitate early mineral loss in vitro. *Caries Res* 31(2):125-131, 1997.
12. Hall, AF, DeSchepper E, Ando M, et al: In vitro studies of laser fluorescence for detection and quantification of mineral loss from dental caries. *Adv Dent Res* 11(4):507-514, 1997.
13. Shi XQ, Welander U, Angmar-Mansson B: Occlusal caries detection with KaVo DIAGNOdent and radiography: an in vitro comparison. *Caries Res* 34(2):151- 158, 2000.
14. Lussi A: Performance and reproducibility of a laser fluorescence system for detection of occlusal caries in vitro. *Caries Res* 33(4):261-266, 1999.
15. Eggertsson H, Analoui M, van der Yeen M, et al: Detection of early interproximal caries in vitro using laser fluorescence, dye-enhanced laser fluorescence and direct visual examination. *Caries Res* 33(3):227-233, 1999.
16. Ferreira Zandona AG, Analoui M, Beiswanger BB, et al: An in vitro comparison between laser fluorescence and visual examination for detection of demineralization in occlusal pits and fissures. *Caries Res* 32(3):210-218, 1998.
17. Ross G: Caries diagnosis with the DIAGNOdent laser: a user's product evaluation. *Ont Dent* 76(2):21-24, 1999.
18. Ross G: DIAGNOdent in pit and fissure caries diagnosis: clinical guidelines. *Oral Health* 29-30, March 2000.
19. *KaVo DIAGNOdent: Clinical Guideline, and Brief Operating Instructions. Manual.* Lake Zurich, IL, KaVo America, pp 4, 2000.
20. Lussi A: *Reproducibility of a Laser Fluorescence System for Detection of Occlusal Caries* [abstract]. 45th ORCA Congress, pp 297, 1998. Abstract 88.
21. Freedman G, Goldstep F, Seif T, et al: Ultraconservative resin restorations. *J Can Dent Assoc* 65(10):579-581, 1999.
22. Kutsch YK: Microdentistry: a new standard of care. *J Mass Dent Soc* 47(4):35- 39, 1999.
23. Ferdianakis K, White GE: Newer Class I cavity preparation for permanent teeth using air abrasion and composite restoration. *J Clin Pediatr Dent* 23(3): 201-216, 1999.