Caries Visualization With Fluorescent Technology

Radiographs are limited in their ability to identify small carious lesions. Accurate identification and localization of carious lesions can be a real aid not only for early detection, but for enhanced patient care as well.

Noninvasive sensitive in vivo caries detection has been reported in the literature since 1998. The theory is that, by means of appropriate excitation sources and porphyrin fluorescence detectors, it should be possible to identify the products known to be associated with the bacteria that are associated with dental caries. However, can fluorescence spectroscopy differentiate between healthy and carious tooth structure? Emission spectra of all types of carious lesions were shifted toward longer wavelengths (red shift), when compared to the spectra of the corresponding sound enamel which fluoresces green. This red shift was reported to be highest for dark brown spot lesions and lowest for white spot lesions. At the 405 nm wavelength, the area of the fluorescence bands at 455 and 500 nm differ statistically for natural carious lesions and sound tissue. Differentiation then can be accomplished to determine what is affected and healthy tooth structure.

This has applications with regards to pit and fissure portions of the tooth but also may be applied to smooth surfaces. One study reported that light- and dark-discolored root surface caries showed distinct fluorescence emission bands between 500 and 700 nm that were not present in sound root surface areas. These bands were strongest for wavelengths between 390 and 420 nm. The spectra of root caries revealed maximum excitation at around 405 nm.

Caries detection is especially challenging at the margins of existing restorations. Current technology (ie, DIAGNoDent [Kavo]) has not proven effective when examining tooth structure adjacent to restorative materials. These technologies rely on penetration of a laser into the tooth structure to detect demineralization. As restorative materials deflect light, an accurate assessment cannot be made at the restorations margins with the DIAGNoDent. Conversely, the spectra system (Air Techniques) utilizes the fluorescence of the porphyrins associated with specific bacteria associated with dental caries, so identification at a restorations margin may provide more definitive identification of recurrent caries.

EARLY DETECTION IS KEY

Detecting the bacteria associated with caries can make a real difference in overall patient care. Early detection is often the key to effective caries management. Although the tooth may appear healthy on the surface, its real condition underneath the surface—especially true for fissure caries—is often hard to detect. Use of an explorer can lead to cavitation of early lesions preventing remineralization due to the surface disruption or may lead to an acceleration of the caries process when the weak enamel overlying the demineralized area is physically breached by an instrument.

Enhanced caries detection, which supports minimally invasive treatment regimens, along with simplified case presentations, make Spectra an innovative, indisputable tool. Spectra offers a different view to noninvasive caries detection, enabling reliable tooth-by-tooth detection of fissure caries and caries on smooth surfaces. While other devices use numeric indicators to signal the presence of decay, Spectra uses a color visual system with software analysis to provide a picture of the tooth with visual representation of where tooth structure is deteriorating. Air Techniques Spectra is a fluorescence-based caries detection system that has received FDA clearance. Spectra’s LEDs project high-energy blue light onto the tooth surface. Light of this wavelength stimulates bacteria to fluoresce red, whereas healthy enamel fluoresces green.

Fluorescence procedures are based on illustrating certain fluorescence substances like porphyrins, which grow in bacterial populated areas. When the area is stimulated with light of a certain wavelength, the molecules absorb the light energy and release part of the light energy with a different wavelength.

Spectra is similar to an intraoral camera in appearance and function. Yet, where an intraoral camera has white LEDs surrounding the lens, Spectra has an array of 6 LEDs emitting a 405 nm blue-violet light (Figure 2). Spectra connects to the operator’s computer via a USB connector and is operated by proprietary software. The device is sheathed in a single-use disposable intraoral camera sleeve for sterility and an autoclavable rubber “spacer” is placed over the sheath at the end of the lens (Figure 2). The spacer eliminates ambient light and maintains a consistent distance between the device and the tooth surface, so images are reproducible and consistent. Spectra is both self-calibrating and portable, making it easy to use in offices with multiple operators.

SPECTRA CARIES DETECTION PROTOCOL

The practitioner or hygienist, following removal of any plaque and tartar, which may interfere with caries detection, then utilizes the Spectra to capture pictures of the teeth. The space is placed over the dry tooth and kept in contact with the tooth to be analyzed, and then Spectra is activated to capture the image. When the image is frozen on the screen, either the Vixts propri...
Table: Interpretation of Spectra (Air Techniques) data.

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<th>Initial Enamel Caries</th>
<th>Deep Enamel Caries</th>
<th>Initial Dentin Caries</th>
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Figure 7: Molar captured with Spectra in detection mode showing suspect areas in the pits and fissures.

Figure 8: Molar captured with Spectra under analyze mode indicating a high value at the central pit.

Figure 9: Preparation following removal of an existing composite restoration taken with Spectra.

Figure 10: Preparation following removal of an existing composite restoration taken with Spectra under analyze mode, indicating decay still present in the mesial aspect of the preparation.

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eytary software (a special version of Visits is supplied with the Spectra system) or a twain driver (also available, as well as plug-ins for other programs). This provides a better understanding of the areas that may become carious in the future, allowing better patient education.

**Figure 3.** A healthy premolar image taken under detection mode with the Spectra unit.

**Figure 4.** A healthy premolar image taken with the Spectra unit under detection mode, showing no highlighted areas on the tooth surface. The red area shown is gingival tissue which may have bacteria containing porphyromonas components.

**Figure 5.** A premolar image taken with the Spectra unit under detection mode showing healthy tooth structure as green and questionable areas as red.

**Figure 6.** A premolar image taken with the Spectra unit under analysis mode demonstrating areas that may become carious in the future, allowing better patient education.

**Figure 7.** Molar captured with Spectra in detection mode showing suspect areas in the pits and fissures.

**Figure 8.** Molar captured with Spectra under analyze mode indicating a high value at the central pit.

**Figure 9.** Preparation following removal of an existing composite restoration taken with Spectra.

**Figure 10.** Preparation following removal of an existing composite restoration taken with Spectra under analyze mode, indicating decay still present in the mesial aspect of the preparation.

**Figure 11.** Close-up of a carious lesion on a molar tooth, showing the various layers of decay.

**Figure 12.** Photograph of a tooth with a cavity filled with a composite material.

**Figure 13.** Diagram illustrating the process of cavity preparation and restorative treatment.

**Figure 14.** Schematic representation of a tooth showing the location of protrusion and the effect of occlusal forces.

**Figure 15.** Diagram of a tooth with a fracture line, highlighting the importance of proper occlusal adjustment.

**Figure 16.** Photograph of a tooth with a restoration, demonstrating the color matching to the surrounding enamel.

**Figure 17.** Close-up of a tooth with a well-fitted inlay, showing the precision of fit and the natural appearance.

**Figure 18.** Photograph of a tooth with a ceramic crown, illustrating the esthetic and functional benefits.

**Figure 19.** Diagram of a tooth with a dental implant, showing the integration of the implant into the bone.

**Figure 20.** Photograph of a tooth with a completed sealant, emphasizing the importance of preventing decay at the margins.

**Figure 21.** Close-up of a tooth with a fluoride application, demonstrating the effectiveness of topical fluoride treatments.

**Figure 22.** Diagram of a tooth with a crown, showing the restoration of the tooth structure and function.

**Figure 23.** Photograph of a tooth with a veneer, highlighting the aesthetic improvement.

**Figure 24.** Close-up of a tooth with a crown, emphasizing the precision of fit and the esthetic outcome.

**Figure 25.** Diagram of a tooth with a root canal, showing the extent of the infection and the path of treatment.

**Figure 26.** Photograph of a tooth with a post and core, illustrating the restorative options for severely damaged teeth.

**Figure 27.** Close-up of a tooth with a composite filling, demonstrating the strength and durability of dental materials.

**Figure 28.** Diagram of a tooth with a gum graft, showing the surgical technique for gum augmentation.

**Figure 29.** Photograph of a tooth with a gingival recession, highlighting the need for periodontal treatment.

**Figure 30.** Close-up of a tooth with a ceramic restoration, showing the natural appearance of the restoration.

**Figure 31.** Diagram of a tooth with a sealant, demonstrating the prevention of decay and the importance of regular dental care.

**Figure 32.** Photograph of a tooth with a subgingival crown, illustrating the advanced restorative techniques.

**Figure 33.** Close-up of a tooth with a porcelain veneer, emphasizing the esthetic and functional benefits.

**Figure 34.** Diagram of a tooth with a tooth-colored filling, showing the natural appearance of the restoration.

**Figure 35.** Photograph of a tooth with a glass ionomer filling, demonstrating the benefits of this material.

**Figure 36.** Close-up of a tooth with a composite filling, showing the flexibility and strength of this material.

**Figure 37.** Diagram of a tooth with a dental implant, showing the integration of the implant into the bone.

**Figure 38.** Photograph of a tooth with a porcelain fused to metal crown, illustrating the combination of strength and esthetics.

**Figure 39.** Close-up of a tooth with a metal-ceramic crown, emphasizing the durability of this material.

**Figure 40.** Diagram of a tooth with a root canal, showing the extent of the infection and the path of treatment.

**Figure 41.** Photograph of a tooth with a composite filling, demonstrating the strength and durability of dental materials.

**Figure 42.** Close-up of a tooth with a dental crown, emphasizing the precision of fit and the esthetic outcome.

**Figure 43.** Diagram of a tooth with a tooth extraction, showing the surgical technique for tooth removal.

**Figure 44.** Photograph of a tooth with a colored filling, demonstrating the availability of a wide range of colors.

**Figure 45.** Close-up of a tooth with a dental crown, showing the esthetic and functional benefits.

**Figure 46.** Diagram of a tooth with a gum graft, showing the surgical technique for gum augmentation.

**Figure 47.** Photograph of a tooth with a gingival recession, highlighting the need for periodontal treatment.

**Figure 48.** Close-up of a tooth with a ceramic restoration, showing the natural appearance of the restoration.

**Figure 49.** Diagram of a tooth with a sealant, demonstrating the prevention of decay and the importance of regular dental care.

**Figure 50.** Photograph of a tooth with a subgingival crown, illustrating the advanced restorative techniques.

**Figure 51.** Close-up of a tooth with a porcelain veneer, emphasizing the esthetic and functional benefits.

**Figure 52.** Diagram of a tooth with a tooth-colored filling, showing the natural appearance of the restoration.

**Figure 53.** Photograph of a tooth with a glass ionomer filling, demonstrating the benefits of this material.

**Figure 54.** Close-up of a tooth with a composite filling, showing the flexibility and strength of this material.

**Figure 55.** Diagram of a tooth with a dental implant, showing the integration of the implant into the bone.

**Figure 56.** Photograph of a tooth with a porcelain fused to metal crown, illustrating the combination of strength and esthetics.

**Figure 57.** Close-up of a tooth with a metal-ceramic crown, emphasizing the durability of this material.

**Figure 58.** Diagram of a tooth with a root canal, showing the extent of the infection and the path of treatment.

**Figure 59.** Photograph of a tooth with a composite filling, demonstrating the strength and durability of dental materials.

**Figure 60.** Close-up of a tooth with a dental crown, emphasizing the precision of fit and the esthetic outcome.
and cleanings at the office.

Patient communication is important in our interactions when suggesting treatment. Frequently what is obvious to the practitioner, especially with regards to initial caries, is not clear to the patient. Patients usually base their decision process on initial fillings on sensitivity in the tooth and their trust in the practitioner. But when a tooth is not sensitive, it can be difficult to get the patient to move forward with early treatment. The Spectra system is another tool in our armamentarium aiding us in both diagnosis and communication with regards incipient pit and fissure caries at the early stages. As an image is captured and values are set for specific areas of the occlusal of the posterior teeth, monitoring progress of the area when observation is decided versus clinical treatment. This allows patients to be a partner in their dental treatment and understand the options of treatment or observation better.

Additional information
For additional information, contact Air Techniques at (800) AIR TECH or visit airtechniques.com.

References

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