Mapping Occlusal Decay: The Puzzle is Solved

Dr. Fay Goldstep, DDS, FACD, FADFE

The management of dental decay, its detection, assessment and treatment, is one of the cornerstones of dental practice. The dentist and hygienist spend each workday dealing with the results of the caries process and yet, until recently, we have not had a scientific, accurate, reproducible and clinically significant way to detect the extent and severity of the damage. This situation is the most problematic on the occlusal surface where decay can lurk undisturbed in pits and fissures, causing significant breakdown of enamel and dentin before it is detected.

THE PUZZLE

The occlusal surface is a network of pits, fissures, ridges and valleys that offer excellent attachment areas for bacteria and plaque. Enamel is porous, allowing for even greater infiltration of bacteria and bacterial products. Demineralization occurs in response to the acid production of oral bacteria. Hydroxyapatite crystals are first dissolved from **the subsurface of the tooth**. The breakdown then works itself both up to the tooth surface, as well as towards the DEJ.

If so much of the early damage is under the surface and is invisible, how can the dental professional detect and judge the extent or severity of the decay?

The accepted standard for occlusal caries detection has, until recently, been visual and tactile. Unfortunately, visual inspection is inconclusive since so much occurs below the surface.

Tactile inspection with an explorer is even more problematic. Explorers can cause damage to the integrity of the enamel surface. Remineralization can sometimes reverse the caries process, but it requires an intact surface layer. The physical penetration of the surface with an explorer converts a subsurface lesion to a frank cavity, with no hope of caries reversal.[1,2]

Radiographic detection of occlusal decay is not much better. X-rays are very effective in determining interproximal decay because the tooth narrows at the interproximal. The centre of the tooth is much wider. When the

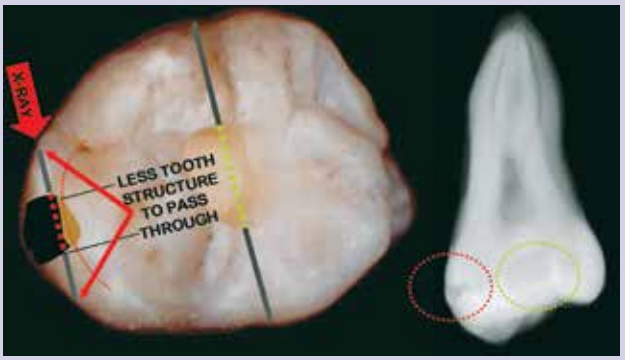

FIGURE 1—Radiographs are ineffective for occlusal decay. The radiopacity of the BLi width of intact enamel masks early decay. The interproximal area is narrower so X-rays are effective.

FIGURE 2—Spectra caries detection system (Air Techniques).

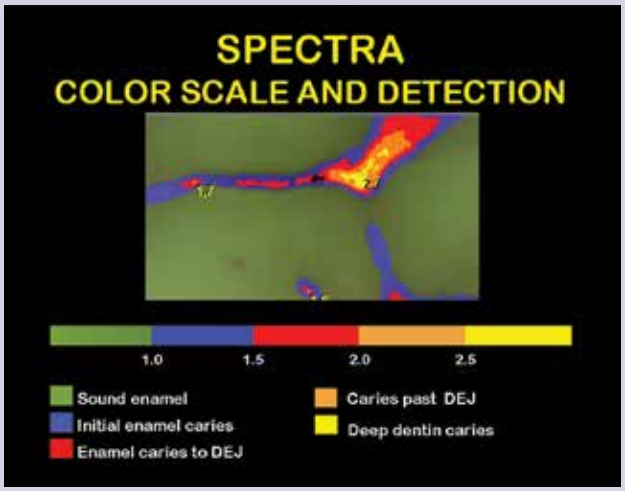

FIGURE 3—Colour map and numeric scale for Spectra.

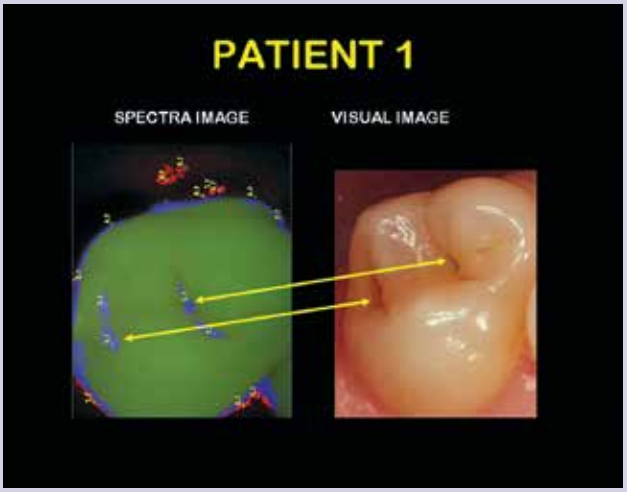

FIGURE 4—Patient 1: Spectra image and visual image (Spectra numbers are mirrored because the visual image was taken through a mirror and Spectra's direct orientation has to be correlated with this reversed image).

FIGURE 5—UL Decayed molar UR Fissurotomy bur (SS White Burs) removes incipient decay LL Minimally invasive preparation LR Preparation bonded with Beautibond (Shofu).

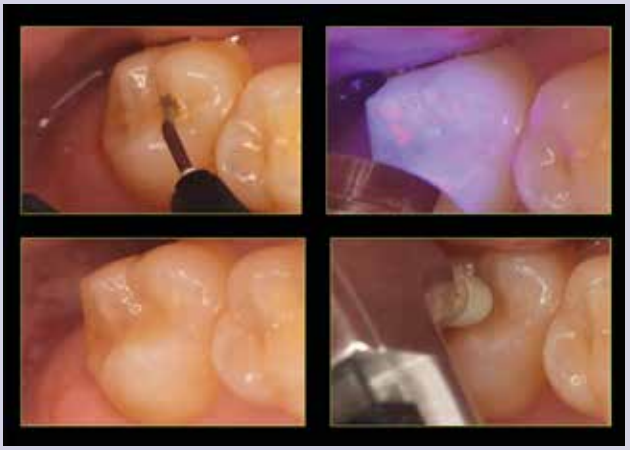

FIGURE 6—UL Beautifil Flow Plus (Shofu) placed UR Restoration polymerized LR Restoration polished with Jazz Supreme (SS White Burs) LL Completed conservative restoration.

X-ray penetrates the centre of the tooth, the high radiopacity of intact enamel can cover up the evidence of early tooth breakdown (Fig. 1). X-rays show occlusal decay only when the damage is severe and much of the tooth is affected.

SOLVING THE PUZZLE
THE WISH LIST

The first requirement of an ideal caries detection system is that it be a scientific instrument with accurate, reproducible results that reflect the clinical situation. Second, the instrument should map the tooth surface and show the location of decay, as well as its severity.

Third, there should be a means to easily visualize and differentiate the full spectrum of caries, from early enamel demineralization to deep dentin caries. This can be provided by a colour scale.

Fourth, there should also be a reproducible numeric scale that can monitor improvements or further breakdown. The values can be used for tracking the lesion or to demonstrate the situation to the patient. An objective scientific system is ideal for patient education and trust.

THE PUZZLE SOLVED
THE SCIENCE

The dental scientific community has been attempting to provide an ideal caries detection system for some time. Several products have become commercially available and have provided an adequate service. Very few have come close to fulfilling the wish list enumerated above.

A recent entry into the field, the Spectra caries detection system (Air Techniques, Melville, New York) (Fig. 2) is finally clos-

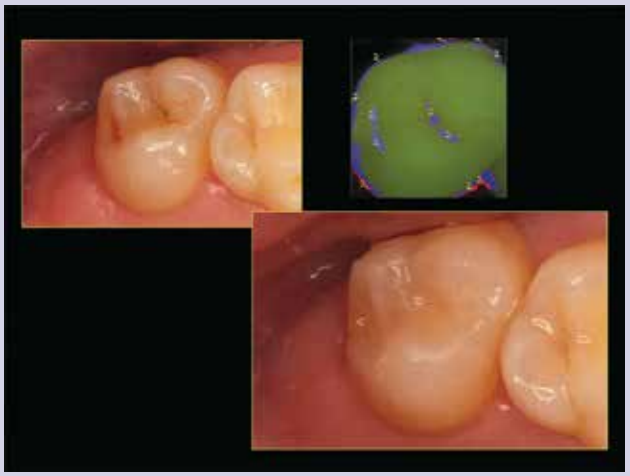

FIGURE 7—Patient 1: Initial lesion and completed restoration. Initial Spectra image.

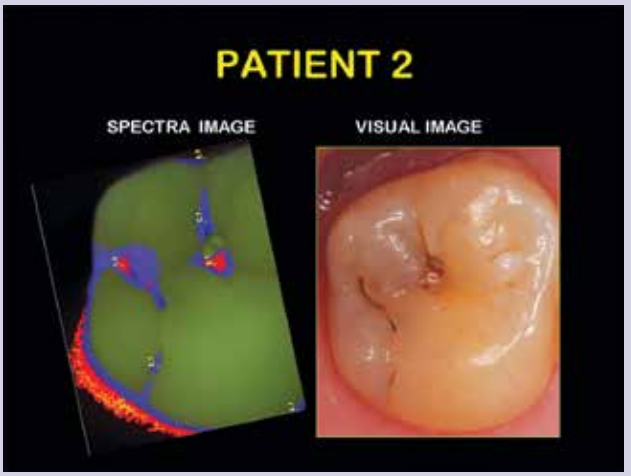

FIGURE 8—Patient 2: Spectra image and visual image.

FIGURE 9—UL Decayed molar UR Fissurotomy bur opens the lesion LR Smart Bur II (SS White Burs) removes infected dentin LL Partial excavation of decay.

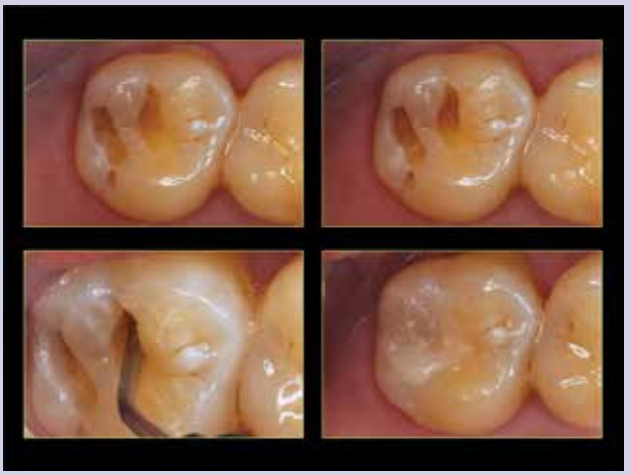

FIGURE 10—UR Partial excavation of decay UL Completed excavation of decay with Smart Bur II LL Beautifil Flow Plus placed LR Restored tooth prior to polishing.

ing in on all the requirements of the ideal caries detection system. The science is as follows:

Changes in tooth fluorescence have been used to detect early tooth surface caries since the 1980s.[3] Although oral microorganisms are not known to fluoresce, several produce orange-red fluorophores as by-products of their metabolism.[4] This fluorescence becomes a good marker for the zone of bacterial invasion into enamel and dentin.[5]

When the tooth absorbs light at 405 nm, healthy enamel will fluoresce green, while caries invaded enamel and dentin will fluoresce red. The intensity of red fluorescence can be analyzed and quantified. A map and scale of fluorescence intensity can be used to show caries location and severity (Fig. 3). This is a real-time image of the entire occlusal, facial or lingual surface, so there is no need to take multiple point readings which can be very time-consuming and technique sensitive.

The Spectra system provides colour images and numbers to show the dentist and patient the severity and extent of the lesions. The colour map is good for visualization while the number is essential for reproducibility and tracking. A value of less than 1.0 signifies healthy enamel, 1–1.5 shows an early enamel lesion, 1.5–2.0 is an advanced enamel lesion with some dentin involvement, and over 2.0 is an advanced enamel lesion with significant dentin involvement. Both the image and numerical data can be saved and used for re-evaluation at the recall exam. Clinicians can use Spectra to monitor lesion progression or regression over time.[6] This data can help determine whether remineralization therapies are sufficient or if the more traditional methods of caries removal are necessary. This is the end of the line for the flawed con-

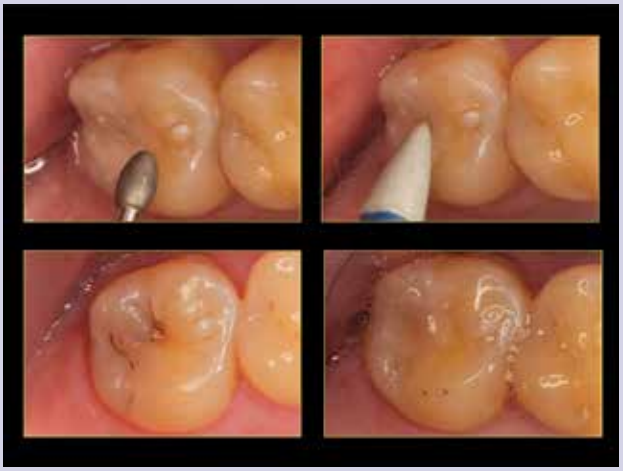

FIGURE 11—UL Restoration finished with ET bur (Brasseler) UR Restoration polished with Jazz Supreme polisher LL Initial lesion LR Completed restoration.

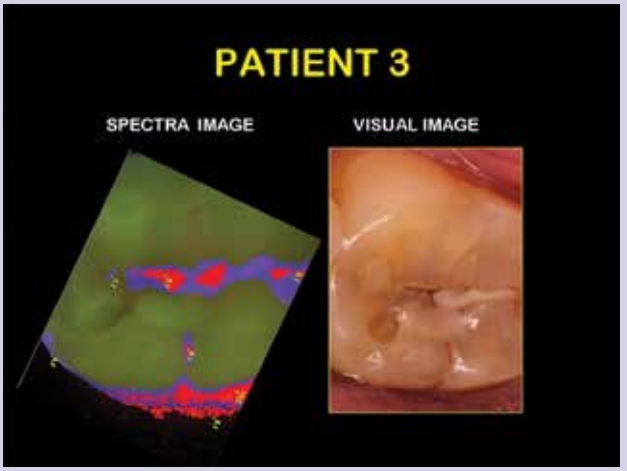

FIGURE 12—Patient 3: Spectra image and visual image.

FIGURE 13—UL Molar with decay around and through a defective restoration UR Fissurotomy bur opens the lesion LR Infected dentin removed with Smart Bur II LL Completed preparation.

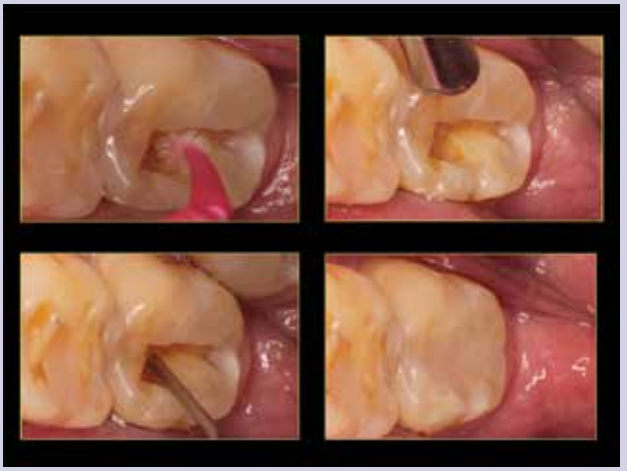

FIGURE 14—UL Preparation bonded with Beautibond UR Tooth dried LL Beautifil Flow Plus placed LR Restored tooth prior to polishing.

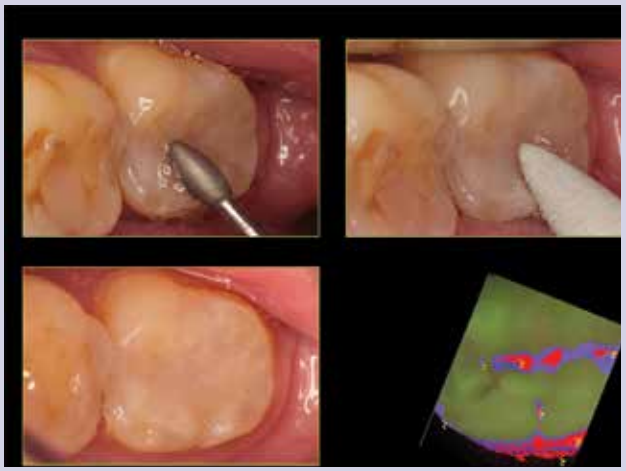

FIGURE 15—UL Restoration finished with ET bur UR Restoration polished with Jazz Supreme polisher LL Completed restoration LR Initial Spectra image.

cept of "watch and wait" and allows for the most conservative treatment possible.

CLINICAL CASES

The following clinical cases were undertaken by the author to demonstrate the reproducibility and clinical significance of using the Spectra caries detection system. The comprehensive map of occlusal decay prepares the operator for what to expect during preparation. The specifically designed minimally invasive caries excavation tools and remineralizing flowable restorative materials ensure a Proactive Intervention approach to treating occlusal decay.

Patient 1

This patient has a history of minimal decay but had one molar where caries progressed quickly,

necessitating an endodontic procedure and a crown.

The Spectra image shows readings of 1.2 to 1.4. This is in the zone of initial enamel caries. Owing to the patient's aggressive caries history, it was decided to proceed with a restoration.

1. A Spectra image is taken and correlated with the visual image (Fig. 4).
2. A Fissurotomy bur (SS White Burs, Lakewood NJ) is used to remove incipient decay in the enamel. The design of this bur ensures minimal tooth removal and no anesthetic is necessary. The tooth is bonded with Beautibond 7th generation adhesive (Shofu, San Marcos, CA) (Fig. 5).
3. Beautifil Flow Plus (Shofu) with remineralizing giomer technology is placed into the preparation and light cured. The restoration is polished using a Jazz Supreme one-step polisher (SS White Burs) (Fig. 6).

Patient 2

This patient has a history of high caries risk and has had many teeth restored.

The Spectra image shows readings from 1.3 to 1.8. This is in the zone of pronounced enamel caries with potential dentin involvement.

1. A Spectra image is taken and correlated with the visual image (Fig. 8).
2. A Fissurotomy bur (SS White Burs) is used to open the lesion. Anesthesia is required since decay is past the DEJ. Infected dentin is removed with a Smart Bur II (SS White Burs), a polymer bur that is harder than infected dentin but softer than affected or healthy dentin. Hence it selectively and conservatively removes only unhealthy tooth structure (Fig. 9).
3. The preparation is examined. The Smart Bur II (SS White) is utilized to remove the remainder of the infected dentin. The tooth is bonded with Beautibond (Shofu). Beautifil Flow Plus (Shofu) is placed into the preparation and polymerized (Fig. 10).
4. The restoration is finished with an ET bur (Brasseler, Savannah, GA) and polished with a Jazz Supreme one-step polisher (SS White Burs) (Fig. 11).

Patient 3

This patient has a history of high caries risk and many restorations. Some restorations have become decayed.

The Spectra image shows readings from 1.2 to 1.9. This is in the zone of pronounced enamel caries with probable dentin involvement. The Spectra image picks up the presence of decay around and within an old restoration.

1. A Spectra image is taken and correlated with the visual image (Fig. 12).
2. A Fissurotomy bur (SS White Burs) is used to open the lesion. Anesthesia is required since decay is past the DEJ. The defective restoration is removed. The Spectra reading of 1.9 corresponds to deep caries under the defective restoration. Infected dentin is excavated with a Smart Bur II (SSWhite) (Fig. 13).
3. The tooth is bonded with Beautibond (Shofu). Beautifil Flow Plus (Shofu) is placed into the preparation and cured (Fig. 14).
4. The restoration is finished with an ET bur (Brasseler) and polished with a Jazz Supreme one-step polisher (SS White Burs) (Fig. 15).

The above cases show clinically that the Spectra caries detection system's readings correspond to the severity and extent of decay. The occlusal surface is finally exposed to view with no hidden secrets, no surprises. Defective restorations can be examined and evaluated. They can then be repaired or replaced. Incipient lesions can be treated with remineralization therapies and then re-evaluated. The dentist is now armed with a scientific method to map decay that is accurate, reproducible and clinically significant... **THE PUZZLE IS SOLVED**. OH

Dr. Fay Goldstep sits on the Oral Health Editorial Board (Healing/Preventive Dentistry), has served on the teaching faculties of the Post-graduate Programs in Esthetic Dentistry at SUNY Buffalo, the Universities of Florida (Gainesville), Minnesota (Minneapolis), and has been an ADA Seminar Series speaker. She has lectured nationally and internationally on Soft-Tissue Lasers, Electronic Caries Detection, Healing/Proactive Intervention Dentistry and Innovations in Hygiene and has published numerous textbook chapters and articles on these topics. Dr. Goldstep is a consultant to a number of dental companies, and maintains a private practice in Markham, Ontario. She can be reached at goldstep@epdot.com.

Oral Health welcomes this original article.

REFERENCES

1. Bergman G, Linden LA. The action of the explorer on incipient caries. Svensk Tandlak Tidsk 1969; 62:629-34.
2. Ekstrand K, Qvist V, Thylstrup A. Light microscope study of the effect of probing in occlusal surfaces. Caries Res 1987; 21:368-74.
3. Bjelkhagen H, Sundstrom F, Angmar-Mansson B, Ryden H. Early detection of enamel caries by the luminescence excited by visible laser light. Swed Dent J 1982; 6:1-7.
4. Konig K, Schneckenburger H. Laser-induced auto fluorescence for medical diagnosis. J Fluoresc 1997; 4:17-40.
5. Lennon A, Buchalla W, Switalski L, Stookey G. Residual caries detection using visible fluorescence. Caries Res 2002; 36:315-319.
6. Graye M, Markowitz K, Strickland M, Guzy G, Burke M, Houpt M. In vitro evaluation of the Spectra early caries detection system. J Clin Dent 2012; 23;1-6.