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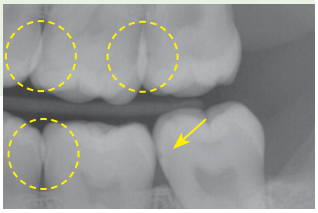
Caries Detection: Optimizing and Augmenting Radiography

Gordon's Clinical Observations: Radiographs are the standard of care for diagnosing caries. All dental team users know, however, the challenges associated with inconsistent images, inaccuracies, and interpreting subtle shades of gray. Digital radiographs do not have the same resolution as film-based radiography. What is being done to improve digital radiography? What can you do to augment radiography? *CR has answers, some positive, to share with you in this issue.*



Bitewing radiographs seldom show all contacts open. Additional images at different angles will be necessary for an accurate diagnosis.

Radiographs readily show large lesions that have cavitated into dentin, but visualizing caries in enamel and accurately monitoring their progression remains difficult or impossible.

Caries extend well beyond what is visible in radiographs—in extent of microbial colonization, demineralized tissue, and staining. Outcomes improve when appropriate interventions are made while lesions are small—tooth structure and strength are saved; material costs are lower; and clinical time and patient discomfort are reduced.

The following report includes clinical tips to optimize radiography, a "First Look" evaluation of DC-Air digital sensor, and a review of other caries detection technologies.

Why are today's radiographs less detailed than analog/film radiographs?

- **Lower resolution:** The effective pixels sizes of digital radiographs are significantly larger than the silver grains of film.
- **Less radiation:** Digital sensor and high-speed film are "fast" *(sensitive)* and require less radiation to produce a diagnostic image. While beneficial in many ways, this can reduce the ability to differentiate subtle differences in tissue density.

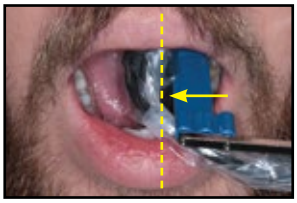
Clinical Tips for Optimizing Caries Detection with Radiographs

- **Position and orient sensor correctly:** Proper alignment is critical for diagnosis. Sensor and teeth should be parallel, and interproximal contacts should be clear.

Use a positioning system to help position the sensor accurately and maintain alignment.

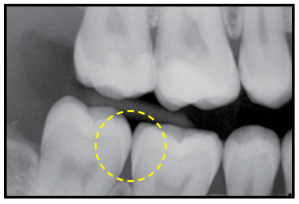
When access is limited, use smaller sensors as necessary *(size 0, 1, or 1-1/2).*

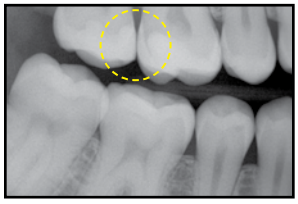
Rounded corners allow for more accurate positioning, especially toward mesial and against palate.



In small mouths or when bony structures intrude, position the sensor toward the vaulted area of the mouth instead of against the teeth to minimize tipping of the sensor when the patient closes.

Thin and cordless phosphor plates can improve access.





Multiple images at different angles are often necessary to visualize questionable areas. Example radiographs show two images of same patient. The first angle opens the contact between teeth 30 and 31. The second opens the contact between teeth 2 and 3.

- **Use correct exposure:** Too little radiation will fail to differentiate structures within the tissues. There is a tendency to under-expose digital radiographs and lose detail because the software automatically adjusts images to make them appear properly exposed. Slightly darker images are generally preferred for identifying caries.
- **Take time to study radiographs:** The longer an image is viewed, the more detail is perceived. However, avoid staring at one spot more than a few seconds, and frequently move the eyes to make comparisons. Look just to the side of an area of interest *(averted vision)* to allow the more sensitive part of the eye to distinguish the shades of gray. Have a staff member also help analyze radiographs.
- **Use image enhancements wisely:** Caries enhancement tools bring out details that would otherwise be missed by the eye and brain, but other information is destroyed. Maximize perception of information by alternately viewing the original image and enhanced image.
- **What's in the future?** Technologies already entering the market include intraoral tomography for 3D visualization and deep learning algorithms *(artificial intelligence)* for automatic identification of structures and analyses of lesions.

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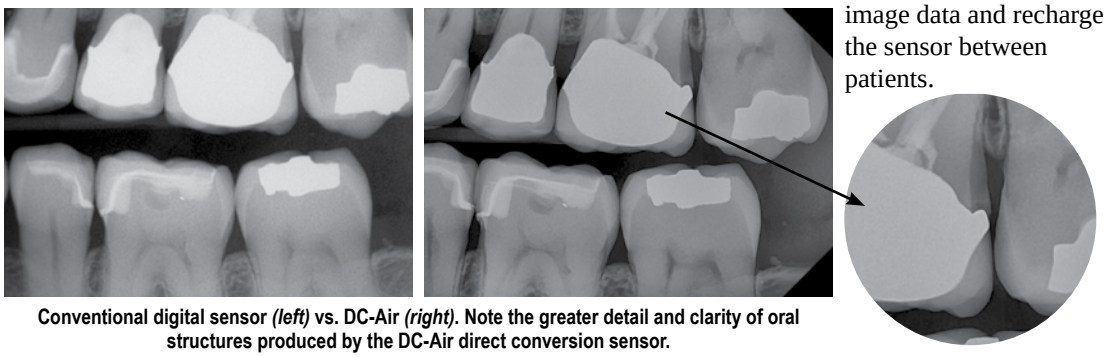
Caries Detection: Optimizing and Augmenting Radiography *(Continued from page 1)*

CR "First Look": DC-Air wireless intraoral radiography sensor

DC-Air
***FTG** (Freedom Technologies Group)* ftgimaging.com
Cost: $12,999, includes 1 sensor, 2 docking stations, positioning system, software, and technical support; additional docking stations: $995/Operatory

DC-Air by FTG is a size 2 cordless digital radiography sensor that utilizes "direct conversion" where the x-ray sensitive layer is bonded directly to the CMOS sensor, improving resolution and eliminating the conventional glass fiber optic plate common in other sensors. This and the lack of a cable make the sensor more robust and durable. It features Bluetooth wireless data transfer and a built-in rechargeable Li-ion battery. The USB-C docking station can be located anywhere within 9 feet of chair to receive image data and recharge the sensor between patients.



Conventional digital sensor *(left)* vs. DC-Air *(right)*. Note the greater detail and clarity of oral structures produced by the DC-Air direct conversion sensor.

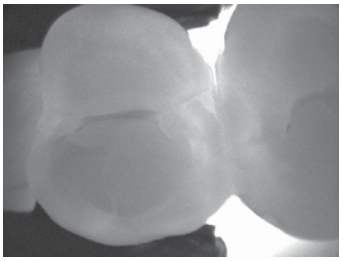
CR's "First Look" evaluation found it produced excellent detailed images with high resolution and excellent dynamic range *(exposure latitude)*. Wireless image transfer and processing took only 6–8 seconds, which was not a noticeable impediment to the digital imaging workflow. Both staff and patients found the wireless sensor easy to work with and more comfortable than conventional corded sensors.

Additional Technologies for Caries Detection

Radiographs have limitations related to caries detection, namely: view from facial only, masking by radiopaque structures *(enamel, restorative materials)*, overlapping anatomy, and difficult placement in some areas of the oral cavity. Numerous products are designed specifically to overcome these challenges, but integration has been limited. Most require additional time for use with increased cost and complexity. Some technologies lack precision or means to document findings. Data from a recent CR survey *(n=717)* are shown.

▶ Transillumination

Visible or infrared light shines through the tooth, allowing visualization of internal structures from occlusal, mesial, and distal directions. Used by 65% of clinicians to aid caries detection.
Example brands: DEXIS CarisVu infrared, Lumindex 3 visible, Microlux 2 visible



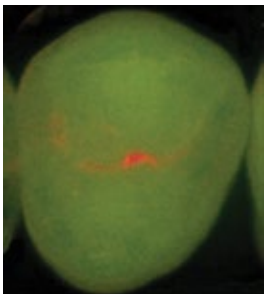
Transillumination example

▶ Caries Indicator Dye

Dyes stain demineralized dentin and caries more profoundly than healthy tooth structure, revealing approximate extent of lesion. Dyes are available in red, blue, and green for contrast with tooth structure. Useful on both the external surface of tooth and inside the prep during excavation. Used by 31% of clinicians to aid caries detection.
Example brands: Caries Detector, Caries Finder, Caries Indicator, Expose, Sable Seek, Seek, To Dye For
Note: If using silver diamine fluoride *(e.g., Advantage Arrest)* to identify caries, apply to occlusal surface only to avoid unsightly black stains on facial surfaces.

▶ Fluorescence

Tooth is illuminated with a specific wavelength of energy causing fluorescence. Demineralized tissue and caries fluoresce a different color than surrounding structures. Particularly useful for occlusal, facial, and lingual surfaces. Can provide a qualitative and quantitative indication of location and extent of lesions making it useful for monitoring caries progression. Used by 11% of clinicians to aid caries detection.
Example brands: The Canary System, CamX Spectra, DIAGNOdent Pen, SOPROLIFE



Fluorescence example

▶ Air Slurry Polisher/Air Abrasion

Polishers using sodium bicarbonate remove plaque and extrinsic stain from pits, fissures, and subgingival areas. This is particularly useful for occlusal caries, and significantly improves the accuracy of fluorescence instruments. Abrasion units using aluminum oxide remove plaque and stains, and can also be used for minimally invasive preparations of pits and fissures. Used by 8% of clinicians to aid caries detection.
Example polisher brands: Air-Flow Handy 3.0, Air-N-Go, Cavitron Prophy Jet, Minipolisher II, PROPHYflex 4
Example air abrasion brands: AquaCare, PrepStart, RONDOflex Plus

CR CONCLUSIONS: Digital radiography has been one of the most rapidly incorporated technologies of recent times and continues to be the standard for caries detection. Unfortunately, the ease of image acquisition can lead to complacency in diagnostic image quality. Radiographs must be optimized for improved caries detection, including: accurate positioning, digital enhancements, proper exposure, attention to detail when interpreting, and understanding of the limitations. Other caries detection technologies useful for specific situations include transillumination, air slurry polishers, air abrasion, fluorescence, and dyes. The DC-Air direct conversion sensor represents a promising improvement in image detail and clarity.

What is CR?

WHY CR?

CR was founded in 1976 by clinicians who believed practitioners could confirm efficacy and clinical usefulness of new products and avoid both the experimentation on patients and failures in the closet. With this purpose in mind, CR was organized as a unique volunteer purpose of testing all types of dental products and disseminating results to colleagues throughout the world.

WHO FUNDS CR?

Research funds come from subscriptions to the Gordon J. Christensen Clinicians Report®. Revenue from CR's "Dentistry Update®" courses support payroll for non-clinical staff. All Clinical Evaluators volunteer their time and expertise. CR is a non-profit, educational research institute. It is not owned in whole or in part by any individual, family, or group of investors. This system, free of outside funding, was designed to keep CR's research objective and candid.

HOW DOES CR FUNCTION?

Each year, CR tests in excess of 750 different product brands, performing about 20,000 field evaluations. CR tests all types of dental products, including materials, devices, and equipment, plus techniques. Worldwide, products are purchased from distributors, secured from companies, and sent to CR by clinicians, inventors, and patients. There is no charge to companies for product evaluations. Testing combines the efforts of 450 clinicians in 19 countries who volunteer their time and expertise, and 40 on-site scientists, engineers, and support staff. Products are subjected to at least two levels of CR's unique three-tiered evaluation process that consists of:

1. Clinical field trials where new products are incorporated into routine use in a variety of dental practices and compared by clinicians to products and methods they use routinely.
2. Controlled clinical tests where new products are used and compared under rigorously controlled conditions, and patients are paid for their time as study participants.
3. Laboratory tests where physical and chemical properties of new products are compared to standard products.

Clinical Success is the Final Test

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***CRA Foundation® changed its name to CR Foundation®* in 2008.**

This team is testing resin curing lights to determine their ability to cure a variety of resin-based composites.

Every month several new projects are completed.

THE PROBLEM WITH NEW DENTAL PRODUCTS.

New dental products have always presented a challenge to clinicians because, with little more than promotional information to guide them, they must judge between those that are new and better, and those that are just new. Because of the industry's keen competition and rush to be first on the market, clinicians and their patients often become test data for new products.

Every clinician has, at one time or another, become a victim of this system. All own new products that did not meet expectations, but are stored in hope of some unknown future use, or thrown away at a considerable loss. To help clinicians make educated product purchases, CR tests new dental products and reports the results to the profession.