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# Clinicians Report®

Reprint



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## Digital Radiography: Addressing the Challenges

**Gordon's Clinical Observations:** Digital CMOS (*complementary metal oxide semiconductor*) x-ray sensors have wonderful advantages but also some glaring limitations. Their thickness, rigidity, high cost, frequent repair, and difficulty of accurate interpretation of caries need immediate attention by manufacturers. Some of the challenges are being overcome by changes in technologies, and most manufacturers know that additional modifications are needed for this everyday technology. *CR scientists and clinicians have analyzed CMOS sensors, and they provide current information and suggestions for you in this issue.*

Digital sensors have revolutionized radiography—from bitewings to endodontics. Advantages include instant radiographs, patient education, reduction of x-ray dose, and elimination of wet chemistry. Clinical challenges include the size and rigidity of the sensors, and inconsistent image quality and detail. **The following report shows ways to address some of the common challenges with intraoral digital radiography, and reviews the features of eight current sensors.**



**Figure 1:** Large sensors (top) can be difficult to position. Options include phosphor plates and smaller sensors.

*Continued on Page 2*



# Digital Radiography: Addressing the Challenges *(Continued from page 1)*

## Common Clinical Challenges and Methods to Minimize Them

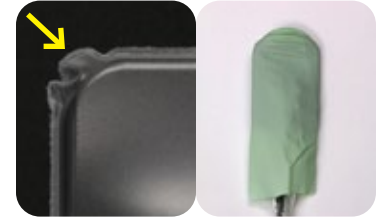
### 1. Bulky, Rigid Sensors

Common complaints include patient pain, difficulty positioning sensor for correct alignment, and dislodging sensor as patient closes.

- Use **phosphor plates** for indications not needing immediate images (e.g., ScanX). Plates have size, thickness, and flexibility similar to film packets. (See Clinicians Report November 2015 for information on phosphor plate systems.)
- Use **smaller sensors** when necessary (e.g., size 1, size 0) for improved intraoral access. (See Figure 1 on page 1.)
- Use **sensors with rounded corners or thin body** (e.g., Clio, DEXIS, DentiMax Dream Sensor, KaVo IXS). (See Figure 2.)
- **Avoid barrier sleeves with sharp seams and edges.** Cover with finger cot, foam guard, or finger of glove. (See Figure 3.)
- **Manufacturers are encouraged to develop soft, comfortable sensors** (e.g., Wave Sensor).



**Figure 2:** Rounded corners can improve sensor positioning and patient tolerance.

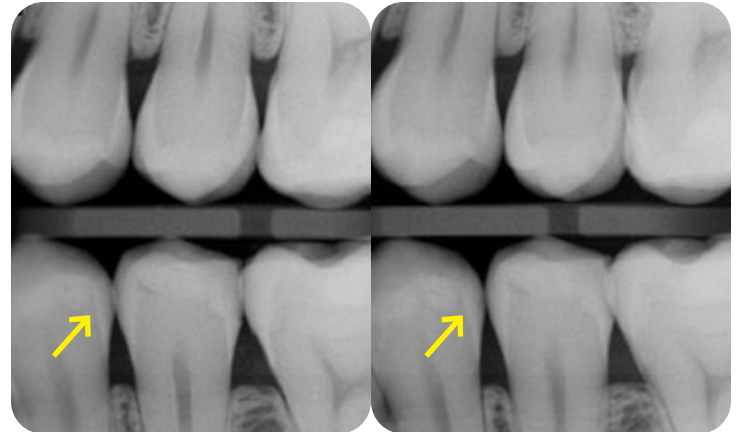


**Figure 3:** Barrier sheaths can have sharp and jagged edges. Cover with a glove finger, finger cot, or foam guards for patient comfort.

### 2. Positioning and Alignment

Proper positioning is essential, regardless of technology used. Clinicians indicated that the most common alignment challenges were periapicals of maxillary canines, maxillary molars, and mandibular centrolaterals—as well as molar and premolar bitewings! Unfortunately, the ease of acquiring digital images can inadvertently lead to sloppy technique.

- **Demand good radiographs. Learn anatomy and evaluate landmarks as sensor and tube head are being positioned.** Don't blindly trust the positioner. (See Figure 4.)
- **Bar and ring positioners (RINN style)** have proven most effective for holding and aligning rigid sensors. Bite tabs and improvised holders are frequently needed for some alignments.
- **Position sensor toward middle of oral cavity**, where the vault of the palate will not impinge on the sensor, using the paralleling technique. Periapicals often require the bisecting angle technique as the sensor must be tilted to capture the root tips.

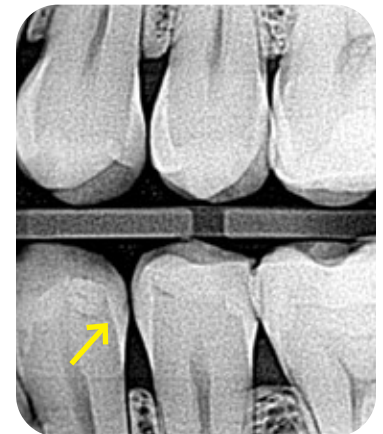


**Figure 4:** Opening all contacts often requires multiple bitewing orientations. Interproximal caries on teeth 20–21 are hidden by overlap in radiograph on left, but obvious in radiograph on right.

### 3. Resolution and Detail

Digital sensors do not equal conventional film in resolution or sensitivity to structural density. However, their instant images, diagnostic capability, patient education value, and reduced radiation are well established. Image enhancement capabilities improve diagnostic value.

- **View original image** in addition to enhanced image. Enhancement tools are a significant advantage of digital radiography, but should be used with care. Images often become **sharp but grainy, creating a false perception of detail** and possible artifacts. (See Figure 5.) **Re-train your brain to perceive details in the subtle shades of gray in unenhanced images.**
- **Make additional radiographs** at different angles if first image is questionable.
- **Avoid under- and over-exposure.** Image processing algorithms often optimize contrast and appearance even if poor exposure failed to capture details. Find correct exposure for your system and post it on equipment. (See Figure 6.)



**Figure 5:** Image enhancement of interproximal region shown in Figure 4 makes caries more apparent, but edge effects and grainy appearance hide other details. Use enhancement with care.

### 4. Cost and Repairs

X-ray imaging technology is complex and expensive. Sensors are subjected to stress events every day, including bites, drops, cord pulls, and disinfection chemicals. (See Clinicians Report May 2016 for information on care and repair of sensors.)

- Use **sensors with improved longevity**—durable outer housing, sealed for immersion disinfection, reinforced cord, replaceable cord, etc.
- **Consider low-cost sensors** available from some manufacturers.
- **Purchase a repair plan.** Many manufacturers offer maintenance and replacement options that cost less over time than replacing a sensor.
- Use **phosphor plates** when immediate image not required. Individual plates are available in a variety of sizes and easily replaced if damaged.


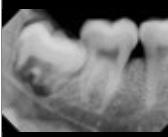

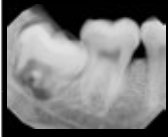














**Figure 6:** Underexposed radiograph where software adjusted the contrast to make it appear acceptable. However, notice the streaking effects and lack of detail.

# Digital Radiography: Addressing the Challenges (Continued from page 2)

## Features of Eight Digital Radiography Sensors

The following chart shows seven CMOS sensors and one phosphor plate sensor, listed alphabetically, that were evaluated in controlled clinical and scientific tests. An example sensor is shown (*size 2 or similar*) with key features related to ease of use.

Brand Company	Photos	Sensor Sizes Available (Approx. Price)*	Dimensions	Active Image Area	Infection Control Options	Cord	Example Radiograph (Jaw Phantom)	Key Features
<b>Clio</b> SOTA Imaging		Size 2: \$5,995 Size 1: \$4,995	Size 2 shown 43 × 31 mm 5.3 mm thick	900 mm <sup>2</sup> ~68% of sensor	Sheath Wipe Submerge	USB 6.4 feet		<ul style="list-style-type: none"> <li>• Round edges</li> <li>• Rounded corners</li> <li>• Thin</li> <li>• Two sizes</li> </ul>
<b>Dexis Titanium</b> KaVo Imaging		PerfectSize: \$10,995	40 × 30 mm 8.8 mm thick	790 mm <sup>2</sup> ~67% of sensor	Sheath Wipe	USB 8.5 feet		<ul style="list-style-type: none"> <li>• Round edges</li> <li>• Clipped corners</li> <li>• Intermediate size</li> <li>• Touch-free control</li> </ul>
<b>Dream Sensor</b> DentiMax		Size 2: \$6,999 Size 1: \$5,999	Size 2 shown 43 × 31 mm 5.3 mm thick	900 mm <sup>2</sup> ~68% of sensor	Sheath Wipe Submerge	USB 6.3 feet		<ul style="list-style-type: none"> <li>• Round edges</li> <li>• Rounded corners</li> <li>• Thin</li> <li>• Two sizes</li> </ul>
<b>KaVo IXS</b> KaVo Imaging		Size 2: \$9,995 Size 1: \$8,995	Size 2 shown 43 × 30 mm 8.2 mm thick	860 mm <sup>2</sup> ~66% of sensor	Sheath Wipe	USB 8.5 feet		<ul style="list-style-type: none"> <li>• Round edges</li> <li>• Rounded corners</li> <li>• Two sizes</li> </ul>
<b>RVG 6200</b> Carestream		Size 2: \$6,000 Size 1: \$6,000	Size 2 shown 44 × 32 mm 7.3 mm thick	930 mm <sup>2</sup> ~66% of sensor	Sheath Wipe Submerge	USB 9.3 feet		<ul style="list-style-type: none"> <li>• Round edges</li> <li>• Two sizes</li> </ul>
<b>Schick 33</b> Dentsply Sirona		Size 2: \$7,995 Size 1: \$7,695 Size 0: \$5,695	Size 2 shown 43 × 31 mm 7.0 mm thick	910 mm <sup>2</sup> ~68% of sensor	Sheath Wipe	USB module 5.8 feet User-replaceable		<ul style="list-style-type: none"> <li>• Round edges</li> <li>• Three sizes</li> <li>• Replaceable cord</li> </ul>
<b>Wave Sensor</b> Vatech		Size 2: \$7,999 Size 1.5: \$7,999	Size 1.5 shown 41 × 30 mm 7.6 mm thick	740 mm <sup>2</sup> ~60% of sensor	Sheath Wipe Submerge	USB 9.5 feet		<ul style="list-style-type: none"> <li>• Comfortable soft silicone</li> <li>• Round edges</li> <li>• Clipped corners</li> <li>• Slightly pliable</li> <li>• Two sizes</li> </ul>
<b>Phosphor Plate</b> ScanX Air Techniques		Size 4: \$180 Size 3: \$73 Size 2: \$58 Size 1: \$60 Size 0: \$60	Size 2 shown 41 × 31 mm 0.4 mm thick	1220 mm <sup>2</sup> ~95% of sensor	Sheath Wipe Submerge	None		<ul style="list-style-type: none"> <li>• Thin</li> <li>• Round corners</li> <li>• Pliable</li> <li>• Large imaging area</li> <li>• Five sizes</li> </ul>

*\* Approximate prices are shown. Actual prices can vary tremendously with promotional discounts.*

### Summary of Evaluation:

- All systems tested made clinically acceptable radiographs. Images could be adjusted and enhanced to clinicians' preferences.
- Imaging software varied greatly among brands, but once learned, all were simple and fast to operate.
- CMOS sensors made nearly instantaneous images and had easier infection control (*one barrier sheath per patient*), but were bulky and rigid. Phosphor plates had similar handling as film, but required scanning and wrapping and unwrapping individual plates.
- If looking to acquire sensors or change brand, consider features that improve ease of use such as rounded corners, smaller size, thinner, replaceable cable, etc. If staying with current brand, suggestions on previous page can help optimize use.
- A survey of 760 clinicians indicated that popular models were DEXIS (38%), Schick (27%), RVG (15%), GXs now KaVo IXS (6%), Dream Sensor (2%), plus 17 additional brands reported in use.

### CR CONCLUSIONS: Digital radiography has revolutionized dentistry, but **manufacturers need to improve sensors immediately!**

- Bulky, rigid sensors are uncomfortable and hamper proper placement and alignment in some situations.
- Image quality and detail are often inferior or inconsistent.
- Cost is high, and sensors frequently suffer damage.

Challenges can be minimized with knowledge of oral anatomy, proper clinical technique, attention to detail, and selection of appropriately sized sensors and positioning equipment. All systems tested produced clinically useful images. Individual convenience features varied among sensor brands and designs.

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## 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.

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## 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:

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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.

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*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.*

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***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.***

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