Further Reading

Advisory Task Force on Bisphosphonate-Related Osteonecrosis of the Jaws, American Association of Oral and Maxillofacial Surgeons. American Association of Oral and Maxillofacial Surgeons position paper on bisphosphonate-related osteonecrosis of the jaws. *J Oral Maxillofac Surg* 2007; 65(3):369–76.

Migliorati CA, Casiglia J, Epstein J, Jacobsen PL, Siegel MA, Woo SB. Managing the care of patients with bisphosphonate-associated osteonecrosis: an American Academy of Oral Medicine position paper. *J Am Dent Assoc* 2005; 136(12):1658–68.

A patient brochure on bisphosphonates produced by McGill University's faculty of dentistry is available online at www.cda-adc.ca/jcda/vol-74/issue-7/617.html.

QUESTION 3

Which digital intraoral sensor is better?

Background

There are 2 types of intraoral sensors: direct sensors and storage phosphor sensors. Direct sensors, whether they use charge-couple-device or complementary metal oxide semiconductor technology, are equivalent in terms of image quality.[1] Image display is instantaneous as these sensors are connected to a computer. The storage phosphor sensor is a plate, with dimensions comparable to those of conventional film; images are obtained when the plate is inserted into and read by a scanner.

Several experts believe that today's sensors are reaching their technological limits. Both direct and storage phosphor sensors are capable of producing diagnostic images for the tasks dentists perform daily, such as diagnosing caries, identifying periapical lesions and evaluating periodontal bone loss (**Figs. 1–4**).[2–7]

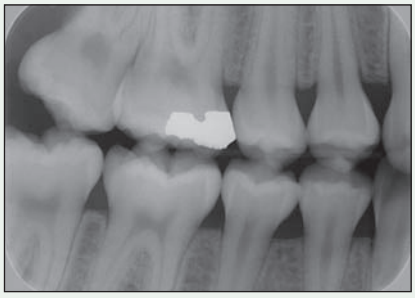

Figure 1: Interproximal image taken with a storage phosphor sensor.

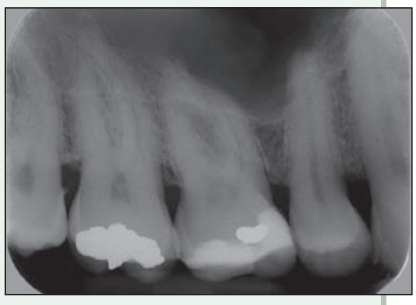

Figure 2: Periapical image taken with a storage phosphor sensor.

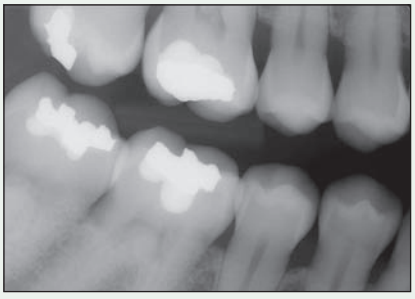

Figure 3: Interproximal image taken with a direct sensor.

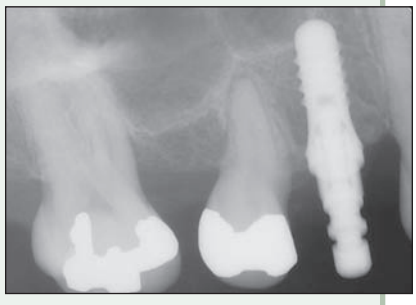

Figure 4: Periapical image taken with a direct sensor.

Digital Sensor Characteristics

The characteristics of digital sensors that have an impact on image quality are contrast resolution, spatial resolution, latitude and sensitivity.

Contrast resolution is the ability to detect differences between shades of grey. Theoretically, a sensor capable of capturing more shades of grey (greater bit depth) is better. However, because computer monitors display only 8-bit images, in practice there will be no difference between intraoral sensors that capture 8-bit images (256 levels of grey), 12-bit images (4,096 levels of grey) and 14-bit images (16,384 levels of grey).[8,9] In addition, the number of grey shades differentiated by the human eye is between 32 and 60.[10]

Spatial resolution is the ability to capture details and is measured in line-pairs per millimetre (lp/mm). Film achieves a resolution of up to 20 lp/mm. Newer sensors with a pixel size of 20 µm are able to resolve 25 lp/mm. Storage phosphor systems achieve a lower resolution than direct sensors. Most dentists can perceive 6 lp/mm and up to 10–12 lp/mm with magnification; images magnified above that become pixilated and non-diagnostic. Digital sensors available today have a resolution of 7 lp/mm or more.[11]

Latitude is the ability of digital receptors to provide diagnostic images

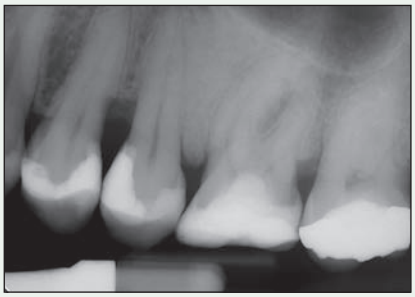

Figure 5: This image, taken with a direct sensor, doesn't show tooth apices.

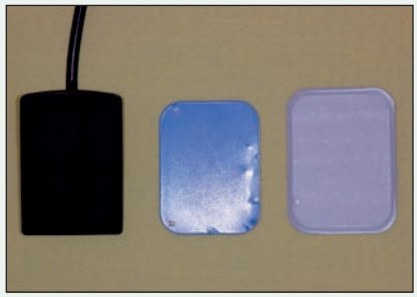

Figure 6: From left: size 2 direct sensor, size 2 plate for a storage phosphor sensor and size 2 film.

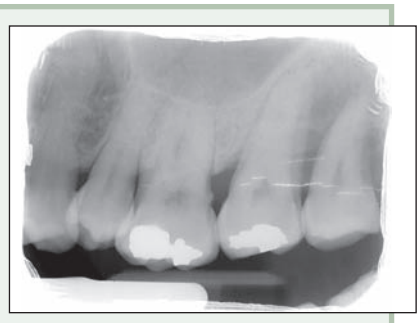

Figure 7: Storage phosphor sensor plate that is scratched and damaged at the edges.

with a range of exposures. A disadvantage of conventional film is that it is easily overexposed or underexposed. Although the latitude of direct sensors is comparable to that of film, storage phosphor sensors have a greater latitude and, under normal conditions, images are unlikely to be overexposed or underexposed.[10] The downside is the greater dose of radiation that patients will receive if greater exposure is used consistently.[12]

Sensitivity is the amount of exposure required to produce an image. The more sensitive the receptor, the less exposure is required. One well-known advantage of intraoral digital radiography is the lower dose of radiation to which patients are exposed. The most sensitive intraoral film available is F-speed. Storage phosphor systems can produce images using half the exposure necessary with F-speed film. Direct systems require more exposure than storage phosphor systems, but less than F-speed film.

All imaging software products offer a range of tools for dentists to use to enhance their images. However, the goal is to acquire good-quality diagnostic images that require no enhancement, as modifying images may have deleterious effects.[13,14] Clear task-specific indications for the various enhancement tools have yet to be developed.

Management Advice

Direct Systems

Advantages

- Instantaneousness
- Additional images can be obtained without removing the sensor from the mouth
- Spatial resolution superior to storage phosphor

Disadvantages

- Sensors are expensive and fragile
- Physical properties of the sensor: thick, rigid, attached cable. Positioning devices are available for all direct sensors to allow the device to be placed parallel to the teeth. However, this technique is not always possible, particularly for patients with a narrow palate. Reverting to the bisecting technique is more frequent than with film. Missed apices are a common problem, particularly for new users of this technology (**Fig. 5**). The presence of the cable makes obtaining an image of vertical bitewings almost impossible.
- More than one size sensor will be needed. Most companies offer size 1 and 2 sensors whose active areas are smaller than their film counterparts. Some companies now offer a size 0 sensor for pediatric applications. Size 2 sensors are required for interproximal examinations to view the bone level, but obtaining a distal image of the canines with these large sensors is challenging (**Fig. 3**).
- More exposures are required compared with film because of the smaller active surface area of direct sensors and difficulties in positioning (**Fig. 6**).
- The learning curve is greater than with storage phosphor sensors.

Storage Phosphor Systems

Advantages

- Latitude superior to direct sensors and film
- Sensitivity superior to direct sensors and film
- Sensor thickness and flexibility are comparable to those of film
- Plates available in sizes 0 to 4
- Plates compatible with standard positioning devices for obtaining periapical, horizontal and vertical interproximal radiographs

- Transition from film to storage phosphor is simple

Disadvantages

- Spatial resolution inferior to that of direct sensors
- Scanning of exposed plates is required. Scanning time increases with the size and number of plates and required resolution
- Space for the scanner is required, preferably in a dimmed environment as exposed plates are sensitive to light
- With handling, plates become scratched and damaged at the edges (**Fig. 7**) and must be replaced regularly[15]

Lighting Requirements

The lighting conditions under which images are interpreted must be considered. Dental operatories are generally equipped with high ambient light; this must be reduced to create an environment suitable for analysis of digital images.[16] Adjusting the contrast and brightness of monitors will also improve image quality.[17] Cathode ray tube monitors tend to lose brightness with time.

Transition Period

Regardless of the system selected, expect a transition period to adapt to looking at digital images, which appear to have less detail. The evidence shows that the information needed to make common diagnoses is there. The medical profession adopted digital radiology to replace conventional plain films before the dental profession, possibly because radiologists were used to reading computed tomography and magnetic resonance imaging scans on monitors. However, as stated by Ludlow and Mol, "It is no longer a matter of *if* but rather *when* the majority of dental offices will use digital imaging."[11]

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