

Dental Radiography – Core Subject

Digital Radiography

Aims: To develop an understanding of the history of digital radiography, the different types of digital x-rays and the advantages and disadvantages of digital dental radiography.

Learning outcomes: On completion of this verifiable CPD article the participant will be able to demonstrate, through completion of a questionnaire, the ability to:

- Identify key dates in the history of dental radiography
- Describe the difference between direct and indirect digital radiography
- Identify the two types of corded sensors used in digital radiography
- Describe some of the advantages and disadvantages of digital radiography

Introduction

Radiography is an invaluable tool for the dental team, providing information that is impossible to obtain by clinical examination alone.¹ Digital radiography is now a common technique which is used in dentistry. It is a reliable and versatile technology that expands the diagnostic and image-sharing possibilities of radiography in dentistry.²

Even if a dental practice is only using digital images the conventional x-ray equipment is still used (x-ray tube) and this means that the same regulations still apply. A dental practice that is only using digital radiography still needs to adhere to the Ionising Radiation Regulations 1999 (IRR99) and the Ionising Radiation Regulations 2000 (IR(ME)R). These regulations are concerned with the protection of exposure to ionising radiation as a result of work activities to workers and the public and minimising patient exposure during medical procedures. These regulations are administered by the Health and Safety Executive (HSE) as part of the Health and Safety at Work Act 1974.³

When a digital system is introduced to a dental practice the necessary computer hardware and software needs to be installed and staff need to undergo appropriate training in the use of the software and computer maintenance of the images.

This article provides an outline of the history of digital radiography, the different types of digital x-rays and the advantages and disadvantages of digital dental radiography.

History of Radiography

X-rays were discovered in 1895 by the German physicist Wilhelm Conrad Roentgen and the first dental radiograph was taken two weeks later by Otto Walkoff a German dentist who placed small photographic plates wrapped in a rubber dam in his own mouth and exposed them for 25 minutes.⁴ The first digital x-ray sensors were introduced in the 1980's by Francis Mouyen.⁵ The first digital system only acquired the image but it could not be stored. Per Nelvig and his colleagues soon developed a more comprehensive system and this was quickly improved upon by more manufacturers'.⁶

Initially most systems used an 8 bit contrast resolution but with the development of computers and computer software this has improved and sensor systems now capture images at 12-16 bit depth. This higher bit depth improves the image quality.⁷

Recently, three dimensional reconstruction and rendering of radiographic image data has been introduced in the form of cone beam computed tomography (CT) and local CT which offer a higher resolution with much lower doses of radiation to the patient.⁸

Digital radiography is now a reliable and versatile technique which can be used in dental practice to improve the diagnostic and sharing possibilities of radiographs in dentistry.

Direct and Indirect Digital Radiography

Digital x-rays can either be captured using a direct or indirect method.

Indirect images are captured by using a digital camera or scanning and digitalising a film captured image.⁹ This method is time consuming and it is still necessary to take and process a conventional film. It does not increase the information available from the original radiograph, it simply turns the image into one that can be read and analysed by a computer.¹⁰

However, once the image has been digitalised possibilities exist for it to be contrast enhanced and it can be shared electronically with ease.

Direct images are divided into two types Real time or corded and Photostimulable Phosphor Storage Plate or cordless.¹¹ Both types are available to use with intra-oral systems and extra-oral systems.

Real time or Corded

These systems use conventional film generating equipment but the film is replaced by a solid-state sensor which is built around a special electronic chip consisting of an array of x-ray sensitive elements called pixels.¹² The solid-state systems are called charge coupled device (CCD) or complementary metal oxide silicon sensors (CMOS) depending on the technology used to create the chip.¹³

These systems work because the pixels are sensitive to x-ray photons and to light photons and this makes it possible to add a layer of luminescent crystals on top of the pixels which produce light when hit by x-ray photons. The sensor is connected to the computer by a cable and the electronic information produced by the pixels is transferred through the cable to the computer.¹⁴



Fig. 1 Corded Digital Radiograph film¹⁵

Photostimulable Phosphor Storage Plate or cordless

These sensors are based on a different technology, a thin plate of synthetic material is coated with a layer of phosphor crystals and some of the energy of the x-ray photons is stored into the phosphor layer during radiographic exposure. A scanner is required to read the image information from the plate, it does this by scanning the plate with a laser beam of near-red wavelengths which releases the energy from the phosphor layer and converts it into a digital image which is then stored on the computer.¹⁶

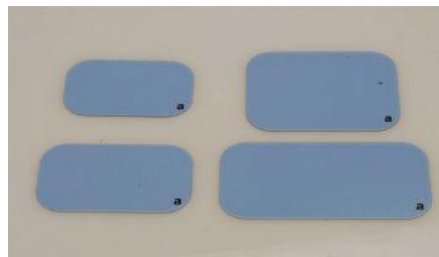


Fig. 2 Cordless Digital Radiograph film¹⁷

Advantages of Digital Radiography

1. Dose Reduction –

This is considered to be one of the major advantages of using digital radiography in comparison to conventional films. Although the dose per radiograph for digital sensors is lower than the dose required for a conventional film, it is sometimes necessary to take more radiographs to gain the same amount of diagnostic information. This is due to the size of the digital intra oral detectors which are

sometimes smaller than conventional films, therefore more radiographs may need to be taken. Positioning of the digital detectors can sometimes prove more difficult which can also result in more retakes.¹⁸

2. Processing –

There is no need for conventional processing and therefore this avoids the processing faults which can sometimes occur with conventional film processing. This also eliminates any risks involved with handling, storage and disposal of processing chemicals.¹⁹

3. Storage –

It is easy to store digital x-rays as they are archived directly into the patient's records and computer software often prevents the deletion of an image from the patient's record once it has been committed to the file. This reduces the risk of misplacing x-rays.²⁰

4. Sharing Images –

The radiographs can easily be shared to other surgeries in the practice or to other dental professionals by electronic transfer.²¹

5. Image Quality –

Contrast and density can be altered with computer software to improve the quality of a digital image. Some software programs also allow the user to perform on screen measurements which can be very accurate. It is possible to magnify a digital image.²²

Disadvantages of Digital Radiography

1. Data Security –

The computer system needs to be backed up so that the images remain secure.²³

2. Expense –

The initial cost of providing this type of system and software can be expensive.

3. Viewing the image –

It is necessary to have a computer monitor in a suitable position within the surgery to enable the operator to view the image on the screen. Reflection of bright lights on the screen need to be avoided as this will affect the quality of the image the operator is viewing.²⁴ If the image is printed onto photographic paper it can compromise the

quality of the image.²⁵ However, as the quality of printers and software is advancing rapidly this is becoming less of a disadvantage.

4. Placement of corded sensors –

Placement of corded sensors can be difficult due to the cord attached.²⁶

5. Tampering of images –

Clinical imaging software should always store a copy of the original image before it is enhanced in any way, however third party software does exist which could allow images to be tampered with.²⁷

Conclusion

Several studies have compared the diagnostic performance of conventional film and digital systems and in general digital systems are as reliable as traditional radiographs.^{28 29} All members of the dental team need to be trained when a dental practice converts from conventional radiography to digital radiography. All of the regulations still apply when adopting this system and risk assessment and auditing should still be completed by the dental practice.

Digital radiography is a reliable and versatile technique which can improve the diagnostic possibilities of radiography in dentistry.

Remember dental hygienists/therapists need to complete five hours of continuing professional development (CPD) on radiology during a five year CPD cycle.

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Portfolio Tip

New non-verifiable CPD on radiography is available on the website. Remember to update your non-verifiable CPD log when you have completed it.

Review your radiography file in your practice to refresh your memory on the local rules.

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