Research paper on dental radiology assignment

Entertainment, Movie

Digital Panoramic Radiograph

This paper discusses the technology, principles, concepts and limitations of digital panoramic radiography, which is an emerging technique in dental radiology and is replacing conventional x-ray films. Some comparisons of digital techniques with conventional films have been made, and technical details of digital techniques are described.

Digital Panoramic Radiography

The radiographic film is a medium used for storing and displaying diagnostic information. The x-ray film, since its discovery in 1895, became the primary medium for obtaining radiographic images. Dental practitioners are particularly used to this modality and are comfortable with its technique, the quality and amount of information it provides, and its ease of interpretation. Intra-oral, panoramic, and extra-oral radiographs are the most common ways of diagnosing disorders of the teeth (Dove & McDavid, 1993).

Dental panoramic radiography, also called ‘ orthopantomography’, plays an important part in the diagnosis of oral diseases. The dental panoramic X-ray shows a two-dimensional view of the entire set of teeth from the left second molar to right second molar, however, it does not provide three-dimensional information of oral anatomical structure (Jianrong, Youjun, & Niya, 2009). By using the rotation of the x-ray source over the radiographic film to generate the ‘ layer forming effect’, it produces an image of the curved plane between the patient’s jaws, and blurs the anatomic structures outside the narrow layer around the curved plane. The figure below shows an example of a panoramic radiograph (In Line Medical and Dental).

In the past, radiographic imaging involved the use of an x-ray film and after that, chemical processing of the film was done to produce the images. The procedure also required delivering quite high amounts of radiation to the patient, and the final result was in the form of a fixed image that could not be manipulated after being captured (Parks & Williamson, 2002). With advancements from the recent research, this film-based technology is being replaced with computer-based devices that use electronic sensors or ' storage phosphor receptors' to record the radiographic image in a digital format (Dove & McDavid, 1993). The first direct digital imaging system, RadioVisioGraphy (RVG), was produced by Dr. Frances Mouyens (Vincennes, France) in the year of 1984. Since then, the market for digital radiography has grown much bigger, and many digital imaging systems have become available from different manufacturers of dental X-ray machines. From some estimates, about 10-20% of dental practitioners are now using digital imaging technology in dental practice. It is expected that these numbers will continue to increase over the next several years, as dentistry consistently moves from film-based to digital imaging (Parks & Williamson, 2002). The figure below shows an example of a digital panoramic radiograph machine (In Line Medical and Dental).

Thus, panoramic radiography for dental practice can be done in two ways today – conventionally using the x-ray film, or with digital techniques.

Some comparisons can be made between conventional and digital panoramic radiographs on technical grounds. A first difference is that in the conventional panoramic x-ray, the film is simultaneously translated at a speed in order to obtain blurring of the anatomic structures which lay outside of the plane of interest. On the other hand, in digital techniques the x-ray film is replaced by the x-ray imager and special electronic techniques are used to produce a similar blurring effect (Molteni, 2012).

In essence, digital imaging incorporates computer technology with radiography. Digital imaging is the result of the interaction of x-rays with electrons in electronic sensor pixels (picture elements), followed by the conversion of analog data to digital data, computer processing, and display of the visible image on a computer screen. Data which is acquired by the sensor is thus transmitted to the computer in analog form (Parks & Williamson, 2002).

Digital imaging can be direct or indirect. Direct digital imaging systems produce a dynamic image that allows for the immediate display, enhancement, storage, retrieval, and transmission of the image after being taken. Indirect digital imaging involved the image being captured first in an analog or continuous format, and later converted into a digital format. The process of this conversion can result in the loss or alteration of information in the image (Parks & Williamson, 2002).

The production of direct digital images requires a number of components and equipment. These include a source of the x-ray beam, an electronic sensor, a digital interface card, a computer that has an analog- to- digital converter (ADC), a screen monitor, software, and a printer (Parks & Williamson, 2002). The electronic sensor can be either ‘ storage phosphor plates’, or charge-coupled device (CCD) sensors. (Molander, Gröndahl, &

Ekestubbe, 2004). The components are shown in the diagram below (Parks & Williamson, 2002).

Digital technology has some distinct advantages over films, and has proved to be an advancement in dental imaging. The digital sensors are more sensitive at picking up the electrons than x-ray film, therefore they require significantly lower amounts of exposure to radiation. They also offer the elimination of processing chemicals, provide instant or real-time production, display, and enhancement of the images, patient education utility, and convenience of storage (Parks & Williamson, 2002). Other advantages of digital techniques include faster communication of images, and smaller storage space needed (Molander et al., 2004). In 1998, a review of the evidence on the diagnostic accuracy of digital imaging systems for diagnosis of caries concluded that digital imaging techniques seem to be as accurate as film (Parks and Williamson, 2002). Therefore, digital imaging is now being increasingly used by the dental profession(Parks & Williamson, 2002).

Most digital panoramic X-ray machines use charge-coupled device (CCD) detectors to capture the images. The CCD is a solid-state detector consisting of a series of x-ray or light sensitive pixels, placed on a silicon chip. A pixel or picture element consists of a small electron well, into which the light energy of the x-ray is deposited at the time of exposure. The individual CCD pixel size is approximately 40µ, with some of the latest versions offering the 20µ range. The rows of pixels are arranged in a matrix of 512 x 512 pixels. In the charge-coupling process, the number of electrons deposited in each pixel are transferred from one well to the next in a sequential manner, to reach a read-out amplifier that will display the images on a monitor (Parks & Williamson, 2002). CCD detectors control the movement of the CCD charge carriers so that their speed corresponds to the speed of the x-ray shadows of the objects within the plane of the image layer. This method is comparatively similar to the formation of a film-based panoramic image; thus, CCD detectors emulate x-ray films to some extent (Noujeim et al., 2011). The primary disadvantages of the CCD sensor include the rigidity and thickness of the sensor, some degree of decrement in the resolution; higher initial cost of installing and running the system, unknown lifespan of the sensors, and the need for perfect charge transfer by the semiconductors. Infection control presented another challenge, as the sensors are not be sterilized and therefore salivary contamination can potentially occur (Parks & Williamson, 2002). Furthermore, like conventional film-based panoramic radiographs, once a CCD-based digital image is produced, the image layer cannot undergo modification, such as changing the brightness. If a patient were found to be incorrectly positioned after taking the image, a repeat x-ray would be required after repositioning the patient, to achieve a satisfactory image (Noujeim et al., 2011).

The other classic technique used for obtaining digital panoramic x-rays storage phosphor plates. Also known as photostimulable phosphor (PSP), these plates are a form of indirect digital imaging. The image is captured on a phosphor plate in the form of analog information, and is transformed into a digital format when the plate undergoes processing (Parks & Williamson, 2002). The PSP consists of a polyester base that is coated with a crystalline halide emulsion. The crystalline emulsion consists of a europium-activated barium fluorohalide compound (BaFBrEu 2+). This chemical mix converts x-rays's energy into stored energy. The energy stored in these crystals is released in the form of blue fluorescent light when the PSP is put under a helium-neon laser beam scanning device. The emitted light is captured, intensified by a photomultiplier tube and finally converted into digital data to send to the computer. As not all of the energy stored in the PSP is released during scanning, the imaging plates need to be treated after storing the image, to remove any residual energy which would distort future images (Parks & Williamson, 2002).

The major advantage of the PSP image receptor is that it is cordless. This significantly improves the ease of placement of the receptor {Parks, 2002 #10}. A few studies have evaluated the image quality of storage phosphor plates and compared it to conventional panoramic radiography. There is some evidence that although the image quality is usually similar for both, measured by a visual grading analysis method, occasionally the quality of the digital images are worse than the film- based ones (Molander et al., 2004). This is because the PSP images seem to have a limiting resolution of approximately 6l p/mm (line pairs per millimeter). This resolution is significantly less than what usually is possible with the conventional film (~20 lp/mm). However, this is not different enough to allow perception with the naked eye (8-10 lp/mm) (Parks & Williamson, 2002).

These challenges with digital techniques have stimulated interest into developing improved methods for digital panoramic radiography. For example, a digital tomosynthesis system of a panoramic image has been developed, which works by overlapping and adding a sequential set of frames acquired at regular intervals throughout the scan to achieve a two-dimensional image (Noujeim et al., 2011). Methods to obtain patient-specific dental panoramic images of the dental arch for three-dimensional visualization of the region's anatomy have also been developed (Jianrong et al., 2009).

A recent study from 2010 compared the accuracy of digital techniques with conventional films for pre-operative evaluation of implantation dentistry, and found that panoramic radiographs showed sufficient accuracy with a good level of inter-examiner agreement (Park, 2010).

In conclusion, it appears that digital panoramic radiography is an excellent tool for dental radiology. Compared to conventional films, it offers some advantages, but is also associated with challenges. Continuing research is improving the techniques of digital panoramic radiography.

References

In Line Medical and Dental. n. d. I-Max Plus Digital OPG. Retrieved from http://www. inline. com. au/digital-dental-xray-imaging

Dove, S. B., & McDavid, W. D. (1993). Digital panoramic and extraoral imaging. Dental clinics of North America, 37(4), 541-551.

Jianrong, Lu, Youjun, Liu, & Niya, Tuo. (2009, 19-20 Dec. 2009). The 3D Visualization of Dental Panoramic X-Ray Images. Paper presented at the Information Engineering and Computer Science, 2009. ICIECS 2009. International Conference on.

Molander, B, Gröndahl, H-G, & Ekestubbe, A. (2004). Quality of film-based and digital panoramic radiography. Dentomaxillofacial Radiology, 33(1), 32-36. doi: 10. 1259/dmfr/17777906

Molteni, Marcello (Gadda 2, I-20052 Monza, IT), Nettis, Costantino (Via Sarzana, 24, I-20159 Milano, IT), Rotondo, Giuseppe (Bixio 8, I-2068 Peschiera Borromeo, IT). (2012).

Noujeim, M, Prihoda, T, McDavid, W D, Ogawa, K, Seki, K, Okano, T, . . . Langlais, R P. (2011). Pre-clinical evaluation of a new dental panoramic radiographic system based on tomosynthesis method. Dentomaxillofacial Radiology, 40(1), 42-46. doi: 10. 1259/dmfr/73312141

Park, Jun-Beom. (2010). The evaluation of digital panoramic radiographs taken for implant dentistry in the daily practice. Med Oral Patol Oral Cir Bucal., 15(4), e663-666.

Parks, E. T., & Williamson, G. F. (2002). Digital radiography: an overview. J Contemp Dent Pract, 3(4), 23-39.