

# Radiology

## Lec.17

## Digital Imaging

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Digital radiography is used to record radiographic images, unlike conventional dental radiographic techniques; there is no film or processing solutions used. It has been widely used in medicine, but the first intra-oral sensors were developed for use in dentistry by Francis Mouyen in the mid 1980's. Later extra oral sensors for panoramic and cephalometric images had been developed. With digital radiography the term image (not radiograph or x-ray film) is used to describe the pictures that are produced.

### Main Components of Digital Imaging System

1. The x-ray source (the same radiation source of conventional technique).
2. Sensor or Detector: it's a small detector placed inside patient mouth and used to capture the radiographic image. it measures the photon intensity of the x-ray beam after it has passed through the patient and convert it into electrical signal (analog signal)
3. Computer: used to store the incoming electronic signal from the sensor and convert it into a shade of gray that is viewed on the computer monitor.

### Methods of Acquiring a Digital Image

- a- **directly** by using sensor or imaging plate replacing conventional film
- b- **indirectly** by scanning and digitizing a film-captured image.

### Direct digital imaging systems are divided into two types:

1. Real time or corded
2. Photostimulable phosphor storage plate or cordless

### Real-time or corded systems

These systems employ conventional x-ray-generating equipment but conventional film is replaced by rigid detectors either a CCD (charge coupled device) or a CMOS (complementary metal oxide semiconductor) sensor which is connected to the computer via a cable (or cord).

The X-ray photons that reach the sensor are converted to light, since it consists of silicon crystals arranged in a network pattern and converts light energy into an electronic signal

(electrical charge) which, once relayed to the computer , produces an almost instantaneous digital image on the monitor (hence the term real time) .

Sensor placed inside patient mouth using same intra oral technique of conventional radiography. specially designed intraoral sensor holders (with and without beam-aiming devices), similar to those used for conventional film, have been developed. When used clinically, the sensors need to be covered with a protective plastic barrier envelope for infection control purposes. Different sized intraoral, as well as panoramic sensors are produced.

### **Photostimulable phosphor imaging or cordless systems**

These systems employ flexible re-usable photostimulable phosphor imaging plates (PSPP) instead of film. The plates contain a layer of barium fluorohalide phosphor. The phosphor layer absorbs and stores the X-ray energy that has not been attenuated by the patient. The image plate is then placed in a reader where it is scanned by a laser beam. The stored X-ray energy in the phosphor layer is released as light which is detected by a photomultiplier. From here the information is relayed to the computer and displayed as a digital image on the monitor.

The time taken to read the plate depends on the particular system being used, and on the size of the plate, but usually varies between approximately 1 and 5 minutes. A range of intraoral plate sizes are available identical in size to the conventional periapical and occlusal film packets

Radiographic techniques are identical to those using conventional film. The intraoral plates are inserted into protective barrier envelopes and can then be used in conventional film holders.

### **Advantages of CCD/ COMS:**

- The image appears on the monitor instantaneously.
- Infection control is easier and quicker.

### **Advantages of PSP:**

- Detectors are thin and flexible, more comfortable for the patient, and easier for operator to use.
- Cheaper, especially when multiple operatories are involved.

## **Indirect digital imaging:**

The essential components of this system are a CCD camera and computer. In this method an existing x-ray film is digitized using CCD camera , which scan the image, convert and displays it on the computer monitor (it's just like scanning image or radiograph to a computer screen.

### **Theory**

- As computers deal with numbers and pictures, a radiographic image within a computer is represented as a sequence of numbers. This image may be considered as a grid or matrix of tiny boxes or pixels. Each pixel has an x and y coordinate and is rendered as a numbered sequence dependent on the amount of X-ray attenuation in each box. Each number, and hence each pixel, is then assigned an appropriate shade of grey.
- The range of numbers is normally from **0** to **256**, with 0 representing black, 256 representing white and all others are shades of grey. The number and size of the pixels, together with the number of shades of grey available, determine the amount of information in an image, the size of the image file and the resolution of the final image. The resolution (in line pairs per mm) of modern digital images on the screen is comparable with, and may be better than film.
- The pictures can be changed by giving the pixels different numbers. The coordinates of pixels may be changed or swapped, allowing different parts of the image to be moved around. The shades of grey may be altered or different colors used. These variables are the basis for image processing or manipulation. Despite being able to alter the final image, the computer cannot provide any additional real information to that contained in the original image. It should be remembered that although enhancement may make images look aesthetically more pleasing, it may also cause clinical information to be lost and diagnoses compromised.

### **Advantages over conventional film-based radiography**

1. Lower dose of radiation required as both types of digital image receptors are much more efficient at recording photon energy than conventional films. Dose reduction of up to 90 per cent compared to E-speed film .

2. No need for conventional processing, thus avoiding all processing film faults and the hazards associated with handling of chemical processing solutions that are potentially allergenic and polluting.
3. Easy storage and archiving of patient information and incorporation into patient records. And Easy transfer of images electronically
4. Image enhancement (density and contrast enhancement) and processing embossing or pseudo 3-D
5. Magnification
6. Automated measurement (distance and angles measurements).
7. Pseudocolourization
8. Digital image subtraction

### **Digital Subtraction Radiography**

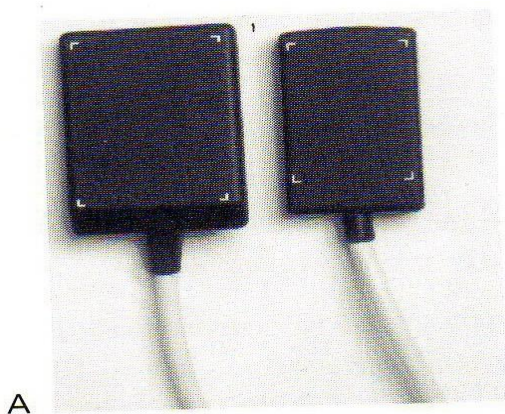
Subtraction radiography is a technique requires two identical images exposed with virtually identical geometry but exposed at different times. used for detection of radiographic changes that occur over time by subtraction of one image from another, leaving only the changes between the two intact.

Although visual examination of standard radiographs cannot detect a 0.85-mm change in the thickness of cortical bone, digital subtraction radiography is so sensitive it can detect a 0.12-mm change. The ability of digital subtraction to record minute differences depends on the degree of matching of the two images. So it's useful in the diagnosis of periodontal and carious lesions, both of which may be characterized by their sometimes insidious and relatively slow rate of progression. Also evaluation of small changes in the condylar position and assessment of osseous remodeling around hydroxyl apatite implant.

### **Disadvantages of digital imaging**

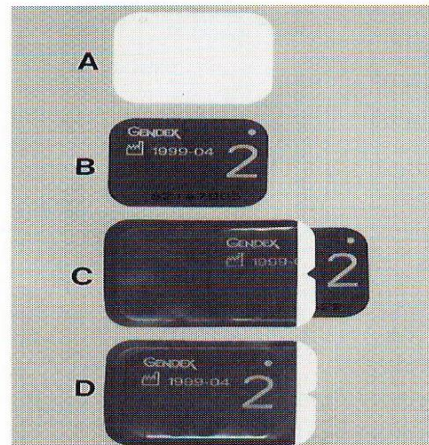
1. Expensive, especially panoramic systems.
2. Long-term storage of the images although this should be solved by saving them on CD-ROM.
3. The connecting cable (or cord) can make intraoral placement of these system's sensor difficult.

4. Sensor dimensions are still quite bulky for the CCD system and difficult to position.
5. Loss of image quality and resolution on the hard copy-out when using thermal, laser or ink-jet printers.
6. Digital image security and the need to back up data.
7. Image manipulation can be time-consuming and misleading to the inexperienced .
8. While manufacturers provide safeguards to any tampering with original images within their own software, it is relatively easy to access these images using software and change them.



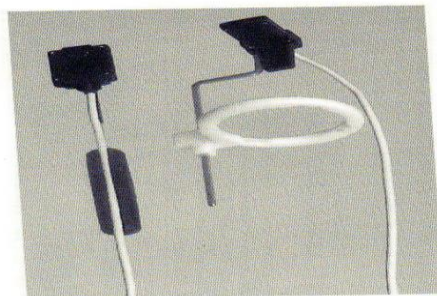
A

A- Real time or corded.



B

B-Photostimulable phosphor storage plate or cordless



Specially designed intraoral sensor holders (with and without beam-aiming devices)

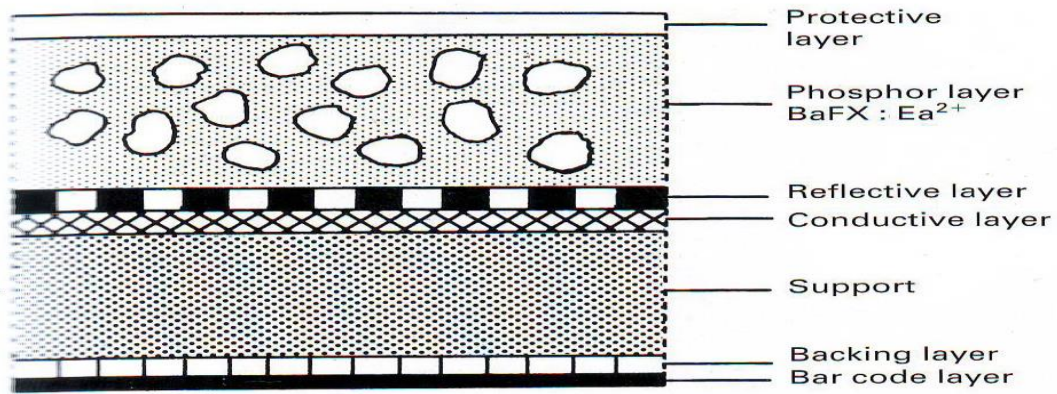
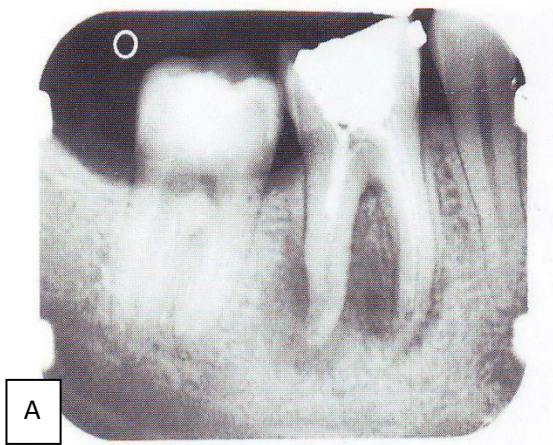


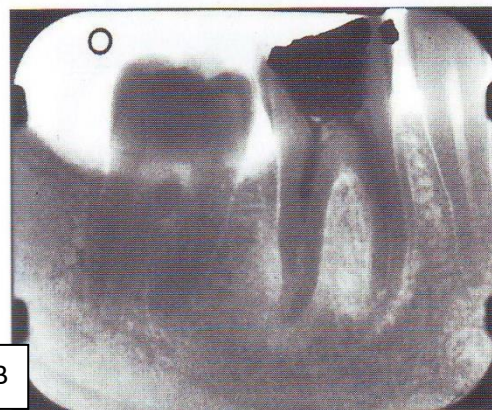
Fig. 17.10 Diagram showing the cross-sectional structure of a typical phosphor imaging plate.

### Image enhancement and processing



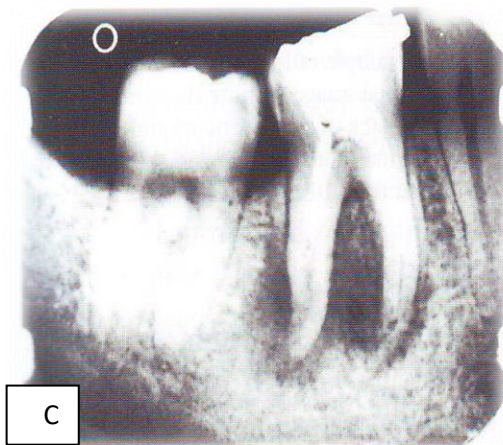
A

a- The original image



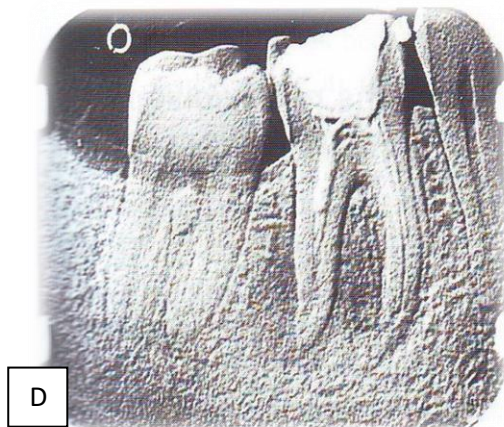
B

b- inversion (reversal)



C

c- alteration in contrast



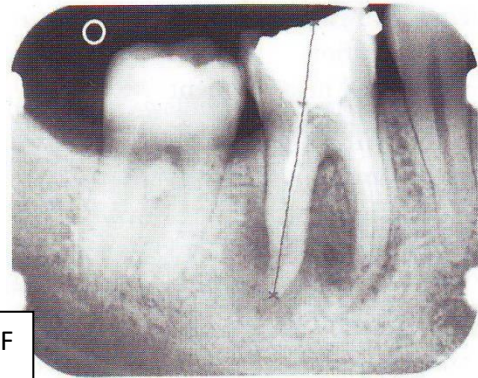
D

d- embossing or (pseudo 3-D)



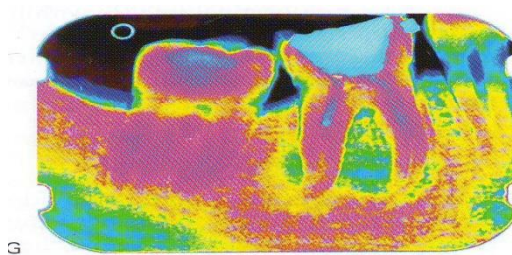
E

e- magnification

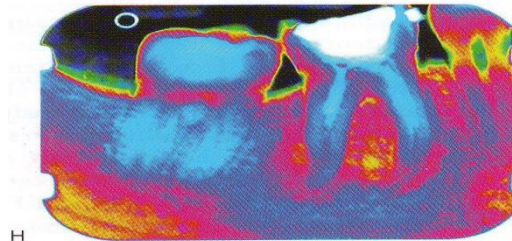


F

f- automated measurements



G



H

g- h : pseudocolourization



First Image  
(subtraction radiography)



second image



the difference between the two image