University of Al-Mustaqbal
College of Science
Department f Medical Physics

Medical physics 4

Fourth stage/ Second course

Conventional and digital dental X -ray radiography

Lecture One

Name of lecturer

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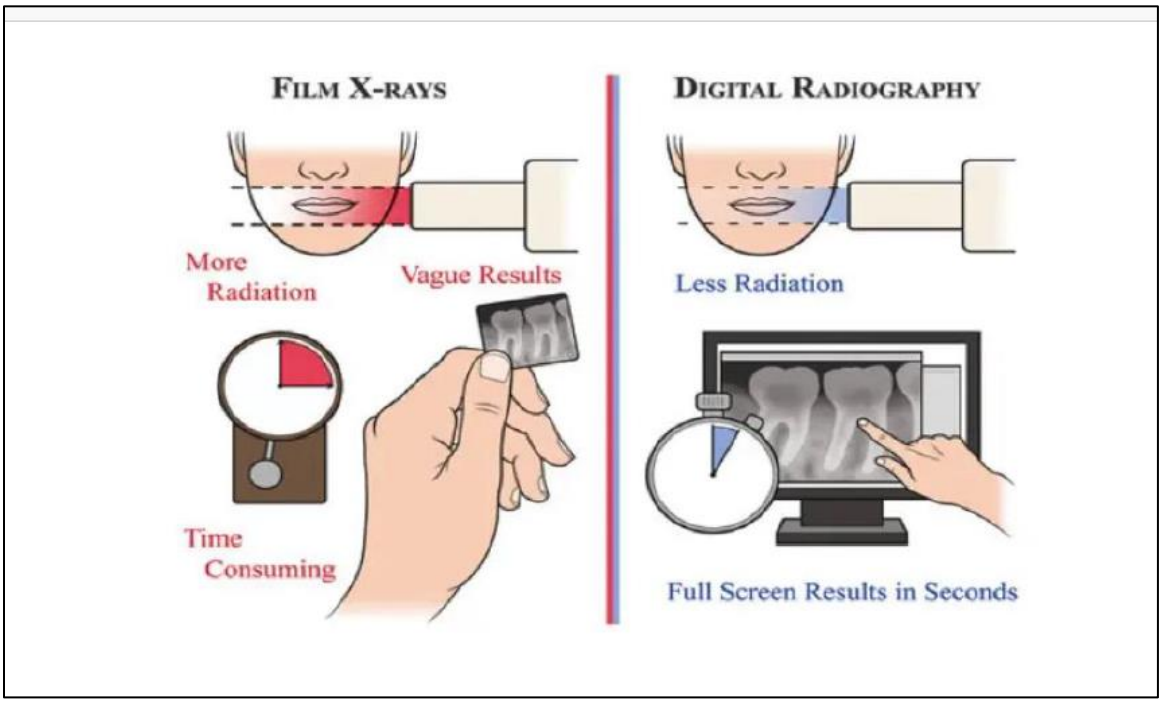
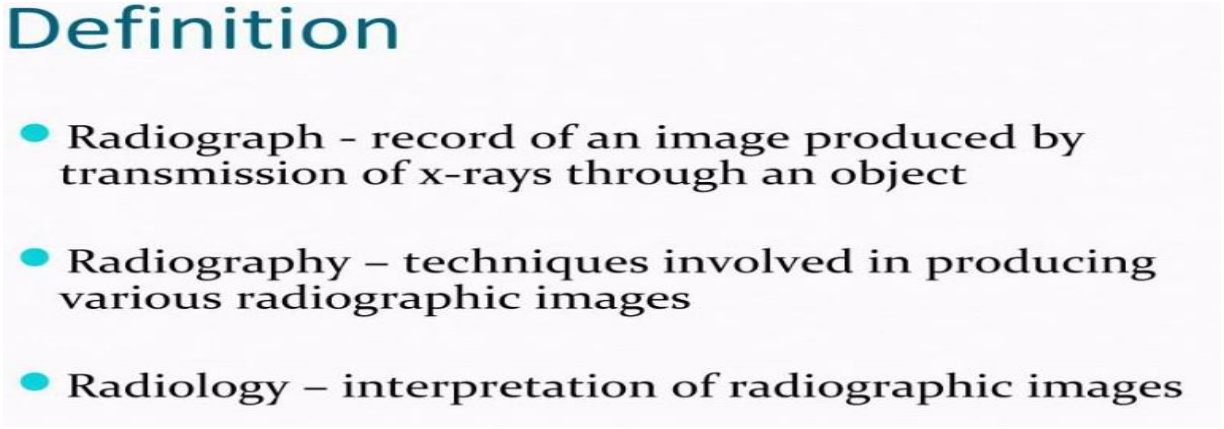
Conventional and digital dental X -ray radiography

The dental X -ray machine is the same as the other medical X -ray machine with some specifications such as the low -level radiation, very small films (sensors in the digital X -ray machines), and easier adjustment to be in contact or very close to the intended teeth or jaws. The conventional X -ray systems are used in dental X -ray radiography, (fig. a), but the digital ones with electronic sensors (which are very expensive) replaces them and become widely used in dentistry. The digital X -ray radiography requires less radiation, processed more quickly, and can be viewed instantly on a computer as a real time image. (Fig. b).

The conventional and digital dental X -ray radiography have nearly the same exposure time and resolution, but each one of them has some advantages and disadvantages.





Digital Dental X-ray Detectors

Digital dental X -ray systems use electronic detectors instead of photographic films. The most common types of digital detectors include:

•CCD (Charge -Coupled Device)

•CMOS (Complementary Metal -Oxide Semiconductor)

•PSP (Photostimulable Phosphor Plates)

CCD and CMOS detectors convert X -ray photons indirectly into electrical signals through a scintillator layer, while PSP plates store latent X -ray energy that is later released during laser scanning.

•PSP plates store latent X -ray energy and require laser scanning to produce the image. Digital detectors provide rapid image acquisition, lower radiation dose, and easy image storage.

Comparison between the conventional and digital dental X-ray radiography

No	conventional	digital
1	It requires low radiation dose to produce the radiograph.	It requires very low radiation dose to produce the Digital radiograph (s 90% of the conventional radiography)
2	The film is less thick, less rigid, and gives better comfort to the patient	The sensor is thicker, more rigid, and it is less comfortable than the film
3	The film can withstand heat sterilization	The sensor cannot withstand heat sterilization, and a plastic disinfectant cover must be used
4	The radiograph takes a certain time to be processed, and the radiography will be repeated at any mistake during the development of the film which consume the time and increase the radiation dose to the patient	The radiograph is immediately processed by the computer and available to view, and there is no mistake in the film processing.
5	The radiograph quality of the film cannot be enhanced	The digital radiograph quality can be enhanced by altering the contrast and brightness in the display unit
6	The film can be stored or archived with some complications	The digital radiographs can be stored and archived easily in the computer
7	The film radiograph cannot be enlarged and cannot get better view when it is hard to see the cavities	The digital radiograph can be enlarged and get better view when it is hard to see the cavities
8	The film radiographs cannot be altered or exposed to fraudulent and legal issues	The digital radiographs can be altered and exposed to fraudulent and legal issues.
9	It has low price and does not need training because it is standard in most of the dental offices	It is very expensive and need training.
10	It requires an X -ray machine and a film cassette	It requires an X -ray machine, sensors, computer, and computer software (to display, store, and transfer the images).
11	It requires a dark room for film processing.	11It does not require a dark room.
12	It does not require professional skills of the staff	It requires professional skills of the staff

Parameter	Conventional	Digital
Image Receptor	Film	CCD / CMOS / PSP
Radiation Dose	Higher	Lower
Spatial Resolution	High	Comparable / High
Dynamic Range	Limited	Wide
Image Processing	Not available	Available
Image Storage	Physical films	Digital (PACS)
Image Acquisition Time	Long	Immediate
Cost	Low	High (initial)

There are three main types of dental X -ray radiography, whether they are conventional or digital, which are the intraoral, extraoral, and Panoramic Radiography

Intraoral and extraoral dental radiography:

There are 32 adult teeth which are; 8 incis8ors, 4 canines (cuspids), 8 premolars, and 12 molars 9 (including 4 wisdom teeth). (Fig1 a).

Two types of dental radiography are employed relative to the applying of X -ray beam, internal or external to the mouth, called intraoral and extraoral dental radiography respectively.

1-Intraoral dental radiography:

It is the most common type of the used dental X -rays, in which the film or the sensor is put inside the mouth, and provides a lot of details for diagnosis of cavities, tooth root, bone loss, bone surrounding the tooth, status of developing teeth, and general health of the teeth and the jaw bones. Also, It may reveal bony changes associated with benign or malignant lesions. (Fig1 b).

2-Extraoral dental radiography:

It is less common type of the used dental X -rays in which the film or the sensor is put outside the mouth. It is used for diagnosis of the jaw and skull, such as looking for impacted teeth, monitoring growth and development of the jaws in relation to the teeth, and identifying potential problems between teeth and jaws, Temporomandibular joint (TMJ) joint (TMJ) disorders, and other bones of the face. (Fig1. c).

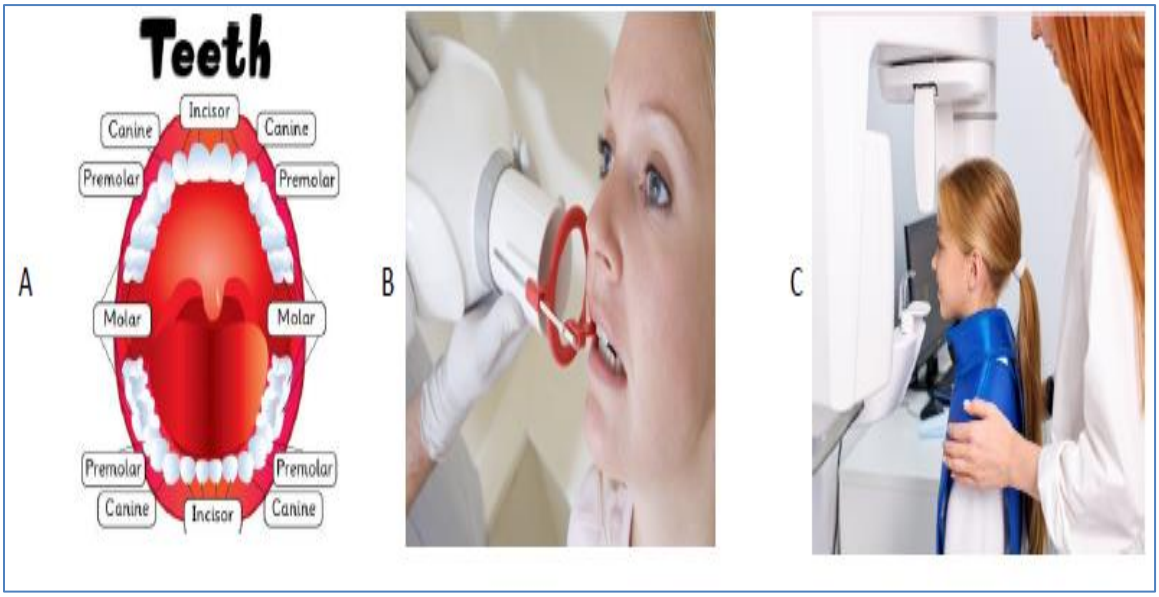


Fig 1: Oral dental X -ray radiography techniques. A-Types of teeth. B-Intraoral dental radiography. C- Extraoral dental radiography.

Dental X -ray protection:

According to the American Dental Association, The effective dose of a full -mouth dental X -ray series ranges from approximately 0.035 to 0.15 mSv depending on the imaging system used, which is equivalent to the background environmental dose received for few days. Adequate shielding is also used to reduce the X -ray dose to the patients, where lead shield, lead apron, and sometimes lead thyroid collar are used to protect the patient.

Fig : Lead apron with thyroid collar shield in dental radiography.

The operator can be protected by stepping out of the room or by using adequate shielding.

Radiation Dose in Dental X -ray Imaging

•Intraoral dental radiography: very low effective dose.

•Panoramic radiography dose is lower than a full mouth intraoral series.

•Digital dental radiography reduces patient dose compared to conventional film systems.

•Dental imaging follows the ALARA principle (As Low As Reasonably Achievable) to minimize radiation exposure.

•Protective measures such as lead aprons and thyroid collars are essential.

Panoramic Radiography (PAN):

It is a developed technique of X -ray tomography, also called panoramic radiography, used in dentistry for radiography of the maxillary and mandibular arches and their contiguous structure on a single receptor. (Fig).

1-Panoramic Radiography technique (PAN):

PAN technique can be described as follows:

I-It consists of a horizontal rotating arm travels in a semi -circle around the head.

II-The X -ray source and a moving receptor mechanism, are arranged on the arm at opposed extremities.

III-X-ray receptor (a film with a cassette or detector) is fixed in a holder, longer than the exposed receptor, and has a protective lead front with narrow slit, through which the receptor is exposed.

IV-The X -ray tube holder and receptor are both rotating during the exposure, moving across the slit as the X -ray tube rotates, and X -ray image of a curved surface is produced. (Fig. X, b).

V-In a case of using X -ray film, the film moving mechanisms has two kinds, one kind is using a sliding flat cassette which holds the film, and the other kind is using a rotating cylinder and the film is mounted around it.

VI-The dental Panoramic Radiography film has two standard sizes, 30 cm x 12 cm and 30 cm x 15 cm , where the smaller size film receives 8% lower X -ray dose than the larger size film.

VII-The X -ray beam is a narrow vertical slit -shaped collimated beam designed to cover the maxilla and mandible, so that the height of the beam covers the mandibles and maxilla regions.

VIII-The panoramic radiography shows a 2D radiographs of a half circle from ear to ear, where radiographs of multiple planes are taken to make up the panoramic image. In this image the maxilla and mandible are in the focal trough, while the other structures, superficial and deep from the focal trough, are blurred.

IX-The modern development of dental panoramic devices utilizes digital X -ray technology instead of the film which is based on the electronic sensors and computers.

X-Digital panoramic radiography represents an important advancement in dental imaging technology, which can be developed more, while the film radiography might become obsolete soon.

Artifacts in Panoramic Radiography

•**Motion artifacts**: caused by patient movement during exposure.

•**Ghost images**: formed by dense objects outside the focal trough.

•**Positioning errors**: incorrect head or bite -block alignment.

•**Blurring**: occurs for structures outside the focal trough.

•**Proper patient positioning and immobilization** are essential to minimize artifacts.

2-Panoramic Radiography procedure:

PAN procedure can be performed as follows:

I-The patient sits on a chair where his skull sits between the X -ray generator in one side and the film in the other side.

II-The head of the patient is carefully secured in the center of the machine, and the device can be adjusted to accommodate the patient standing, or sitting on a wheel chair. (Fig X. c).

III-Just before the machine starts, a bite -blocker is placed in the mouth of the patient to make sure a proper alignment.

IV-The patient should be asked to remain very still when the radiographs are taken.

V-The exposure time of Panoramic Radiography scanning typically = 10-12 s, and it produces a panoramic X-ray radiograph of a curved surface on a 2D image. (Fig X.d).

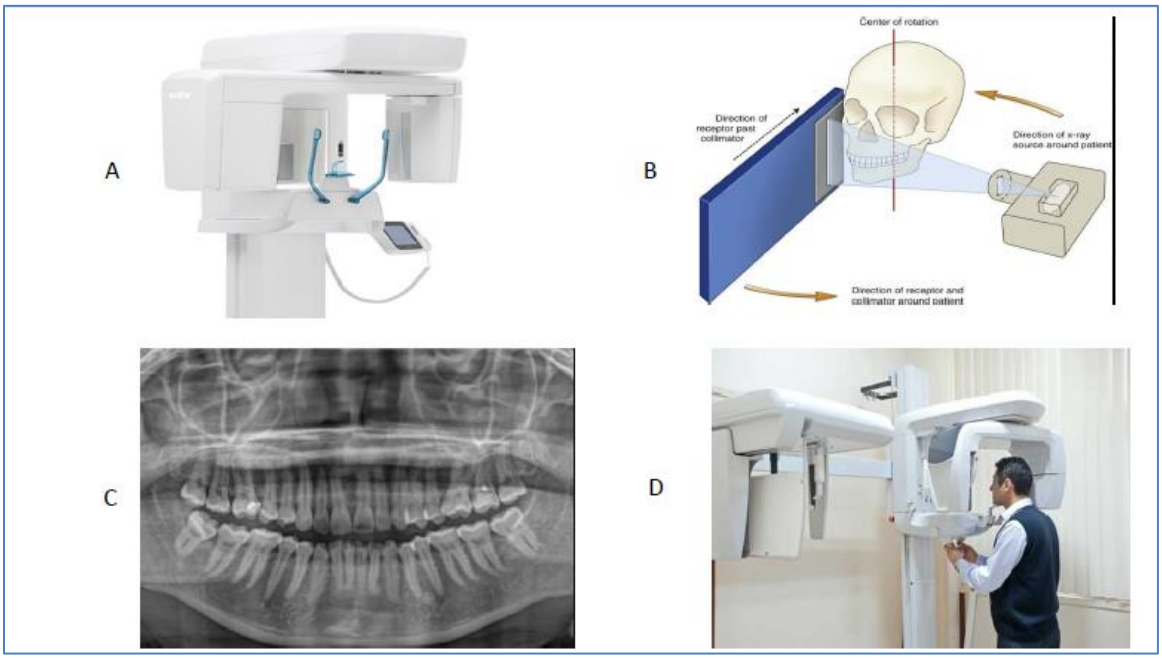


Fig X: Dental pantomography (PAN). a-PAN device. b-schematic diagram of PAN work. c-patient panoramic imaging. d-panoramic radiograph

3-Pantomography medical uses:

Panoramic X -rays are widely used by dentists and oral surgeons for clinical purposes such as:

I-Providing information about maxillary sinuses, tooth positioning, and other bone abnormalities.

II-Planning treatment for partial and full implants braces, dentures, and extractions.

III-Diagnosis of tumors, oral cancer, cysts, and disorders in the jaws.

IV-Diagnosis of advanced periodontal disease and sinusitis (swelling of the sinuses).

Panoramic Radiography vs Cone Beam CT (CBCT)

•Cone Beam CT (CBCT) provides three -dimensional (3D) dental imaging.

•CBCT delivers higher radiation dose compared to panoramic radiography.

•Panoramic radiography is preferred for routine screening and general diagnosis.

•CBCT is mainly used for implant planning and complex dental cases.

•Selection of imaging technique depends on diagnostic requirement and radiation dose.

•CBCT delivers a higher radiation dose than panoramic radiography but provides superior 3D diagnostic information.