ENDODONTIC RADIOPHraphy
Traditionally in endodontics, radiographs are used for diagnostic, intra-operative, post-operative, and recall appointments.

Although imaging in dentistry has greatly advanced recently, the most common images used in endodontics are the periapical and bitewing radiographs.
Periapical radiographs show the whole tooth and the surrounding bone. They reveal caries, periodontal diseases and periapical lesions.
NORMAL RADIOGRAPHIC LANDMARKS

Enamel: Most radiopaque structure
Dentin: Slightly darker than enamel

PDL: Appears as a narrow radiolucent line around the root surface. The space begins at the alveolar crest, extends around the tooth roots and returns to the alveolar crest on the opposite side of tooth.

Lamina dura: Radiopaque line representing the tooth socket. Sound teeth show that the tooth socket is bounded by a thin white or radiopaque shadow known as lamina dura. The presence of intact lamina dura suggests a healthy pulp.

Pulp cavity: Pulp chamber and root canals are seen as radiolucent lines within the tooth.

Alveolar crest: The gingival margin of alveolar process extending between teeth is apparent on properly exposed X-ray as a radiopaque line known as alveolar crest.
RADIOGRAPHIC TECHNIQUES

- PARALLELING TECHNIQUE
- BISECTING ANGLE TECHNIQUE
PARALLELING TECHNIQUE

SYNONYMS: FITZGERALD TECHNIQUE, LONG CONE TECHNIQUE OR EXTENDED CONE TECHNIQUE.

REQUISITE:

- Target film distance should be 16-20 inches
- Central x-ray beam should strike both the object and the film at right angle
- The film and the object should be parallel
ADVANTAGES OF PARALLELING TECHNIQUE

- More accurate reproduction of tooth dimensions.
- Enhancing length determination and relation to anatomic structure.
- Reduces possibility of superimposing zygomatic process.
- Helps accurate reproducibility of film and cone placement for comparison and follow up.
LIMITATIONS OF PARALLELING TECHNIQUE

- May be uncomfortable to the patient
- Film holder is necessary
- Not feasible with: shallow palates, tori, long roots, gagging patients
BISECTING ANGLE TECHNIQUE

SYNONYMS: SHORT CONE TECHNIQUE

• The bisection of the angle technique is based on a geometric principle of bisecting a triangle (bisecting means dividing into two equal parts).
• The angle formed by the long axis of the teeth and the film is bisected, and the x-ray beam is directed perpendicular to the bisecting line.
• Perpendicular means at a right angle to the film.
ADVANTAGES OF BISECTING ANGLE TECHNIQUE

- Quick and easy to use.
- Less patient discomfort.
- May be used even in small mouths with shallow palates or tori.
- Simple to use with rubber dam in place.
- No additional equipments required
LIMITATIONS OF BISECTING ANGLE TECHNIQUE

- Dimensionally inaccurate because the central beam is not perpendicular to the tooth or film.
- Imaginary line is difficult to assess.
- Superimposition of zygomatic process might occur.
- Radiographs are difficult to reproduce during follow up, so comparisons for healing cannot be made.
Radiographs are two dimensional representation of 3-D objects.

This limitation is overcome by using two different radiographs obtained from different usually horizontal directions.
The SLOB rule is one of the most widely used radiographic concept in endodontics.

On periapical radiographs, roots are often superimposed upon one another and require separation for proper identification.

The SLOB rule is an acronym for SameLingual Opposite Buccal.

The premise is that one radiograph is taken straight on at a 90 degree angle to the tooth and a second radiograph is taken with the tubehead shifted either mesially or distally.

The rule simply states that the object imaged will move in the same direction as the tubehead is moved if it is located on the lingual (Same Lingual).

Conversely, the object being imaged will move opposite the tubehead movement if it is located on the buccal (Opposite Buccal).

An example of this would be a palatal root, which is on the lingual side of a maxillary molar, will move mesially on the image if the tubehead moves mesially (Same Lingual).
ADVANTAGES OF CONE SHIFT TECHNIQUE

- Separation and working length determination of overlapping canals
- Determination of the direction of root curvature
- Useful in the identification of anatomic landmarks and pathosis
- Helps in the identification of missed canals
- Helps to locate the root resorptive processes in relation to the tooth
- Helps in locating the perforations
- In case of instrument separation, it helps to locate in which canal the broken instrument is present
DISADVANTAGES OF CONE SHIFT TECHNIQUE

Decreased clarity
BITE WING RADIOGRAPHS

- A bite-wing radiograph shows the crowns and interproximal areas of the maxillary and mandibular teeth and the areas of crestal bone on one film.

- Bite-wing radiographs are used to detect interproximal caries (tooth decay) and are particularly useful in detecting early carious lesions that are not clinically evident.

- Reveal secondary caries below restorations that may escape recognition in periapical view.

- Useful in examining the crestal bone levels between the teeth.

- Reveal the anatomy of the pulp chamber
The film is placed in the mouth parallel to the crowns of both the upper and lower teeth.

The film is stabilized when the patient bites on the bite-wing tab or bite-wing film holder.

The central ray of the x-ray beam is directed through the contacts of the teeth, using a +10° vertical angulation.
RADIOGRAPHIC INTERPRETATION

- Knowledge of normal anatomical landmarks
- Organized method of evaluation and interpretation involving review of one structure at a time thoroughly and completely and then proceeding to the next structure.
- Such interpretation done in an organized habitual way ensures that nothing is overlooked.
RADIOGRAPHIC EVALUATION OF THE CROWN

- Depth of caries and restorations with respect to the pulp
- Evidence of pulp cappings or pulpotomy, dens invaginatus or dens evaginatus,
- Size of the preparations under porcelain or resin jacket crowns
- Size of the pulp chamber and presence of pulp stones
RADIOGRAPHIC EVALUATION OF THE ROOTS

Tracing the dark periodontal membrane space will reveal the:

- Number
- Size
- Shape of the roots
- Position
- Fractures, resorption
- Open apices
- Periradicular lesions
DETECTION OF EXTRA CANALS

Whenever the outline of the root is:

- unclear
- has an unusual contour
- strays in any way from the expected radiographic appearance,

one should suspect an additional root canal.
Follow the image of the test file in the length-of-the-tooth film, particularly in the coronal part of the root. If an extra dark line is apparent in the coronal third of the root, running parallel to the instrument, one should suspect a second canal. Eg; mesiobuccal canal of maxillary first molar and distal canal of mandibular first molar.

When viewing a radiograph, if there is a sudden change in the radiolucency within a canal, this change in density probably signals the beginning of an additional canal. It could be called the fast break. This is a frequent occurrence in maxillary first premolars.
RADIOGRAPHIC DIAGNOSIS OF PERIAPICAL LESIONS

- Pulpal inflammation and necrosis eventually produce periradicular changes. The earliest is a widening of the periodontal ligament space, usually at the apex.
- Occasionally, however, these signs may be associated with occlusal traumatism. This emphasizes the need for additional tests beyond radiographs.
- A widened PDL space may also be expected with other conditions: acute apical periodontitis, a beginning acute apical abscess, or occasionally, acute pulpitis.
Diagnostic

Intra oral periapical radiographs are used in

- Identification of abnormal conditions in the pulp and periapical tissue.
- Determination of: number of roots, canals and curvatures.
- Supplemental radiographs enhance visualization of “3D” structure of the tooth.
During treatment

- Determination of working length
- Locating the canals
- Moving superimposed structures
- Evaluate the quality of obturation
Recall Radiographs:

They are useful for

- Identification of new pathosis.
- Evaluating healing.
DIGITAL RADIGRAPHY

- Advances in digital technology have led to a unique “filmless” imaging system known as digital radiography.
- Introduced in 1987, digital radiography has influenced both how dental disease is recognized and how it is diagnosed.
- In the last 2 years, the use of digital radiography is rapidly increasing in both general and specialty dental practices.
Digital radiography uses a sensor to capture a radiographic image, breaking it into electronic pieces and storing the image in a computer. The image is displayed on a computer screen rather than on film. The term *image* (*not* radiograph) is used to describe the pictures that are produced. The x-ray beam strikes the sensor. An electronic charge is produced on the surface of the sensor, and this electronic signal is digitized. The digital sensor in turn transmits this information to the computer. Software in the computer is used to store the image electronically.
EQUIPMENT

For digital radiography, special equipment is required. The essential components include:

- Dental x-ray unit
- Intraoral sensor
- Computer
TYPES OF DIGITAL IMAGING

- Direct digital imaging
- Indirect digital imaging
- Storage phosphor imaging
- The difference between each method is in how the image is obtained and in what size the receptor plates are available (e.g., panoramic).
DIRECT DIGITAL IMAGING

- Direct digital imaging systems produce a dynamic image that permits immediate display in the monitor.
- Direct digital sensors are either a charge-coupled device (CCD) or complementary metal oxide semiconductor active pixel sensor (CMOS-APS).
- The CCD is a solid-state detector composed of an array of X-ray or light sensitive pixels on a pure silicon chip.
- Approximately the size of dental film, the CCD sensor has a slightly smaller sensitive area; a thicker, rigid case; and an electrical lead that attaches to the computer unit.
The complementary metal oxide semiconductor active pixel sensor (CMOS-APS) is the latest development in direct digital sensor technology.

Externally, CMOS sensors appear identical to CCD detectors but they use an active pixel technology.

They have low system power requirement to process the image and are less expensive to manufacture.
INDIRECT DIGITAL IMAGING

- Indirect digital images are obtained by converting images that are acquired by conventional radiographs into a digital format by means of a flatbed scanner.

- As with any data conversion, this analog to digital conversion (ADC) results in the loss and alteration of information.
STORAGE PHOSPHOR IMAGING

- Also called as semi-direct image plate systems
- The image is captured on a phosphor plate as analog information and is converted into a digital format when the plate is processed.
- Thus, the plates hold the latent image until it is “processed.”
- The energy stored in these crystals is released as blue fluorescent light when the PSP is scanned with a helium-neon laser beam during processing.
- The light is then converted to a digital form, and the data can be displayed and seen on a computer monitor.
ADVANTAGES OF DIGITAL IMAGING

- Immediate observation of radiographic images
- Ability to enhance or post-process the image
- Data storage
- Ease of communication with other practitioners
- Film processing chemicals not required
- Less radiation
ADVANTAGE OF DIGITAL RADIOGRAPHY DURING ENDODONTIC TREATMENT

The digital image is available on the computer screen within a few seconds. As a result, digital radiographic systems are efficient aids in an endodontic procedure, in which a second image easily can be made from a slightly different angle without removing the sensor out of patient’s mouth—for example, to make the second root canal better visible—with the sensor still in the same position, but with different angulation.
DISADVANTAGES OF DIGITAL RADIOGRAPHY

- Cost of devices
- Cost of converting previous records to digital
- Learning to use the concept
- Wire attached to the sensor
- Thickness of the sensor
- Rigidity of the sensor
- Loss or breakage of sensors
- Lack of universal use of digital radiography
Subtraction in digital radiology is another image enhancement method with purpose to produce two radiographs of the same area in the mouth at the different time intervals.

The first image can be subtracted from the second one to identify changes that may have occurred during a certain time period.

Minimal changes in loss or gain of hard tissue can be detected using this technique, otherwise undetectable by visual examination and traditional radiography.

A main requirement for subtraction digital radiography is an identical or almost identical image projection at these different time periods.

This procedure of image registration (alignment of the two views) also requires correct exposure and processing techniques.
XERORADIOGRAPHY

- Xeroradiography which is a method of imaging uses the xeroradiographic copying process to record images produced by diagnostic x-rays.
- It differs from halide film technique in that it involves neither wet chemical processing nor the use of dark room.
XERORADIOGRAPHIC PLATE

- Xeroradiography is an electrostatic process which uses an amorphous selenium photoconductor material, vacuum deposited on an aluminum substrate, to form a plate.
- The plate, enclosed in light tight cassette, may be likened to films used in halide-based technique.
- This plate is made up of a 9 ½ by 14 inch sheet of aluminum, a thin layer of vitreous or amorphous selenium photoconductor, an interface layer, and an overcoating on the thin selenium layer.

![Diagram of Xeroradiographic Plate]

- Overcoating (0.1μm)
- Vitreous Selenium (150μ or 320μ)
- Interface layer (0.1μm)
- Aluminum Substrate (2mm)
FUNCTIONAL STEPS

- Sensitization of the photoconductor plate in the charging station by depositing a uniform positive charge on its surface with a device called scorotron.
- In the absence of electromagnetic radiation, the photoconductor remains nonconductive.
- When exposed to x-rays, the photoconductor will then conduct its electrostatic charge into the grounded base in proportion to the intensity of the exposure.
- The generated latent image is developed through an electrophoretic development process using liquid toner.
- By applying negatively charged powder (toner) which is attracted to the residual positive charge pattern on the photoconductor, the latent image is made visible and the image can be transferred to a transparent plastic sheet or to paper.
ADVANTAGES OF XERORADIOGRAPHY

- Elimination of accidental film exposure
- High resolution
- Better ease and speed of production
- Economical
- Reduced exposure to radiation hazards
DISADVANTAGES OF XERORADIOGRAPHY

- Technical difficulties
- Fragile selenium coat
- Transient image retention
RECENT ADVANCES

- Conventional (both chemical and digital) radiography renders a three-dimensional (3-D) anatomical structure two dimensionally with inherent distortions.
- Cone beam computed tomography (CBCT) has been used in dentistry since 1998.
- Unlike medical CT, which captures the image in slices, CBCT data are captured in a 3-D pixel unit called voxel (volume pixel).
- As these voxels are isotropic, the object is accurately measured in different directions.
- In addition to providing higher resolution image, CBCT has a much reduced radiation dosage than medical CT.
ADVANTAGES OF CBCT

1. Three dimensional rendition
2. Geometrically accurate images
3. Increased sensitivity and specificity for caries, periodontal and periapical lesions
4. Patient comfort - no intra-oral placement of film or sensor.
5. Soft tissue rendition
DISADVANTAGES OF CBCT

1. Increased radiation
2. Expensive
3. Inferior resolution
4. Beam scatter and hardening by high density materials cause artifacts
5. Dentist needs to be computer savvy
ENDODONTIC APPLICATIONS OF CBCT

- Diagnosis of endodontic pathosis
- Canal morphology
- Assessment of pathosis of non-endodontic origin
- Evaluation of root fractures and trauma
- Analysis of external and internal root resorption and invasive cervical resorption
- Pre-surgical planning
- Implant planning