Section 4

Extraoral Imaging
1. Pronounce, define, and spell the Key Terms.

2. Discuss panoramic imaging, including:
   - Describe the purpose and uses of panoramic imaging.
   - Describe the equipment used in panoramic imaging.
   - Describe the steps for patient preparation and positioning in panoramic imaging.
   - Describe the errors that may occur during patient preparation and positioning during panoramic imaging.
Introduction

- **Extraoral images** (outside the mouth) are taken when large areas of the skull or jaw must be examined, or when patients are unable to open their mouths for film placement.
  - Extraoral radiographs are useful in evaluating large areas of the skull and jaws but are not recommended for detection of subtle changes, like caries or early periodontal changes.

- Introduction of full-featured *digital panoramic units* and a new technology called *cone beam computed tomography (CBCT)*.
  - Almost all digital extraoral images have better resolution than film-based images.
Panoramic Imaging

- Panoramic imaging allows the dentist to view the entire dentition and related structures on a single image
  - Used to locate impacted teeth, detect jaw lesions, observe eruption patterns

- In the past, panoramic images were not recommended for diagnosing dental caries or periodontal disease or lesions because of the overlapping of posterior contact areas
  - Bitewing images had to be used to supplement the panoramic
Structures Seen on a Panoramic Image

Panoramic Imaging (Cont.)

- This situation has changed with the introduction of the new full-featured digital panoramic units with a special C-arm.
- Panoramic digital images produced with these machines can show small interproximal carious lesions.
- They can “open up” contacts in the premolar areas that traditional panoramic machines showed as being overlapped.
Types of Panoramic Units

- Two types of panoramic machines: *film-based imaging* and *direct digital imaging*
- The main difference between direct digital panoramic imaging and film-based panoramic imaging is the image receptor
- Digital units use a sensor array rather than film, and the image is produced immediately on the computer monitor rather than on film after processing
Film-Based Panoramic Unit
Basic Concepts

- In panoramic imaging, both the film/sensor and the tubehead rotate around the patient
  - Produce a series of individual images
- When these images are combined on a single film, an overall view of the maxilla and the mandible is created
Panoramic Radiography
The Focal Trough

- Focal trough is an imaginary three-dimensional curved zone in which structures appear clear on a panoramic radiograph.
- When patient’s jaws are positioned within this zone, the resulting radiograph is reasonably clear and well defined.
- If jaws are positioned outside of this zone, images on the radiograph appear blurred or indistinct.
The size and shape of the focal trough vary with the manufacturer of the panoramic unit.

Panoramic x-ray units are designed to accommodate the average jaw.

The quality of the resulting radiograph depends on how the patient’s jaws are positioned within the trough and how closely the patient’s jaws conform to the focal trough.
Schematic Representation of the Focal Trough

Equipment

- Tubehead
- Head positioner
- Exposure controls
- Film and intensifying screens
Panoramic x-ray tubehead is similar to intraoral tubehead

- Has a filament that produces electrons and a target that produces radiographs
- *Collimator* used in the panoramic x-ray machine is a lead plate with an opening shaped like a narrow vertical slit

Different from the intraoral tubehead, the vertical angulation of the panoramic tubehead is not adjustable

- Tubehead of the panoramic unit rotates behind the patient’s head as the film rotates in front of the patient
Head Positioner

- Each panoramic unit includes a head positioner used to align the patient’s teeth as accurately as possible.

- Each head positioner consists of a chin rest, a notched bite-block, a forehead rest, and lateral head supports or guides.

- Each panoramic unit is unique, and the operator must follow the manufacturer’s instructions to position the patient correctly in the focal trough.
Head Positioner
Exposure Controls

- Allow the milliamperage and kilovoltage settings to be adjusted to accommodate patients of different sizes
- The exposure time cannot be changed
Film and Intensifying Screens

- Film-based panoramic imaging uses a type of extraoral screen film that is held in a film cassette.
- This type of film is sensitive to the light emitted from intensifying screens in the film-holding cassette.
To produce a diagnostic panoramic image and minimize patient exposure, you must avoid mistakes. You must be able to recognize the following common patient preparation and positioning errors and understand what you can do to prevent such errors from occurring.
Patient Preparation Errors

- **Ghost images**
  - If all metallic or radiodense objects are not removed before exposure, a “ghost” image results
  - A ghost image looks similar to the real object, except that it appears on the opposite side of the film
  - The ghost image will appear blurred and larger

- **Solution**
  - The patient must be instructed to remove all radiodense objects from the head and neck region before being positioned
Large Hoop Earrings and “Ghost” Images

Patient Preparation Errors (Cont.)

- **Lead-apron artifact**
  - If the lead apron is incorrectly placed, or if a lead apron with a thyroid collar is used during exposure of panoramic films, a radiopaque cone-shaped artifact results.
  - Interferes with the diagnostic information.

- **Solution**
  - Use a lead apron without a thyroid collar, and place the lead apron low around the neck of the patient so that it does not block the x-ray beam.
Lead Apron Artifact
Patient Positioning Errors: Lips and Tongue

- The patient’s lips must be closed on the bite-block during exposure of a panoramic film.
  - If they are not, the result is a dark radiolucent shadow that obscures the anterior teeth

- Also, the tongue must be in contact with the palate during exposure of a panoramic film
  - If it is not, the result is a dark radiolucent shadow that obscures the apices of the maxillary teeth

- Solution
  - Close the lips around the bite-block. Swallow and then raise the tongue up to the palate
Tongue Position

Also referred to as positioning of the Frankfort plane

If the *Frankfort plane* is incorrect and the patient’s chin is positioned too high or is tipped upward:
- The hard palate and the floor of the nasal cavity will appear superimposed over the roots of the maxillary teeth
- Detail in the maxillary incisor region will be lost
- The maxillary incisors will appear blurred and magnified
- A “reverse smile line” will be apparent on the radiograph

Solution
- Position the patient so the Frankfort plane is parallel to the floor
“Reverse Smile Line”
Patient Positioning Errors: Chin Too Low

- If the Frankfort plane is incorrect and the patient’s chin is positioned too low or is tipped downward:
  - The mandibular incisors will appear blurred
  - Detail in the anterior apical regions will be lost
  - The condyles will not be visible
  - An “exaggerated smile line” will be apparent on the radiograph

- Solution
  - Position the patient so the Frankfort plane is parallel to the floor
“Exaggerated Smile Line”

Patient Positioning Errors: Posterior to Focal Trough

- If the patient’s anterior teeth are positioned too far back on the bite-block, or posterior to the focal trough, the anterior teeth appear “fat” and out of focus on the radiograph.

- Solution
  - Position the patient so that the anterior teeth are placed in an end-to-end position in the groove on the bite-block.
Patient is Biting Too Far Back on the Bite Stick
Anterior Teeth Appear Widened and Blurred

Patient Positioning Errors: Anterior to Focal Trough

- If the patient’s anterior teeth are not positioned in the groove on the bite-block and are too far forward or anterior to the focal trough, the teeth appear “skinny” and out of focus.

- Solution
  - Position the patient so that the anterior teeth are placed in an end-to-end position in the groove on the bite-block.
Anterior Teeth Appear Narrowed and Blurred

Patient Positioning Errors: Spine Not Straight

- If the patient is not standing or sitting with a straight spine, the cervical spine appears as a radiopacity in the center of the film and obscures diagnostic information.

- Solution
  - The patient must be instructed to stand or sit “as tall as possible” with a straight back.
Superimposition of the Cervical Spine

3. Discuss three-dimensional imaging, including:
   • Explain the difference between a CT scan and CBCT.
   • Describe the uses of three-dimensional (3D) imaging.
   • Discuss the advantages and disadvantages of cone beam computed tomography (CBCT).

4. Identify the specific purpose of each type of the extraoral film projections.
How it works:

- During a cone beam CT examination, the arm rotates around the patient’s head in a complete 360-degree rotation.
- While doing this, it takes anywhere from 200 to 600 two-dimensional (2D) images which the software collects.
- It then digitally combines them to form a 3D image that can provide the dentist or oral surgeon with valuable information.
Advantages of Cone Beam Computed Tomography

- This technology provides 3-D views of the mouth, face, and jaw from any direction
  - Manufacturers can provide software programs that will make it possible to clearly see all anatomical structure, including soft tissue
  - Some programs will even overlay the patient’s facial image onto the radiographic image
  - The digital images can be easily adjusted, manipulated, and colorized on the computer
  - Because the images are digitized, they can be easily sent over the Internet, allowing for collaboration and consultation on cases
Additional Advantages

- Even digital two-dimensional images cannot provide any information about width or depth, nor can they distinguish between the types of hard and soft tissues.

- CBCT has greatly enhanced the diagnostic abilities of the dentist by providing vital information necessary for:
  - The proper placement of implants
  - The extraction of impacted teeth
  - Determining the exact location of the mandibular nerve prior to surgery
Common Uses of CBCT

- More dentists, and especially dental specialists, are investing in CBCT units for their offices.
- Time for training is necessary to learn to use the CBCT hardware.
- Additional training is required to interpret the data because it is presented in a 3-D view or as tomographic slices.
Specialized Extraoral Imaging

- Extraoral images may be obtained using film-based or digital systems
- Extraoral radiographs provide images of larger areas such as the skull and jaws
Specialized Extraoral Imaging: Equipment

- Extraoral radiographs may be taken with the use of a standard intraoral x-ray machine
  - Special head positioning and beam alignment devices can be added to the standard x-ray unit to aid patient positioning

- Panoramic x-ray units may also be fitted with a special device known as a cephalostat
  - The cephalostat includes a film holder and head positioner that allow the operator to easily position the patient
Film and Intensifying Screens

- Most extraoral exposures use screen film placed in a cassette that has an intensifying screen.

- An occlusal film (size #4) may be used for some extraoral radiographs, such as lateral jaw or transcranial projection.

- An occlusal film is a nonscreen film that does not require a cassette; however, it requires more radiation than is needed with screen film.
A grid is a device that is used to decrease the amount of scatter radiation that reaches an extraoral film during exposure. Scatter radiation causes film fog and reduces film contrast.

A grid is composed of a series of thin lead strips embedded in plastic that permits passage of the x-ray beam. The grid is placed between the patient’s head and the film.
When certain x-rays interact with the patient’s tissues, scatter radiation is produced, which is directed at the grid and film at an angle.

As a result, scatter radiation is absorbed by the lead strips and does not reach the surface of the film to cause film fog.

Increased exposure time must be used to compensate for the lead strips found in the grid.
A Grid Decreases the Amount of Scatter Radiation

Procedures

- Step-by-step procedures for the exposure of an extraoral film involve the same equipment preparation, patient preparation, and patient positioning as for panoramic radiographs.

- Before an extraoral film is exposed, infection control procedures must be completed.

- If an extraoral x-ray unit with a cephalostat is used, the ear rods must be wiped with a disinfectant between patients.
Skull Radiography

- Used most often in oral surgery and orthodontics
- Although some skull films can be exposed with a standard intraoral radiograph machine, most require the use of an extraoral unit and cephalostat
Skull Radiography (Cont.)

- Skull radiographs may be difficult to interpret because of the numerous anatomic structures that exist in the area.
  - Often, these structures appear superimposed over one another.

The most common skull radiographs used in dentistry include:
- Lateral cephalometric projection
- Posteroanterior projection
- Temporomandibular joint projection
Lateral Cephalometric Projection

- Used to evaluate facial growth and development, trauma, disease, and developmental abnormalities
- This projection shows the bones of the face and skull, as well as the soft tissue profile
Lateral Cephalometric Radiograph
Posteroanterior Projection

- Used to evaluate facial growth and development, trauma, disease, and developmental abnormalities
- This projection shows the frontal and ethmoid sinuses, the orbits, and the nasal cavities
Patient and Film Positioning for Posteroanterior Skull Projection

Radiographs of the *temporomandibular joint* (TMJ) can be very difficult to examine because of the multiple adjacent bony structures.

- The articular disc and other soft tissues of the TMJ cannot be examined radiographically.
- Special imaging techniques (e.g., arthrography, magnetic resonance imaging) must be used.
- Radiographic projections of the TMJ can be used to show the bone and the relationship of the jaw joint.