<table>
<thead>
<tr>
<th>Lecture Topics</th>
<th>Reading Assignments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>I. Infection Control in Radiography Review</strong></td>
<td>Langland, Langlais, Preece; Chapter 4, pp. 69-83 Radiography Manual p. 7 Coursespace Module 2</td>
</tr>
<tr>
<td>A. Explain why all patients should be treated as potentially infectious.</td>
<td></td>
</tr>
<tr>
<td>B. Identify the protective barriers that should be worn during film and tube placement and during film processing to minimize risks to the operator and patient.</td>
<td></td>
</tr>
<tr>
<td>C. Explain why supplies should be dispensed rather than stored in a drawer.</td>
<td></td>
</tr>
<tr>
<td>D. Identify the infection control procedures to be followed before seating and after dismissing the patient.</td>
<td></td>
</tr>
<tr>
<td><strong>II. Review</strong></td>
<td>Langland, Langlais, Preece; Chapter 3 pp. 51-64 Coursespace Module 2</td>
</tr>
<tr>
<td>A. Diagnostic quality of radiographs</td>
<td></td>
</tr>
<tr>
<td>1. Define and explain the visual characteristics of radiographs</td>
<td></td>
</tr>
<tr>
<td>2. Define and explain the geometric characteristics of radiographs</td>
<td></td>
</tr>
<tr>
<td>3. Explain anatomical accuracy of radiographic image</td>
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</tr>
<tr>
<td>4. Explain adequate coverage of anatomical regions of interest</td>
<td></td>
</tr>
<tr>
<td>5. Define: attenuation, radiopaque, radiolucent</td>
<td></td>
</tr>
<tr>
<td><strong>III. Normal Radiographic Anatomy</strong></td>
<td>Langland, Langlais, Preece; Chapter 14 Haring &amp; Lind Chapter 2 &amp; 3 Coursespace Module 3</td>
</tr>
<tr>
<td>A. Recognize anatomical landmarks and their implications on radiographs.</td>
<td></td>
</tr>
<tr>
<td>1. Recognize anatomical structures and their implications on radiographs.</td>
<td></td>
</tr>
<tr>
<td>2. Use knowledge of anatomical landmarks to identify films of specific areas.</td>
<td></td>
</tr>
<tr>
<td>3. Recognize anatomical structures which have implications for modification in film taking.</td>
<td></td>
</tr>
<tr>
<td><strong>IV. Occlusal Film Examination</strong></td>
<td>Langland, Langlais, Preece; pp. 45, 131-134 Coursespace Module 4</td>
</tr>
<tr>
<td>A. Know techniques for film placement and procedures:</td>
<td></td>
</tr>
<tr>
<td>1. Describe an occlusal film examination.</td>
<td></td>
</tr>
<tr>
<td>2. List conditions that can be detected by an occlusal film examination.</td>
<td></td>
</tr>
<tr>
<td>3. Determine appropriate film placement and the angle of projection of the central ray for various occlusal exposures</td>
<td></td>
</tr>
<tr>
<td>4. Differentiate between a topographical exposure and a cross-sectional exposure.</td>
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<tr>
<td>Lecture Topics</td>
<td>Reading Assignments</td>
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<td>----------------------------------------------------------</td>
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<tr>
<td><strong>V. Extraoral Radiography</strong></td>
<td></td>
</tr>
<tr>
<td>A. Understand theory and specific uses of extraoral films.</td>
<td></td>
</tr>
<tr>
<td>1. Identify the specific uses of extraoral films.</td>
<td>Langland, Langlais, Preece; Chapter 9, 10, p. 271-278</td>
</tr>
<tr>
<td>2. Explain the basic principles of panoramic radiography.</td>
<td>Haring &amp; Lind; Chapter 4</td>
</tr>
<tr>
<td>3. Identify the anatomical structures that may be present on a panoramic radiograph.</td>
<td>Coursespace Module 5</td>
</tr>
<tr>
<td>4. Identify patient preparation and positioning errors seen on panoramic radiographs.</td>
<td></td>
</tr>
<tr>
<td>5. Explain the causes of patient preparation and positioning errors and the necessary measures to correct such errors.</td>
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<tr>
<td>6. Differentiate between the advantages and limitations of panoramic radiography.</td>
<td></td>
</tr>
<tr>
<td>7. Explain the use of cephalometric radiographs in orthodontics.</td>
<td></td>
</tr>
<tr>
<td><strong>VI. Periodontics: A Radiographic Review</strong></td>
<td></td>
</tr>
<tr>
<td>A. The use of radiographs in periodontics:</td>
<td></td>
</tr>
<tr>
<td>1. Identify the use of x-rays in the evaluation of periodontal disease.</td>
<td>Haring &amp; Lind; Chapter 7</td>
</tr>
<tr>
<td>2. Identify the limitations of radiographs in the evaluation of periodontal disease.</td>
<td>Langland, Langlais, Preece; Chapter 15</td>
</tr>
<tr>
<td>3. Differentiate between horizontal and vertical bone loss.</td>
<td>Coursespace Module 6 &amp; 7</td>
</tr>
<tr>
<td>4. Explain how to determine the amount of bone loss.</td>
<td></td>
</tr>
<tr>
<td>5. Explain how to coordinate radiographs and periodontal charting in the evaluation of periodontal disease.</td>
<td></td>
</tr>
<tr>
<td><strong>VII. Identification of some Pathologic Entities</strong></td>
<td></td>
</tr>
<tr>
<td>A. Interpretation of films:</td>
<td></td>
</tr>
<tr>
<td>1. Understand the rationale for producing adequate diagnostic radiographs.</td>
<td>Haring &amp; Lind; Chapter 2, 6 &amp; 8</td>
</tr>
<tr>
<td>2. Discuss the role of the dentist in making radiographic diagnosis.</td>
<td>Langland, Langlais, Preece; Chapter 17, 18</td>
</tr>
<tr>
<td>3. Identify common pathologic conditions seen on radiographs.</td>
<td>Coursespace Module 8 &amp; 9</td>
</tr>
<tr>
<td>4. Identify pulp stone on a radiograph.</td>
<td></td>
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<tr>
<td>5. Identify tori on a radiograph.</td>
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<tr>
<td>6. Identify calculus on a radiograph.</td>
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<tr>
<td>7. Identify decay on a radiograph.</td>
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<tr>
<td>8. Identify cervical burnout on a radiograph.</td>
<td></td>
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</tbody>
</table>
### Lecture Topics

<table>
<thead>
<tr>
<th>VIII. Legal and Ethical Considerations of Radiography</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Explain state laws and regulations regarding dental radiographs.</td>
</tr>
<tr>
<td>2. Explain ethical responsibility with regards to dental radiographs.</td>
</tr>
<tr>
<td>3. Identify the ownership of radiographs.</td>
</tr>
<tr>
<td>4. Identify the legal responsibilities with regards to dental radiographs.</td>
</tr>
<tr>
<td>5. Explain the ALARA concept and discuss risk from dental x-rays.</td>
</tr>
<tr>
<td>6. Explain the procedure for and the importance of labeling and filing radiographs.</td>
</tr>
<tr>
<td>7. Define quality assurance/control.</td>
</tr>
<tr>
<td>8. Explain the importance of quality control as related to x-ray equipment and processing procedures and identify the factors that influence this quality control.</td>
</tr>
</tbody>
</table>

### Reading Assignments

| Langland, Langlais, Preece; Chapter 8 |
| Coursespace Module 10 |

## Lab Requirements:

1. Attendance at all labs. Requirements are the student's responsibility and meeting the requirements will be difficult to impossible if you have poor lab attendance. Each student will be allowed (2) two lab absences with or without written excuse. After a student surpasses the (2) two allowable absences, (2) two points will be deducted from the final lab grade for each additional absence. A student who is more than 15 minutes late for lab is considered absent. Due to maximum lab enrollment it is impossible to make up missed labs.

2. 2 CRS requirements on Dexter
   - 1 Rinn with tab BWX
   - 1 BSA with snap-a-ray and vertical BWX

3. CRS requirements:
   - 2 CRS (with Rinn) on patients

4. BW requirements:
   - 5 patients - using tab technique (may be included with CRS)

5. 1 panoramic survey on a patient

6. Occlusal films:
   - 2 films on Dexter

7. Film Duplicating - CRS or BWX

8. All x-rays submitted for a grade must be accompanied by a completed evaluation/interpretation form and all other forms noted. X-rays must be evaluated for a grade with a radiology instructor.
9. Lab Exercises
   A. Review slides and radiographic review book
      1. exposure and processing errors (from DEN 111)
      2. landmarks on maxilla and mandible
      3. bone evaluation
      4. radiographic pathologies
   B. Radiographic Interpretation exercises -- bone evaluation and decay
   C. Mounting and charting exercises on CRS's provided by lab instructors
<table>
<thead>
<tr>
<th>Lab</th>
<th>X-rays Due</th>
<th>Slides/Video Lab Work</th>
<th>Reading Assignments</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td></td>
<td>Introduction to Rinn Rinn: Video</td>
<td>Langland, Langlais, Preece; pp 97-115</td>
</tr>
<tr>
<td>II</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>III</td>
<td>Rinn-CRS on Dexter</td>
<td>BSA films with snap-a-ray</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td></td>
<td>Film duplicating</td>
<td>Langland, Langlais, Preece; p. 149-150</td>
</tr>
<tr>
<td>V</td>
<td>BSA-CRS on Dexter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VI</td>
<td></td>
<td>Introduction to Occlusal Films</td>
<td>Langland, Langlais, Preece; pp 131-134</td>
</tr>
<tr>
<td>VII</td>
<td></td>
<td>Assigned Perio Report</td>
<td>Haring &amp; Lind; Chapter 7, Langland, Langlais, Preece; Chapter 15</td>
</tr>
<tr>
<td>VIII</td>
<td></td>
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</tr>
<tr>
<td>IX</td>
<td></td>
<td>Assigned Perio Report Due</td>
<td></td>
</tr>
<tr>
<td>X</td>
<td></td>
<td>Assigned Decay Exercise</td>
<td>Haring &amp; Lind; Chapter 6, Langland, Langlais, Preece; Chapter 17</td>
</tr>
<tr>
<td>XI</td>
<td></td>
<td>Decay Evaluation Due</td>
<td></td>
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<tr>
<td>XII</td>
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<td></td>
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<tr>
<td>XIII</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>XIV</td>
<td>Occlusal films on Dexter</td>
<td>All patient requirements complete</td>
<td></td>
</tr>
</tbody>
</table>
REVIEW – DIAGNOSTIC QUALITY

As you review how previous factors discussed in Den 111-Dental Radiography I affect the diagnostic quality of radiographs consider the following. (See Powerpoint labeled REVIEW)

1. How would you define density and what factors effect density?
2. How would you define contrast and what is the difference between short-scale and long-scale contrast?
3. What is magnification and what influences magnification?
4. What is penumbra?
5. What is the difference between radiopaque and radiolucent?

The diagnostic quality of radiographs depends on the following:
1. the visual characteristics of the radiograph (i.e. density and contrast)
2. the geometric characteristics of the radiograph (i.e. minimal unsharpness, magnification and distortion)
3. the anatomical accuracy of the radiographic image
4. adequate coverage of the area of interest

Let’s first examine the visual characteristics of a radiograph. Therefore the role density and contrast play in the diagnostic quality of a radiograph.

Density is the overall blackening of a film. The number of silver halide crystals exposed initially will determine the density of a radiograph. Density relates to variations in the amount of light transmitted through the film. The film will be darker when more light reaches the film. A dark film, therefore, has a high degree of radiographic density whereas a light film has a low degree of radiographic density. Density is effected by three exposure factors (mAs, kvp and source-film distance). Let’s review the role each of these factors play in density.

Milliamperage (mAs) is directly proportional to density. Therefore, as you increase milliamperage you increase density. The higher the milliamperage the more x-rays that will strike the film. The more x-rays that strike the film the more halide crystals exposed.

Kilovoltage (kvp) is also directly proportional to density. The higher the kvp the shorter the wavelengths. The shorter wavelengths give increased penetrating power allowing more radiation to strike the film. The more radiation that strikes the film the more the silver halide crystals are exposed.

The last exposure factor that effects density is source-film distance. Source-film distance is inversely (indirectly) proportional to density. As source-film distance is increased density is decreased. If you wanted to maintain the same density but had to increase source-film distance you would have to increase exposure time.

There are some secondary factors that also play a role in density. These include patient thickness, developing, fixing and the type of film used. You may want to review your notes from last semester relative to these factors.

Now let us look at contrast. Contrast refers to the visual differences in densities of adjacent areas. In
other words, contrast refers to the differences between light and dark. Short-scale contrast or high contrast means there is a definite difference between light and dark. Short-scale contrast is basically black and white with very few shades of gray. Short-scale contrast is obtained with a low kvp. With the low kvp either the beam penetrated the object or it did not (i.e. blocked or reached the film).

Long-scale contrast or low contrast shows many shades of gray or very little differences in densities. Long-scale contrast is obtained with a high kvp. The high kvp gives a more penetrating beam allowing the x-rays to penetrate the objects and pass to the film. The visual density differences of adjacent areas is, therefore, small or few.

Now that we have examined the visual characteristics of a radiograph let’s look at the effect of geometric principles related to the diagnostic quality of a radiograph. The formation of an accurate radiographic image depends somewhat on minimizing certain geometric characteristics. When we look at geometric characteristics we are examining such factors as unsharpness, magnification and distortion.

In radiography, we want a sharp or clear outline of the image on the film. This is referred to as sharpness or clarity. When we refer to unsharpness we suggest there is diffusion of detail, fuzziness or blurring. In other words, there is loss of definition. There are basically three types of radiographic image unsharpness. They are penumbra, motion unsharpness and screen unsharpness.

Penumbra is the blurred or ill-defined outline of an image. This fuzzy outline of the image gives loss of definition or geometric unsharpness. To minimize this fuzziness, penumbra must be reduced. As you recall from Den 111, penumbra is produced by the size of the focal spot and influenced by source-object and object-film distance. The smaller the focal spot the less the penumbra the sharper the image. The shorter the object-film distance is the sharper the image. Lastly, as you increase source-object distance you increase image sharpness.

Motion unsharpness is the blurred image caused by movement. Patient, film or tube movement may cause this.

When we refer to screen unsharpness we are referring to the intensifying screens used in extraoral radiography. The amount of unsharpness is dependent upon the thickness of the screen, crystal size and film-screen content.

The second geometric consideration in the formation of an accurate radiographic image is magnification. Magnification is the enlargement of the actual size of the object as it is projected onto the radiograph. We want to reduce magnification and therefore increase sharpness. Source-film and object-film distances are the two primary factors that influence magnification. Reducing the object-film distance and increasing the source-film distance minimizes magnification.

The third and last geometric consideration is distortion in the shape of the radiographic image. Distortion is an inaccuracy in the size or shape of the object as seen on the radiograph. Paralleling technique reduces distortion.

We have now examined the visual characteristics relative to the diagnostic quality of a radiograph. The last two factors, anatomical accuracy and adequate coverage, that affect the diagnostic quality of the
radiograph are self-explanatory. The anatomical accuracy of the radiographic image refers to the alignment of the object, film and beam. Placing the film parallel to the object and directing the central ray perpendicular to the object and film minimizes distortion and yields anatomical accuracy. Lastly, adequate coverage of the anatomical region of interest is critical to the diagnostic quality of the radiograph. Adequate coverage of the image is dependent upon the proper alignment of the object, film and beam, proper selections of film and proper selection of projection technique. Refer to Den 111 with regards to the criteria for acceptable periapicals and acceptable bitewings.
## Factors Affecting: Contrast and Definition

<table>
<thead>
<tr>
<th>Radiographic Contrast</th>
<th>Definition*</th>
<th>Radiographic Mottle</th>
<th>Film Graininess</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Subject Contrast</strong></td>
<td><strong>Film Contrast</strong></td>
<td>Geometric Factors</td>
<td>Screen Mottle</td>
</tr>
<tr>
<td><strong>A. Tissue thickness,</strong> density or atomic number differences in subject (pathology) age</td>
<td>A. kVp</td>
<td>A. Focal spot size</td>
<td>A. Type of screen-speed</td>
</tr>
<tr>
<td><strong>B. Scattered radiation,</strong> collimation, filtration, OFD-air gap, alignment of tube/object</td>
<td>B. Type of film</td>
<td>B. SID</td>
<td>B. Quantum scintillation</td>
</tr>
<tr>
<td><strong>C. Radiation quality – kVp</strong></td>
<td>C. Screen or direct exposure</td>
<td>C. Object film distance</td>
<td>B. Radiation type 1. light 2. x-rays</td>
</tr>
<tr>
<td><strong>D. Use of contrast media</strong></td>
<td>D. Screen contact</td>
<td>D. Screen-film contact</td>
<td>D. kVp</td>
</tr>
<tr>
<td><strong>E. Density</strong></td>
<td><strong>F. Development, time,</strong> temperature, and agitation</td>
<td><strong>G. Fog</strong> 1. age 2. radiation 3. chemical 4. light</td>
<td><strong>E. Motion</strong></td>
</tr>
</tbody>
</table>

* Other terms might include Detail, Sharpness, Image Quality
RADIOGRAPHIC QUALITY

Fog
  - Film age fog
  - Radiation
  - Light
  - Chemical
  - Compton scatter
  - Radiation

Controlled by:
  - OFD-Air Gap
  - Cones
  - Diaphragm
  - Compression
  - Grids
  - Movable
  - Stationary

Radiographic Contrast
  - Directly
  - Controlled by kVp (as increase kVp decrease contrast indirectly proportional)

Indirectly
  - Films
  - Processing
  - Filter
  - Screen contact
  - Screens/Non-screen
  - Contrast Media
  - Anode Heal Effect
  - Pathology
  - Tissue thickness
  - Atomic composition
  - Specific Gravity
  - Alignment of tube
  - Alignment of object
  - kVp

Radiographic Density
  - Directly
  - Controlled by mAs
  - SID

Indirectly
  - Screen/Non-screen
  - Contrast Media
  - Anode Heal Effect
  - Pathology
  - Tissue thickness
  - Atomic composition
  - Specific Gravity
  - Alignment of tube
  - Alignment of object

Radioographic Definition
  - Sharpness
  - Controlled by
    - Magnification and/or Distortion
    - Object film distance
    - SID

Motion
  - Voluntary
  - Involuntary

Screen/Non-screen
  - Screen contact
  - Film

Subject-to-Image-Receptor Distance (SID)

Controlled by:
  - Improper alignment of tube
  - Improper location of film
  - Alignment of part to film
## COMMON ANATOMICAL LANDMARKS

### Maxillary

<table>
<thead>
<tr>
<th>Molar Film</th>
<th>Premolar Film</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zygomatic arch (zygoma)</td>
<td>Zygomatic arch</td>
</tr>
<tr>
<td>Zygomatic process of maxilla</td>
<td>Zygomatic process</td>
</tr>
<tr>
<td>Floor and lateral walls of the maxillary sinus</td>
<td>Maxillary sinus</td>
</tr>
<tr>
<td>(antrum of Highmore)</td>
<td>Nerve Canal (posterior superior alveolar nerve)</td>
</tr>
<tr>
<td>Maxillary tuberosity</td>
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<tr>
<td>Hamular process of sphenoid</td>
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<tr>
<td>Coronoid process of ramus</td>
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<tr>
<td>Maxillary sinus</td>
<td></td>
</tr>
<tr>
<td>Nerve Canal (posterior superior alveolar nerve)</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Canine Film</th>
<th>Central Film</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medial wall of maxillary sinus</td>
<td>Mental process (ridge)</td>
</tr>
<tr>
<td>Wall of the nasal fossa</td>
<td>Genial tubercles</td>
</tr>
<tr>
<td>Nasal fossa</td>
<td>Inferior border of mand.</td>
</tr>
</tbody>
</table>

### Mandibular

<table>
<thead>
<tr>
<th>Molar Film</th>
<th>Premolar Film</th>
</tr>
</thead>
<tbody>
<tr>
<td>External oblique ridge</td>
<td>Submandibular fossa</td>
</tr>
<tr>
<td>Internal ridge</td>
<td>Mandibular canal</td>
</tr>
<tr>
<td>Submandibular fossa</td>
<td></td>
</tr>
<tr>
<td>Mental foramen</td>
<td></td>
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<tr>
<td>Mandibular canal</td>
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</table>

<table>
<thead>
<tr>
<th>Canine Film</th>
<th>Central Film</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mental ridge</td>
<td>Mental process (ridge)</td>
</tr>
<tr>
<td>Mental foramen</td>
<td>Genial tubercles</td>
</tr>
<tr>
<td>Mandibular canal</td>
<td>Inferior border of mand.</td>
</tr>
<tr>
<td>Lingual foramen</td>
<td></td>
</tr>
</tbody>
</table>

### Anatomical landmarks common to both maxillary and mandibular films include:

1. Nutrient canals
2. Lamina dura
3. Periodontal ligament space
4. Alveolar crest
5. Trabeculae (note the differences between maxillary and mandibular bone patterns)
6. Enamel, dentin, cementum, pulp, apical foramen
The following structures may be seen on dental films:

<table>
<thead>
<tr>
<th>RADIOPAQUE</th>
<th>RADIOLUCENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amalgam</td>
<td>Porcelain</td>
</tr>
<tr>
<td>Crowns</td>
<td>Caries</td>
</tr>
<tr>
<td>Bridges</td>
<td>Abscesses</td>
</tr>
<tr>
<td>Ortho wires</td>
<td>Cysts</td>
</tr>
<tr>
<td>Gutta-percha</td>
<td>Fracture lines</td>
</tr>
<tr>
<td>ZOP cement</td>
<td>Resorption</td>
</tr>
<tr>
<td>ZOE cement</td>
<td></td>
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<tr>
<td>Calculus</td>
<td></td>
</tr>
<tr>
<td>Hypercementosis</td>
<td></td>
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<tr>
<td>Exotosis (tori)</td>
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</tbody>
</table>
Criteria For Exposure and Exposure Procedures
(Adopted by the House of Delegates - AADS - 1989)

1. If prior radiographs are available, they should be evaluated before new radiographs are taken.
2. Radiographs should not be used merely to document clinically apparent lesion.
3. Technical proficiency in radiographic technique must be achieved on skulls or manikins before students are allowed to expose patients.
4. Radiographs of patients may not be made merely for the purpose of training or demonstration.
5. Students must complete all retakes under the direct supervision of an instructor.
6. To maximize the risks associated with radiation exposure, intraoral imaging should be accomplished with the fastest systems appropriate to the diagnostic need.
7. When feasible, periapical and bitewing radiographs should be made with rectangular collimation. The longer side of the rectangular beam should be limited to 2.0 inches at the face or to the size of the film. Circular collimation should be limited to a beam diameter of 2.75 inches or less at the patient’s face. Only open ended, shielded position-indicating devices should be used.
8. Film holding devices should be used. Digital retention of intraoral films is to be avoided.
9. The tube head should not vibrate or drift during exposure. The equipment should not be stabilized by hand during exposure.
10. No operator should hold patient's films during exposures. If assistance is required for children or handicapped a designated nonradiation worker may help. This individual should wear a leaded apron and gloves when stabilizing the patient and stay out of the primary beam.
11. During each exposure, the operator should stand out of the primary beam and behind an adequate protective barrier that permits observation of and communication with the patient.
12. The exposure control switch should be positioned and immobilized behind the barrier.
NORMAL RADIOGRAPHIC ANATOMY

Enamel-most radiopaque

Dentin

Cementum

Pulp chamber and canal-radiolucent

Periodontal membrane space = Radiolucent band between cementum and lamina dura

Lamina dura = Continuous radiopaque line surrounding periodontal membrane space represents cortical bone of wall of tooth socket

Alveolar bone = Appear as a series of small radiolucent spaces (bone marrow) separated by radiopaque honeycomb (trabecular bone)

Tooth germ = Round or oval radiolucency before tooth calcification. As crown formation progresses see radiolucent follicle surrounding calcifying tooth crown

Nutrient canals = Appear as vertical radiolucent lines

Nutrient Foramina = Appear as radiolucent "circle" near crest of alveolar ridge
An x-ray viewer should be used to sort films (right and left, buccal or lingual aspect). Raised dot on film is on buccal side of film. The convex side of the dot should face towards the operator. You are, therefore, looking at the films as if you were facing the patient, and the patient's right side is on your left. Anatomical landmarks are used to identify the maxillary and mandibular arches as well as the right and left. Radiopaque are areas which appear lighter in radiographs whereas radiolucent are areas which appear darker.

For the following anatomical landmarks identify the radiograph on which it may be seen and whether the landmark is radiolucent or radiopaque.

**Anatomical landmarks of maxilla:**

<table>
<thead>
<tr>
<th>Number</th>
<th>Landmark</th>
<th>Radiolucent or Radiopaque</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Zygomatic process of the maxilla</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Zygomatic bone (malar)</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Maxillary tuberosity</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Coronoid process of the mandible</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Pterygoid plates with hamular process</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Maxillary sinus</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Nasal cavity and nasal septum</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Inferior nasal concha (turbinates)</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Anterior nasal spine</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>Inverted &quot;Y&quot;</td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>Median palatine suture</td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>Incisive or palatine foramen</td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>Maxillary molars have 3 roots; 1st premolar-2 roots</td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>Canine Fossa (Incisive/lateral fossa)</td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td>Shadow of nose</td>
<td></td>
</tr>
</tbody>
</table>
**Anatomical landmarks of the mandible:**

<table>
<thead>
<tr>
<th></th>
<th>Radiolucent or Radiopaque</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Mental ridge</td>
</tr>
<tr>
<td>2.</td>
<td>Cortical plate of lower border of mandible</td>
</tr>
<tr>
<td>3.</td>
<td>Lingual foramen</td>
</tr>
<tr>
<td>4.</td>
<td>Genial tubercles</td>
</tr>
<tr>
<td>5.</td>
<td>Mental foramen</td>
</tr>
<tr>
<td>6.</td>
<td>Mandibular canal</td>
</tr>
<tr>
<td>7.</td>
<td>External oblique ridge</td>
</tr>
<tr>
<td>8.</td>
<td>Internal oblique ridge</td>
</tr>
<tr>
<td>9.</td>
<td>Submandibular fossa</td>
</tr>
<tr>
<td>10.</td>
<td>Mental fossa</td>
</tr>
<tr>
<td>11.</td>
<td>Mandibular molars have 2 roots</td>
</tr>
<tr>
<td>12.</td>
<td>Lips</td>
</tr>
</tbody>
</table>
OCCLUSAL RADIOGRAPHS

USE:
1. To localize objects in the buccolingual dimension.
2. To visualize areas not seen on a periapical film.
3. When a periapical film is too difficult to obtain.

FILM:
a. Large #4 occlusal film (2 1/4 x 3 inches), double or single packets.
b. Standard #2 periapical film may be used for children.

PRINCIPLE:
The technique is based on the correlation of certain head positions with specific vertical angulations. The tube side of the film must always face toward the occlusal surfaces. The film is held in place by slight pressure of the opposite jaw or by the thumbs for edentulous arches.

PATIENT POSITION:
1. Maxillary exposures: the occlusal plane of the teeth should be parallel to the plane of the floor. The midsagittal plane is perpendicular to the floor.
2. Mandibular exposures: The patient is reclined and the occlusal plane may be perpendicular to the plane of the floor.

TECHNIQUES:
1. Topographical: The rules of bisecting are followed with the radiation directed through the apices of the teeth perpendicular toward the bisector (55°-70°). NOTE: because a larger area is involved and it is not always possible to use the most favorable vertical angulation, the images of the teeth generally appear longer. More detail in alveolar crest/apice.

2. Cross-sectional (right-angle): The CR is directed toward the area of interest and parallel with the long axis of the teeth and adjacent areas. A circular or elliptical appearance of the teeth is obtained. Yields more detail about location of tori, impacted teeth, or malposed teeth.

The choice of technique depends on:
a. size and shape of the arches
b. alignment of the teeth
c. presence/absence of anatomic irregularities
d. type of lesion or area of interest
PROCEDURES

A. Maxillary:

1. Topographical
   a. Seat the patient upright
   b. Insert film vertically with tube side toward occlusal surfaces as far back as it will go. Have patient bite firmly.
   c. Horizontal angulation: CR parallel with midsagittal plane and directed through the arch toward the center of the film.
   d. Vertical angulation: direct the CR at +65°
   e. Point of entry: above the bridge of the nose toward the center of the film.

2. Cross-sectional (right-angle):
   a. Film is placed horizontally.
   b. Horizontal angulation: same as topographical technique.
   c. Vertical angulation: direct CR perpendicularly toward center of the film.
   d. Point of entry: about the hairline of the forehead.

B. Mandibular:

1. Topographical:
   a. Recline the patient with the plane of occlusion at 45° to the plane of the floor.
   b. Place film vertically with the tube side toward the floor of the mouth.
   c. Horizontal angulation: CR parallel to the midsagittal plane.
   d. Vertical angulation: Parallel the PID with the film and note the reading, subtract 60° from the reading.
   e. Point of entry: tip of the chin.

2. Cross-sectional (right-angle):
   a. Place film horizontally.
   b. Horizontal angulation: 0° to the midsagittal plane
   c. Vertical angulation: PID parallel to the film with the CR at right angles.
   d. Point of entry: about 1 inch below point of the chin.
MODIFIED EXPOSURES

A. Canine survey: Shift the film laterally
   Direct CR at 45° to the midsagittal plane
   Vertical angulation about +60°
   Point of entry at canine fossa near the infraorbital foramen

B. Molar survey: Shift film laterally
   Horizontal angulation 90° to the midsagittal plane
   Vertical angulation about +60°
   Point of entry immediately below outer canthus of the eye

C. Sinus survey: Shift film laterally
   Horizontal angulation 0° midsagittal plane
   Vertical angulation about 80°
   Point of entry toward the center of the film at canine fossa area

NOTE: This survey would require an increase in exposure time, so an extraoral film with intensifying screens is more desirable.
121 OCCLUSAL RADIOGRAPH REQUIREMENT

REQUIREMENT:

One (1) diagnostically acceptable maxillary anterior topographical
One (1) diagnostically acceptable mandibular crossectional

PROCEDURE:

Maxillary Anterior Topographical

1. Film placement
   – Placed vertical (long axis of film directed from lip to throat and approximately half inch of film is extraoral)
   – Dot/convexity placed extraoral toward occlusal surface of maxillary teeth

2. Patient position
   – Midsagittal plane perpendicular to floor
   – Occlusal plane parallel to the floor

3. Angulation
   – Vertical angulation +60 to +70
   – Horizontal angulation – central ray parallel with midsagittal plane

4. Point of entry
   – Central ray enters just above the tip of the nose

Mandibular Cross-sectional

1. Film placement
   – Placed horizontal (long axis of film directed cheek to cheek)
   – Dot/convexity placed extraoral toward occlusal surface of mandibular teeth

2. Patient position
   – Patient reclined and occlusal plane perpendicular to floor

3. Angulation
   – Vertical angulation – central ray directed perpendicular to center of film
   – Horizontal angulation – open face PID parallel to the film

4. Point of entry
   – Midline of floor of mouth approximately one inch below point of the chin
EXTRAORAL RADIOGRAPHY

Extraoral: Film packet or cassette is not placed in mouth

Advantages

1. Can be easier than intraoral i.e., film placement
2. Minimal equipment needed (except panoramic): can use standard x-ray unit
3. Interpretation not difficult: can view large areas

Indication for use

I. Patient has difficulty opening or uncooperative and won't open
   A. Trismus; ankylosis of TMJ; fracture mand/max
      Swelling limiting opening
   B. Uncooperative patient; child; handicapped; some elderly, i.e. Alzheimer patient
II. View area larger than intraoral or can't be seen on intraoral
   A. TMJ; Angle or ascending ramus of mandible; maxillary sinus; salivary gland obstruction:
      floor of mouth tumors
      Palatal deviations/tumors
   B. Record facial profiles, measurements i.e.: orthodontics or prosthodontics

Extraoral Film

A. Types
   1. Screen film = requires intensifying screens within cassettes to produce image
   2. Non-screen = no intensifying screens; use direct radiation; use cardboard holders, cassettes without screens

B. Sizes
   1. Vary a great deal depending on technique used
   2. Most common 5 x 7", 8 x 10" profiles, posteroanterior;
      5 x 6 x 12 = panoramic

C. Cassettes
   1. Light-tight container or holder in which film is placed - then exposed to radiation
   2. Rigid or flexible; flat or curved
   3. Have LEAD or "L" or "R" imprinted so it will appear on radiograph (extraoral film does NOT have identification dot)
   4. Close tightly (clasp) to avoid screen lag = blurry areas on film
   5. Place tube side toward head/face of patient as radiation enters patient from opposite side of film and film on outside of face.
D. **Intensifying Screens**
   1. Not essential, but desirable; depends on film
   2. Reduces radiation exposure to patient
   3. Mounted on inside of cassette (front and back) so film is between them (within cassette)
   4. Consists of and function
      -- plastic sheet coated with fluorescent material
      -- these crystals emit **visible light** when irradiated with ionizing radiation
      -- **Speed** (amount of intensification) depends on size of fluorescent crystals. **Larger**
         crystals and **thicker** layer the **faster** the screen.

   **Function:** The light is emitted in the same pattern as the penetrating x-rays. The visible
   light given off by screens provides additional means of exposing the film thereby
   **intensifying** the x-ray exposure.

   **Image:** Formed by primary beam of x-rays and light emitted from screens.

   **Screen and Film = Indirect Imaging = exposure of film by light**

   **Disadvantages:** causes loss in image definition
   -- light produces loss of detail at borders or edges of structures (**blurring**)
     * As speed or sensitivity increases, image definition decreases.
   -- Recommend: medium speed screens = gives best diagnostic image in relation to the
     decrease in radiation exposure (for dentistry).
PROJECTIONS

Lateral oblique projection of mandible

**DIAGNOSTIC AREA:** This projection is diagnostic from the distal surfaces of the canine to the angle, ramus, coronoid, and condylar process of the mandible. A true lateral projection of the mandible will superimpose structures from both sides. The lateral oblique projection is not diagnostic for conditions anterior to the canine, because the curve of the mandible superimposes the contralateral structures. The projection is not useful for viewing the maxilla because of superimposition on it of the side of the mandible not being viewed.

**INDICATIONS:** The projection is used for viewing impactions, large pathological areas, fractures, and salivary stones in the floor of the mouth. It can also be used in children as a compromise view instead of bite-wings and posterior periapical films.

**TECHNIQUE:** The patient is seated upright with the occlusal plane parallel to the floor and the mouth closed. The chin is protruded forward to prevent superimpositions of the spinal column. The patient's head is tipped 5 to 10 degrees away from the x-ray machine.

The cassette is placed against the side to be radiographed in a holder or supported by the patient's shoulder and held by his hand. For projections of the posterior body, angle, and ramus, the cassette should be in contact with the zygomatic arch and mandible. For anterior areas, the cassette is positioned against the mandible and the lateral portion of the nose.

The central ray should be nearly perpendicular to the cassette in both the vertical and horizontal planes. With a 14-inch FFD, the central ray is directed from a position just beneath and anterior to the angle of the mandible. For more anterior regions, the central ray can be directed from behind the mandible.

An average exposure time for an adult when fast film and intensifying screens are used is about 12 impulses (2/10 second).

Lateral skull projection

**DIAGNOSTIC AREA:** This projection is diagnostic for a lateral or sagittal view of the entire skull. Bilateral structures are superimposed upon one another with the structures farthest from the film being magnified more than structures closer to it.

**INDICATIONS:** In dentistry, this projection is used in cephalometrics and the diagnosis of fractures and pathological conditions of the skull. It is used in diagnosing metabolic disease, such as Paget's disease, sickle cell anemia, and multiplying myeloma, in which intraoral findings need further confirmation.
**TECHNIQUE:** The patient is positioned with the sagittal plane perpendicular and occlusal plane parallel to the floor. The cassette is positioned parallel to the sagittal plane of the skull and contacting side of the head. The cassette can be placed in a holding device or supported by the patient's shoulder and held by his hand.

With an FFD of a minimum of 36 inches, the central ray is directed at the extraoral auditory meatus and perpendicular to the sagittal plane of the skull.

An average exposure time for an adult when fast film, intensifying screens, and settings of 65 kVp and 10 mA are used is 30 impulses (1/2 second).

**Lateral sinus projection**

**DIAGNOSTIC AREA:** This projection is a modification of the lateral skull projection, which has a smaller field size.

**INDICATIONS:** This projection is used to visualize the maxillary sinus to detect growths, infections, or foreign bodies.

**TECHNIQUE:** The patient and cassette are positioned in the same way as for a lateral skull projection. A 5 x 7 inch cassette can be used because of the smaller field size. The point of entry is the apices of the maxillary first molar, and the central ray is directed perpendicular to the sagittal plane of the skull. The FFD is 20 inches, and with fast film and intensifying screens, the average exposure time is 20 impulses (1/3 seconds).

**Posteroanterior (PA) projection of the skull**

**DIAGNOSTIC AREA:** This is the complementary film to the lateral skull and shows all structures of the skull in the frontal plane. The x-ray beam enters the skull posteriorly with the film positioned anteriorly. When the film is positioned in the back of the skull and the x-ray beam enters from the anterior, it is referred to as an anteroposterior projection (AP). In dentistry, the PA is the projection of choice, because structures closer to the film show less magnification and the most structures that dentists are concerned with are in the anterior third of the skull.

**INDICATIONS:** It is used to detect and localize fractures and pathological conditions of the skull in the frontal plane. This projection is not effective for studying the maxillary sinus because of the superimposition of the petrous portion of the temporal bone and the base of the skull.

**TECHNIQUE:** The patient's face is positioned against the cassette in a wall-mounted device or held by the patient. The sagittal plane of the skull is perpendicular to the cassette, with the patient's nose and forehead touching the cassette. The orbitomeatal line is perpendicular to the cassette. At a minimum of FFD of 36 inches, the central ray is directed perpendicular to the cassette with the point of entry being the external occipital protuberance.

An average exposure time, using flat film and intensifying screens at 65 kVp and 10 mA, is 30 impulses (1/2 second).
Posteroanterior projection of the mandible

**DIAGNOSTIC AREA:** This is a modification of the posteroanterior skull projection using a smaller field size and showing only the mandible in the frontal plane.

**INDICATIONS:** It is used in dentistry with other views to localize impactions, fracture segments, and pathological conditions in the mediolateral plane. In the anterior symphyseal region, it is used to detect fractures that would not be seen on lateral oblique projections because of superimposition of the opposite side of the arch.

**TECHNIQUE:** The patient is positioned in the same manner as for a PA skull projection. The central ray is directed perpendicular to the cassette in the midsagittal plane at the level of the angle of the mandible. When an FFD of 24 inches, fast film and intensifying screens are used, an average exposure time is 30 impulses (1/2 second).

Posteroanterior view of the sinus (Waters view)

**DIAGNOSTIC AREA:** This is a modified PA of the skull that is specific for the middle third of the face. The patient’s head is positioned to distort and enlarge the middle third of structures and free the sinuses from the superimposition of denser structures.

**INDICATIONS:** This projection is used to diagnose fractures of the maxilla, malar bone, and zygomatic arch. It is the best projection for visualization of the maxillary sinus. The projection can help in the diagnosis of root tips, foreign bodies, tumors, and infections of the sinus in the frontal plane. This projection complements the lateral view of the sinus previously described.

**TECHNIQUE:** The patient is positioned against the cassette in the same manner as in the PA projection, except that the patient’s mouth is opened and the nose and chin touch the cassette. The central ray is directed through the external occipital protuberance perpendicular to the cassette. When a 24-inch FFD, 65 kVp, 10 mA, fast film, and intensifying screens are used, an average exposure is 45 (3/4 seconds).

Submental vertex (inferosuperior) zygomatic arch projection

**DIAGNOSTIC AREA:** This projection gives an inferior view of the zygomatic arches.

**INDICATIONS:** It is used to detect fractures and displacements of the zygomatic arch.

**TECHNIQUE:** The patient is positioned with the head back and the cassette supported or held at the vertex of the skull. The central ray is directed from beneath the chin through the midsagittal plane of the skull perpendicular to the cassette at an FFD of 24 inches.

When fast film and intensifying screens are used with settings of 65 kVp and 10 mA, an average time is 10 impulses (1/6 second).
Lateral Oblique  
Transcranial TMJ  
Lateral Skull  
Submental Vertex

Posteroanterior  
Posteroanterior of mandible  
Posteroanterior of sinues

**Other Extraoral Radiations**

Sialography: examination of salivary gland. (parotid and submandibular)
--take initial radiograph
--inject radiopaque substance into ducts
--duct probed and needle held in place
--take successive radiographs to visualize draining of gland. (normal glands empty in 30 mins)

**Temporomandibular Joint Survey**

--limited use
--arthrography = aqueous radiopaque medium injected into TMJ
--TMJ survey to view:
  --calcified areas
  --ankylosis of joint
  --malignancies
  --fractures
  --tissue changes of arthritis

**Cephalometric radiographs**

--Extraoral radiographs of head used for making skull measurements
--purpose is to correlate skeletal growth with tooth development and position
--used in ortho
--lateral skull projection and posteroanterior projection most common

**Hand and Wrist Films**

Use: to correlate patient's chronological age with skeletal age and development and dental age and development.

Principle: bones of hand and wrist are all good indications of skeletal maturation because there are many centers of ossification in these areas: The findings are compared with reference standards.

Equipment: Standard x-ray unit, occlusal or 5 x 7 film.

Technique: CR directed perpendicular to film.

**Panoramic Radiography**

Produces broad view of the maxillary and mandibular arches and their associated structures.

Panoramic radiograph is produced by using tomography and technique is referred to as pantomography.
1. Stylohyoid ligament
2. Mandibular condyle
3. Angle of mandible
4. Hyoid bone
5. Mandibular foramen
6. Mandibular canal
7. Mental Foramen
8. Mental Ridge
9. Genial tubercles
10. Coronoid Process
11. Maxillary tuberosity
12. Articular eminence
13. Maxillary sinus
14. Palate
15. Nasal Fossa
16. Incisive foramen
**Terminology:**
Pantomography = curved-surface tomography
Tomography = body sections on radiographic film
Laminography = selected layers of body tissue on radiographic film

**Curved-surface Tomography:**
-- Tomogram made by moving x-ray source and film in opposite directions in a fixed relationship through one or a series of rotation points while a patient is stationary
-- Focal trough = plane of acceptable detail
  -- any object that lies in focal plane will be clear whereas objects above or below focal plane will appear blurred
  -- size and shape vary
-- patient is positioned so that the dental arches are placed in the zone corresponding to the focal trough
-- only structures in/or near focal trough are defined in image

**Pantomographic units:**
-- differ in number and location of rotation centers
  1. Single-center rotation
  2. Double-center rotation = "split image"
  3. Triple-center rotation = continuous image
  4. Moving-center rotation = continuous image

**Uses of Panoramic radiographs:**
1. Preliminary exam
2. Oral Pathology
3. Problem patients
4. Specialty uses:
   a. Oral and Maxillofacial Surgery
   b. Prosthodontics
   c. Pediatric dentistry
   d. Orthodontics

**Advantages**
1. Provides greatest coverage of oral structures
2. Simplicity
3. Patient Cooperation
4. Time
5. Dose
   - CRS skin dose ranges from 500-5000 mR
   - Panoramic skin dose low with most areas of face receiving less than 50 mR with maximum dose less than 1100 mR
6. Patient education
Disadvantages *
1. Image quality - inherent magnification, geometric distortion and poor definition
2. Ghost images - images from the other side of the patient’s jaw that is seen as a blurred shadow
3. Overlap
4. Superimposition
5. Overuse
6. Cost

Shadows and artifacts
1. Vertebral column - vertical radiopaque band
2. Submandibular shadow - area of increased radiolucency apical to mandibular posterior
3. Ghost shadow of the opposite mandible
4. Bite block
5. Chin rest
6. Ghost shadow of opposite chin rest
7. Pancreatic head position device

Soft Tissue Shadows
8. Tongue - radiopaque area superimposed over maxillary posterior teeth
9. Ear - radiopaque and projects anteriorly - inferiorly from the mastoid process
10. Soft palate and uvula - diagonal radiopacity projecting posteriorly and inferiorly from maxillary tuberosity region
11. Lip line - seen anteriorly
   - areas of teeth not covered by lips = radiolucent
   - areas of teeth covered by lips = more radiopaque

Air Space Shadows
12. Palatoglossal air space - horizontal radiolucent band above apices of maxillary teeth
13. Nasopharyngeal air space - diagonal radiolucency superior to the radiopaque shadow of soft palate and uvula
14. Glossopharyngeal air space - vertical radiolucent band superimposed over the ramus of the mandible
Common Errors

1. Frankfort plane angled downward
   - Exaggerated smile
   - Occlusal plane curves downward in the middle
2. Frankfort plane angled upward
   - Frown/Reverse Smile
   - Occlusal plane goes straight across the radiograph
3. Incorrect positioning of tongue
   - radiolucent shadow obscures apices of maxillary teeth
4. Lead apron artifact
   - radiopaque
5. Spine in path of beam
   - radiopacity
6. Metallic or radio dense objects left on patient during exposure
   - ghost image
7. Incorrect positioning of lips
   - if lips not closed on bite block a radiolucent shadow obscures anterior teeth
8. Teeth positioned anterior to focal trough
   - anterior teeth appear skinny and out of focus
9. Teeth positioned posterior to focal trough
   - anterior teeth appear fat and out of focus
10. Midsagittal plane not perpendicular to the floor
    - unequal magnification
11. Static electricity
    - radiolucent
12. Light leak
    - radiolucent
13. Double exposure
14. Movement
    - part of film being exposed at the time of movement is blurred
15. Film cassette slows upon patient contact
    - black vertical bands due to localized over exposure
FIGURE 15-16 Panoramic shadows: (1) vertebral column; (2) submandibular shadow; (3) ghost shadow of the opposite mandible; (4) bite block; (5) chin rest; (6) ghost shadow of the opposite chin rest; (7) pancentric head position device.

*Radiographic Imaging for the Dental Team*, by Sally M. Mauriello, Vickie P. Overman, Enrique Platin
Soft tissues images (Figure 15-18)
8. Tongue
9. Ear
10. Soft palate and uvula
11. Lip line

Air spaces (figure 15-20)
12. Palatoglossal air space
13. Nasopharyngeal air space
14. Glossopharyngeal air space

Figure 15-20 Panoramic air spaces: (12) palatoglossal air space; (13) nasopharyngeal air space; (14) glossopharyngeal air space

Radiographic Imaging for the Dental Team, by Sally M. Mauriello, Vickie P. Overman, Enrique Platin
Periodontics--Radiographic Review

Value of radiographs in Perio:
1. Identification of predisposing factors
2. Discovery of bone changes
3. Evaluation of amount and location of bone loss
4. Determination of prognosis of affected teeth
5. Evaluation of post-treatment results

Technique preferred is paralleling
- BSA films exhibit dimensional distortion
- 90 KVP - long scale contrast to show subtle bone changes

Normal alveolar bone and periodontal membrane space
- alveolar crest 1.0-2.0 mm. apical to adjacent CEJ line
- posterior - alveolar crest usually flat
- anterior - alveolar crest usually pointed with dense cortex
- alveolar crest continues with lamine dura of adjacent teeth and forms sharp angle adjacent to tooth root
- slight widening of perio membrane space around cervical portion is normal
- Crown root ratio = how much support tooth has in bone (1:2)

Radiographic changes

NOTE: Bony changes not radiographically detected until relatively progressed.
Extent of bone loss does not indicate activity
Active = radiolucent or loss of radiopacity

Early periodontitis
- triangulation of perio membrane space
- crestal changes may be:
  - loss of radiopacity or crestal fuzziness due to fading of crest density
  - rounding of crest with irregular and diffuse border

Cratering = trough-like depressions of interproximal septal bone - incipient horizontal bone loss

Angular defect= incipient vertical bone loss

Horizontal bone loss
- loss in alveolar crest height in a horizontal plane parallel to a line drawn connecting adjacent CEJ’s
Periodontics--Radiographic Review (cont.)

**Vertical bone loss**
- resorption of one tooth root sharing the alveolar crest area is greater than on the other tooth
- generally V-shaped and sharply outlined

**Interradicular (Furcation)**
- periodontal membrane space at apex of interradicular bony crest thickened
SYSTEMATIC RADIOGRAPHIC EXAMINATION OF PERIODONTIUM

NOTE: Plate of bone best defined is one closest to film packet in the mouth.

A. Bone quality - trabecular pattern
   1. Is the pattern generally few trabeculae, wide marrow spaces or many trabeculae, few marrow spaces
   2. Are there changes in density and shape
   3. Note definite radiolucencies in the bone

B. Lamina Dura
   1. Present in all interdental crests and surrounding roots
   2. Absent
   3. Lack of continuity

C. Periodontal membrane space (variations)
   1. Narrow
   2. Wide

D. Crestal bone, bone level and furcations
   1. Use probe to measure
      - normal 1.0 - 1.5 mm apical to adjacent CEJ line
   2. Note any area of bone loss
      a. horizontal/vertical
      b. localized/generalized
      c. mild, moderate, severe (amount of bone loss in millimeters)
   3. Cratering, angular defects, loss of radiopacity (crestal fuzziness)
   4. Note furcation involvements

E. Crown: Root ratio
   1. Normal 1:2 (1:3)
C.R.S. BONE EVALUATION
SUMMARY GUIDELINES

READING ASSIGNMENT:
Langland, Langlais. “Radiologic Diagnosis of Periodontal Disease.” Principals of Dental Imaging. (Chapter 15)
Haring, Lind. "Radiographic Interpretation for the Dental Hygienist" (Chapter 7)

Note: When evaluating patient radiographs, answer the following questions and follow the guidelines. Based on your findings:

1. Is the bone level W.N.L. across the board in all areas? (yes or no?)
   Need to know what is normal bone level (1-1.5 up to 2 mm away from adjacent CEJ line)

2. If “no”, give examples of areas where there is bone loss seen. Estimate how much bone loss is present. Use a probe or a small mm ruler to approximate the amount of bone loss.
   Example: Tooth #3 distal has 7 mm. distance between CEJ and bone. If normal is 2 mm., then approximate bone loss = 5 mm.

3. Type of bone loss.
   Is it generalized?
   Is it localized?
   Is it horizontal?
   Is it vertical?

4. Irrespective of bone level, note the crestal contours across the board.
   Are the crests normal?

Normal

Deviation

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DEN 121 Outline
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5. If the crested contours are not normal, in what way do you see abnormality?
   - Loss of crestal radiopacity (density, lamina dura)
   - Fuzziness without sharp lamina dura
   - Slight reverse contours
   - Deep cratering

   Indicate sites where above is seen. These may be present even when bone level is normal.

6. Note furcation areas in molar teeth and indicate teeth with furcation involvement (radiolucency at furcation).

7. Give crown root ratio for anterior segments and posterior segments both arches.

8. Look for periapical radiolucencies (indicate teeth with such involvement).

Please note:

Absence of lamina dura does not necessarily mean there is disease but if there is discontinuity of the sharp lamina dura at crest, may indicate incipient perio disease.
RECOGNIZE AND IDENTIFY THE FOLLOWING ON A RADIOGRAPH:

- Impacted Teeth
- Linguoversion/buccoversion
- Rotated
- Supernumerary
- Dilaceration
- Tori/exostosis
- Pulp Stones
- Attrition
- Blunted Apices
- Retained Roots
- Incomplete Root Formation
- Calculus
- Decay
  - Occlusal
  - Proximal
  - Cemental (Root)
- Cervical Burnout
- Periapical Radiolucency (Rare Faction)
CARIES DETECTION AND INTERPRETATION ON RADIOGRAPHS

Dental examination for caries includes clinical examination of all accessible surfaces of all teeth with an explorer and a set of radiographs (CRS or bitewings or both). For detecting proximal caries, bitewings are the radiographs of choice.

Carious lesions appear as radiolucent areas in enamel and dentin depending upon the progression.

Quality criteria for diagnostic bitewing radiographs

1. There should be no proximal overlaps.
2. The occlusal plane should be horizontally along the middle of the film.
3. Proper film exposure and proper processing for adequate contrast and density of films.
4. Accurate film positioning to include upper and lower premolars and molars.
5. Radiographs should be free of technique errors.

Items required for radiographic interpretation

1. View box (screen should be free of dirt particles)
2. Properly mounted radiographs.
3. Charting forms/interpretation forms.
4. Magnifying glass.

Interpretation

- Read films left to right, examine each tooth carefully using the magnifying glass to locate radiolucencies in enamel and dentin.
- Whenever possible, confirm the radiographic findings with clinical exam.

Types of Caries

Interproximal caries - Mesial, Distal surfaces
Occlusal caries - occlusal surface
Buccal/Lingual caries - confirm with clinical charting
Root surface caries - involving cementum/dentin
Recurrent or secondary caries - adjacent to existing restorations
Rampant caries - severe caries affecting numerous teeth
Proximal Caries

With the magnifying glass, examine the mesial/distal surfaces at the contact area and just below the contact area. (Most commonly proximal caries is found at the contact or just a little below the contact between two adjacent teeth).

**Incipient** - Beginning caries, very small, confined to enamel only, extends less than half way in the enamel (may appear as a notch or a small triangle with its apex directed towards the dentin).

![Incipient](image)

**Moderate** - When the lesion extends more than half way through the enamel thickness. This is still confined to enamel (may appear as a larger notch or larger triangle with the apex very near the DEJ).

![Moderate](image)

**Advanced** - When caries has progressed through the thickness of the enamel and extends to the DEJ and, through the DEJ extends into dentin, but has not extended more than half way in the dentin thickness.

![Advanced](image)

**Severe** - When caries has progressed through the enamel, beyond the DEJ involving more than half the thickness of dentin. (Appears as large radiolucency).

![Severe](image)
**Occlusal Caries**

Incipient occlusal caries

Moderate occlusal caries

Severe occlusal caries

**Pulp Exposure**

When proximal and/or occlusal caries progresses towards the pulp and involves the pulp horns, it is called "pulp exposure".

**Buccal/Lingual Caries**

Due to superior position of buccal and lingual surfaces, these carious lesions should be confirmed on clinical chart.
**Root Surface Caries**

Occurs just below the cervical areas of the tooth. Involves the cementum, rarely involving the enamel. Loss of bone height precedes the caries formation. (Root caries is seen only when the bone level is lost). [Appears as saucer shaped radiolucencies]

Root caries progresses very rapidly through the dentin and invariably involves the pulp.

Conditions resembling caries.

- Restorative materials (radiolucent types)
- Abrasions
- Attrition
- Cervical burnout
GUIDELINES FOR PRESCRIBING DENTAL RADIOGRAPHS

The recommendations in this chart are subject to clinical judgment and may not apply to every patient. They are to be used by dentists only after reviewing the patient’s health history and completing a clinical examination. Because every precaution should be taken to minimize radiation exposure, protective thyroid collars and aprons should be used whenever possible. This practice is strongly recommended for children, women of childbearing age and pregnant women.

<table>
<thead>
<tr>
<th>TYPE OF ENCOUNTER</th>
<th>CHILD WITH PRIMARY DENTITION (PRIOR TO ERUPTION OF FIRST PERMANENT TOOTH)</th>
<th>CHILD WITH TRANSITIONAL DENTITION (AFTER ERUPTION OF FIRST PERMANENT TOOTH)</th>
<th>ADOLESCENT WITH PERMANENT DENTITION (PRIOR TO ERUPTION OF THIRD MOLARS)</th>
<th>ADULT, DENTATE OR PARTIALLY EDENTULOUS</th>
<th>ADULT, EDENTULOUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEW PATIENT* BEING EVALUATED FOR DENTAL DISEASES AND DENTAL DEVELOPMENT</td>
<td>Individualized radiographic exam consisting of selected periapical/occlusal views and/or posterior bitewings if proximal surfaces cannot be visualized or probed. Patients without evidence of disease and with open proximal contacts may not require a radiographic exam at this time.</td>
<td>Individualized radiographic exam consisting of posterior bitewings with panoramic exam or posterior bitewings and selected periapical images.</td>
<td>Individualized radiographic exam consisting of posterior bitewings with panoramic exam or posterior bitewings and selected periapical images. A full mouth intraoral radiographic exam is preferred when the patient has clinical evidence of generalized dental disease or a history of extensive dental treatment.</td>
<td>Individualized radiographic exam, based on clinical signs and symptoms.</td>
<td></td>
</tr>
<tr>
<td>RECALL PATIENT* WITH CLINICAL CARIES OR AT INCREASED RISK FOR CARIES**</td>
<td>Posterior bitewing exam at 6-12 month intervals if proximal surfaces cannot be examined visually or with a probe</td>
<td>Posterior bitewing exam at 6-18 month intervals</td>
<td>Posterior bitewing exam at 18-36 month intervals</td>
<td>Not applicable</td>
<td></td>
</tr>
<tr>
<td>RECALL PATIENT** WITH NO CLINICAL CARIES AND NOT AT INCREASED RISK FOR CARIES***</td>
<td>Posterior bitewing exam at 12-24 month intervals if proximal surfaces cannot be examined visually or with a probe</td>
<td>Posterior bitewing exam at 24-36 month intervals</td>
<td>Posterior bitewing exam at 24-36 month intervals</td>
<td>Not applicable</td>
<td></td>
</tr>
</tbody>
</table>
### GUIDELINES FOR PRESCRIBING DENTAL RADIOGRAPHS, cont’d.

<table>
<thead>
<tr>
<th>TYPE OF ENCOUNTER</th>
<th>PATIENT AGE AND DENTAL DEVELOPMENTAL STAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Child with Primary Dentition (prior to eruption of first permanent tooth)</td>
</tr>
<tr>
<td>Recall patient* with periodontal disease</td>
<td>Clinical judgment as to the need for and type of radiographic images for the evaluation of periodontal disease. Imaging may consist of, but is not limited to, selected bitewing and/or periapical images of areas where periodontal disease (other than nonspecific gingivitis) can be identified clinically.</td>
</tr>
<tr>
<td>Patient for monitoring of growth and development</td>
<td>Clinical judgment as to need for and type of radiographic images for evaluation and/or monitoring of dentofacial growth and development</td>
</tr>
<tr>
<td>Patient with other circumstances including, but not limited to, proposed or existing implants, pathology, restorative/endodontic needs, treated periodontal disease and carries remineralization</td>
<td>Clinical judgment as to need for and type of radiographic images for evaluation and/or monitoring in these circumstances.</td>
</tr>
</tbody>
</table>

*Clinical situations for which radiographs may be indicated include but are not limited to:

A. **Positive Historical Findings**
   1. Previous periodontal or endodontic treatment
   2. History of pain or trauma
   3. Familial history of dental anomalies
   4. Postoperative evaluation of healing

Document created: November 2004
5. Remineralization monitoring
6. Presence of implants or evaluation for implant placement

B. Positive Clinical Signs/Symptoms
1. Clinical evidence of periodontal disease
2. Large or deep restorations
3. Deep carious lesions
4. Malposed or clinically impacted teeth
5. Swelling
6. Evidence of dental/facial trauma
7. Mobility of teeth
8. Sinus tract (“fistula”)
9. Clinically suspected sinus pathology
10. Growth abnormalities
11. Oral involvement in known or suspected systemic disease
12. Positive neurologic findings in the head and neck
13. Evidence of foreign objects
14. Pain and/or dysfunction of the temporomandibular joint
15. Facial asymmetry
16. Abutment teeth for fixed or removable partial prosthesis
17. Unexplained bleeding
18. Unexplained sensitivity of teeth
19. Unusual eruption, spacing or migration of teeth
20. Unusual tooth morphology, calcification or color
21. Unexplained absence of teeth
22. Clinical erosion

**Factors increasing risk for caries may include but are not limited to:**
1. High level of caries experience or demineralization
2. History of recurrent caries
3. High titers of cariogenic bacteria
4. Existing restoration(s) of poor quality
5. Poor oral hygiene
6. Inadequate fluoride exposure
7. Prolonged nursing (bottle or breast)
8. Frequent high sucrose content in diet
9. Poor family dental health
10. Developmental or acquired enamel defects
11. Developmental or acquired disability
12. Xerostomia
13. Genetic abnormality of teeth
14. Many multisurface restorations
15. Chemo/radiation therapy
16. Eating disorders
17. Drug/alcohol abuse
18. Irregular dental care
Quality Assurance

Purpose--to check and monitor:
1. x-ray machines
2. darkroom procedures
3. Chairside technique
   -- to make sure that ionizing radiation is being used properly
   -- to make sure that the maximum diagnostic yield is achieved

QUALITY ASSURANCE
Purpose of quality assurance is to check and monitor x-ray machines, darkroom procedures and chairside technique to make sure that ionizing radiation is being used properly and that the maximum diagnostic yield is achieved for the energy expended.

The x-ray machine should be checked for the following (usually done by an outside agency):
1. Time accuracy—this refers to the timer. Simply set a timer and time an exposure and this will show any exposure discrepancy

2. Radiation output—checked by using a test object referred to as a stepwedge
   The stepwedge can be made of aluminum or purchased. A radiograph of the wedge produces an image made up of multiple densities, with each density representing a different thickness of aluminum. The thickest step results in the most radiopaque and the thinnest step is the most radiolucent, with many graded densities in between. A stepwedge has 8 steps usually consisting of 2, 4, 6, 8, 10, 12, 14 and 16-millimeter increments of aluminum thickness. The stepwedge is imaged using two different mA and time settings while maintaining the same mAs.
   A reference radiograph is prepared by placing the stepwedge on top of piece of film. The kvp, mA and exposure times are set to the equivalent of exposing a maxillary posterior radiograph. The reference radiograph is retained so it may be compared in the future to other exposures made with the test objects.
   Densities of films can then be compared to that of the reference radiograph.
   Summary: Different combinations of mA and exposure times produce the same mAs. This is called exposure linearity. For example, 15mA and 30 impulses produce same mAs as 10mA and 45 impulses. They both produce 450mAs. The stepwedge is imaged using two different mA and time settings, while maintaining the same mAs. Compare the resulting images. If the corresponding steps in each pattern are the same densities, the mAs are operating okay. If the densities of the corresponding steps vary by more than two steps, the milliamperage should be adjusted. Usually milliamperage must be adjusted by a qualified service person
QUALITY ASSURANCE

3. Collimation and beam alignment
To test place 4 film on a sheet of paper in the shape of a cross. Adjust the edge of the BID to cross the middle of the films. Mark the outline of the BID and films on the paper with a pencil. Radiopaque objects, such as a coin, are then placed on the films inside the beam. Expose the films using half the exposure time used for anterior radiographs. Process the radiographs and place them on the paper in their original place. Exposed areas of the film identify the edge of the x-ray beam. If the exposure is greater then 2.75 inches the collimator opening is too large and must be replaced. If the circumference or shape is different then the shape of the collimator than the collimator or component is misaligned.

Collimation may also be tested by placing the end of the PID against a rare earth fluorescent screen of a loaded panoramic cassette. Set the exposure time for 1-2 seconds. Turn all lights in the room off and observe from a leaded barrier window to see if the fluorescence is limited to the diameter of the PID. The film may also be processed to see if the exposed area of the film is limited to the diameter of the beam.

4. Focal spot condition
Tested by using pinhole camera technique. Place a piece of lead approximately 1mm thickness over the collimator. Half-millimeter hole is made in the center of the lead. Place film on a small film box in the middle of the BID. Image produced should be 1mm x 1mm. There are also focal spot test tools that can be purchased.

5. Kilovoltage
A Kilovoltage meter checks for the relationship between kvp selected on generator control and actual obtained kvp

6. Exposure control (timer)
Uses a spinning top. The top consists of a disk with a hole in it. Based on the principle that x-rays are generated in impulses. There are 60 impulses in 1 second (i.e. 1/10 second equals 6 impulses). The spinning top is placed on top of an occlusal film or panoramic film in the cassette. Set your timer (for example 15 impulses or 0.25 seconds). Direct the central ray perpendicular to the spinning top, which is in motion. When the timer is activated, one small black dot will be seen on the processed film for each impulse. The dots are counted and compared with timer setting. Using this example there should be 15 dots.
QUALITY ASSURANCE

7. Half-value layer (HVL)
   The half value layer is an index of filtration. HVL is measured using aluminum filters and a dosimeter. HVL is measured at the kvp for which the filtration is being tested. For example, an exposure is made using a combination of kvp, mA, and time that would produce a reading of 300 milliroentgens. Repeated exposures are made placing aluminum attenuating sheets in front of the beam. Each time a sheet of aluminum is added a dosimeter reading is taken. This is done until the output of the x-ray intensity has been reduced to half its original value (i.e. 150 mR). The amount of aluminum used is the HVL.

Processing:
To test processing solutions: (both manual and automatic)
- 7 films using a stepwedge test object are exposed
- process one film in new chemicals
- each subsequent week process 1 film and compare to first film
- lessening of densities indicates weak solutions
- NOTE: full strength fixer should clear an unexposed, undeveloped film within 2 minutes. 4 minutes clearing time would indicate a weak solution.

Darkroom conditions:
Coin test can be used to check safelight conditions:
- Shut off all lights
- Unwrap a film packet
- Place the film on a clean work table
- Place a coin on top of the film
- Leave in position for 5 minutes
- Remove coin and process film
- Clear film indicates no light leaks
- Fogged area on film indicates light leak

Personnel monitoring

Required by state law for:

1. Individuals 18 years or older who receive or are likely to receive in any calendar quarter:
   a) 300 rems to whole body; or
   b) 5 rems to hands and forearms; or
   c) 2 rems to skin of whole body
2. Individuals is younger than 18 years who receive or likely to receive:
   a) 60 mrem to whole body; or
   b) 900 mrem to hands and forearms; or
   c) 400 mrem to skin of whole body

3. Individuals who receive or likely to receive one-fourth of MPD

**X-ray Measurement**

- Units by which radiation measured
  - roentgen (milliroentgen)
  - rad (millirad)
  - rem (millirem)
  - gray
  - sievert

- Exposure
  - How much radiation comes out of x-ray machine

- Dose
  - Amount of x-ray energy absorbed by a unit mass of tissue
  - Dose does not equal exposure

- Dose Equivalent
  - Allows for the comparison of the biologic effects of different types of radiation
  - Effective dose equivalent adjust for
    1. volume of tissue irradiated
    2. radiosensitivity of tissue irradiated

**Assessing Risks from Dental**

- Most biologic effects not a risk in dental because threshold dose needed to give effect much higher than that used in dentistry

- Consider risk estimates
  - to eye
  - gonadal
  - cancer
    - leukemia
    - thyroid

  ALARA Concept = As Low As Reasonably Achievable

**Miscellaneous**

The following is additional information not fully covered in radiology class time. The information presented is based on questions and notes from previous students upon completing the dental assisting boards.
MISCELLANEOUS QUESTIONS:

- Several questions on pregnancy and radiation exposure:
  - If operator is pregnant can she still take x-rays? Answer: Yes, in an emergency/
  - If patient is pregnant what is the most critical time? Answer: First trimester.

- If a child can’t hold the film, who should hold the film? Horrible question because first of all NO ONE should be holding the film. Best answer from choices of DA, DDS, parent is parent.

- If a child sits on parent’s lap does the lead apron go on child or both? Answer: both.
Protocol and Tray Setup

1. All tray setups must have the patient’s name that is receiving the x-rays on the tray cover. This name must be visible and not covered by film or equipment.

2. All exposed film must be placed in a paper cup labeled “exposed film” and have the patient’s name on the cup. This should be done with marker or tape.

3. If for any reason the exposure of the series is interrupted (i.e. the patient has to leave, etc.) the exposed film is to be discarded and the equipment sterilized immediately.
**Instrument Components**

**Aiming Rings XCP and BAI**

Anterior and Bitewing 54-859

Posterior 54-690

**XCP Bite Blocks**

Stock numbers are for packages of 25.

Anterior 54-861

Posterior 54-862

Also available: 54-863, containing 10 each. anterior and posterior.

**BAI Bite Blocks**

Stock numbers are for packages of 25.

Anterior 54-919

Posterior 54-920

Also available: 54-864, containing 10 each. anterior and posterior.

**Interproximal Bite Blocks**

Stock numbers are for packages of 12.

Horizontal #2 Film 54-929

Vertical #2 Film 54-2041

Horizontal #3 Film 54-931

Horizontal #0 & #1 Film 54-933

**Indicator Arms XCP and BAI**

Bite-wing 54-827

Anterior 54-857

Posterior 54-858