

It's Time to Clean up Your Image: Better Radiographic Technique

- KDA
- 2016

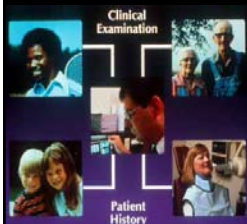
Optimize Your Radiographic Imaging

- Intraoral Technique
 - Error Recognition and Correction
 - Use of Digital Receptors
- Panoramic Technique
 - Patient Preparation
 - Error Recognition and Correction
- Image Enhancement

Selection Criteria

- Guidelines for prescribing radiographs – the need, type and frequency
- Purposes
 - Produce high yield, individualized radiographic examinations
 - Information generated will influence diagnosis and treatment
 - Ensures maximum benefit while minimizing patient exposure
- Dentist examines patient and prescribes radiographs

Selection Criteria



- Selection based on
 - Patient medical/dental history
 - Positive clinical signs and symptoms
 - Patient risk factors
 - Type of visit
 - Patient age/dentition
- Use selection criteria to individualize radiographic examinations – revised 2004

Changes in Document

- Expanded use of panoramic images in combination with bitewings for adult patients
- Category added for specific situations
 - Implant placement
 - Evaluation of the TMJ
 - Evaluation of pathology
 - Follow caries progression or remineralization
- Reminders about exposure reduction and patient shielding

Selection Criteria

- Highlights from 2012 Update
 - Thyroid collar usage same for all patients
 - Receptor selection
 - Handheld x-ray units
 - Technique charts
 - X-ray beam collimation
 - Radiation risk communication
 - Shielding recommendations consistent with Council on Radiation Protection

Intraoral Receptor Selection

- Digital Imaging
 - Rigid (CCD/CMOS)
 - Phosphor plate sensors (PSP/SPP)
 - Exposure reduction
 - ≈ 80% less than D
 - ≈ 25% less than F
- High Speed Film
 - F speed – 60% less than D speed film
- Retakes undermine dose reduction



Extraoral Receptor Selection

- Digital panoramic systems
 - Direct digital
 - Phosphor plate
 - Dose is equivalent to film-based systems using rare earth screens
- Rare earth intensifying screens with matched film
 - Most common phosphors lanthanum or gadolinium
 - Recommended for extraoral radiography
 - 50% exposure reduction over calcium tungstate screens

Instruments and Technique

- Receptor holders
 - Maintain position
 - X-ray beam ring guides
 - Fewer errors
- Paralleling technique
 - Preferred over bisecting angle
 - More diagnostic images
 - Greater accuracy
 - Fewer retakes

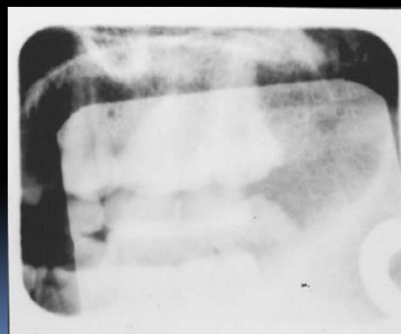
Collimators

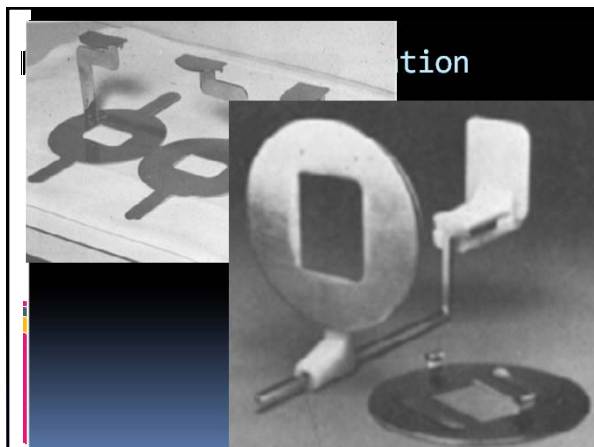


Round Collimation



Rectangular Collimation





Tru-align

- The TRD is increased by 4 inches
- Original TRD 8 inches; exposure time 0.2 s
- New TRD 12 inches

The intensity of the x-ray beam is inversely proportional to the square of the Target-Receptor distance

INVERSE SQUARE LAW

Do The Math

- $\frac{0.2}{64} = \frac{?}{144}$
- $28.8 = 64?$
- $? = 0.45s$



Receptor Selection

- Use High Speed Film
 - F speed – 60% less than D, 20% less than E
 - E speed – 50% less than D
- Digital Imaging
 - CCD or phosphor plate sensors
 - Exposure reduction
 - ≈ 80% less than D
 - ≈ 40% less than E



Rules of Accurate Image Formation

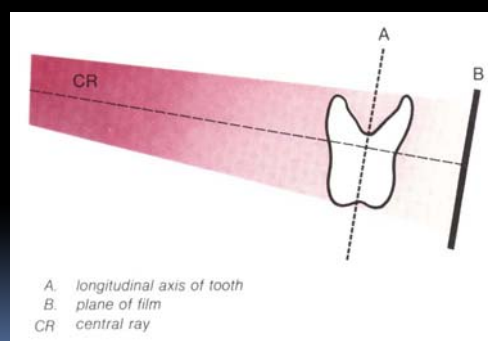
1. Place the film as close to object as practical
2. Use the longest source-to-object distance as practical
3. Place film parallel to the object
4. Direct the central ray at a right angle to the object and film



Requirements for Anatomic Accuracy

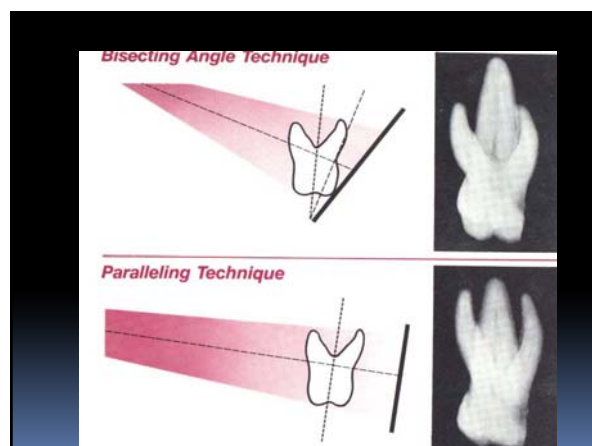
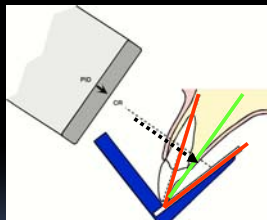
- Labial and Lingual CEJs of Anterior Teeth are Superimposed
- Buccal and Lingual Cusps Superimposed
- Interproximal Contacts Open
- Superimposition of Buccal and Lingual Alveolar Crests
- No Superimposition of Zygoma

Paralleling Technique

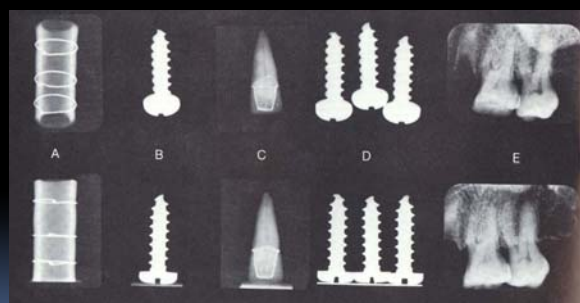


Bisecting Angle Technique

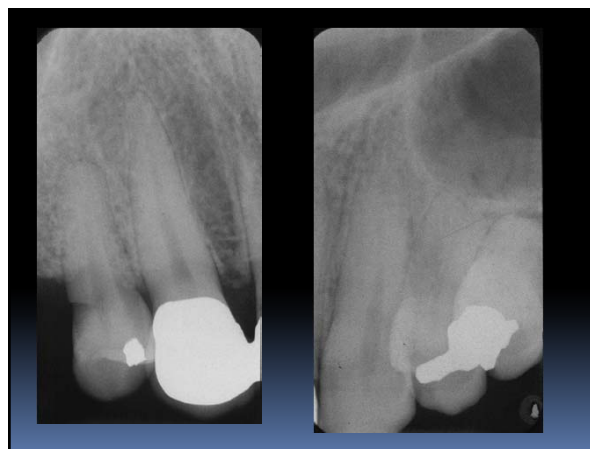
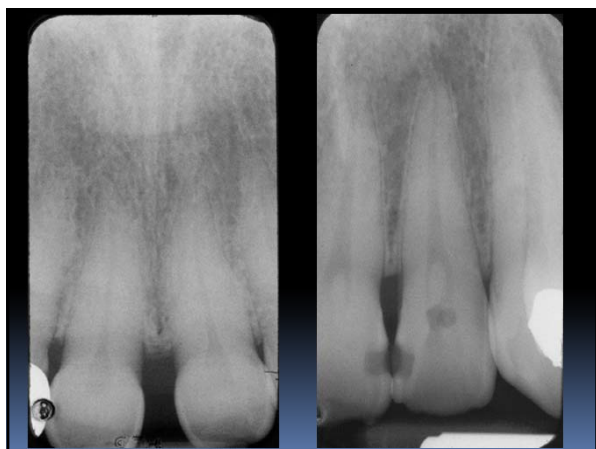
- ▣ Applies one of the rules for accurate image formation
- ▣ Angle is formed by film and object
- ▣ CR right angle to "bisecting plane"
- ▣ Produces images with shape distortion
- ▣ 2° periapical technique

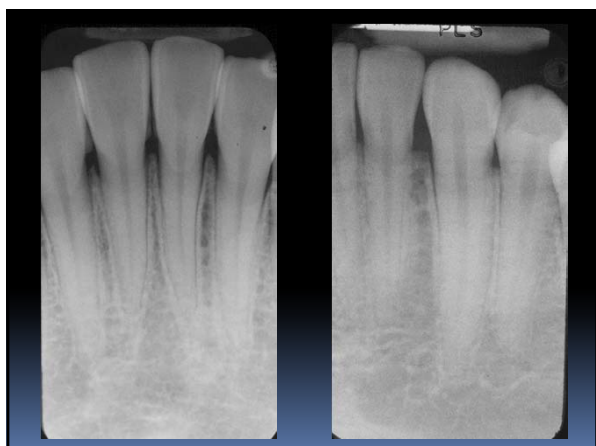


Bisecting Angle Vs. Parallelizing

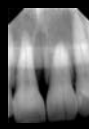


Full Mouth Series



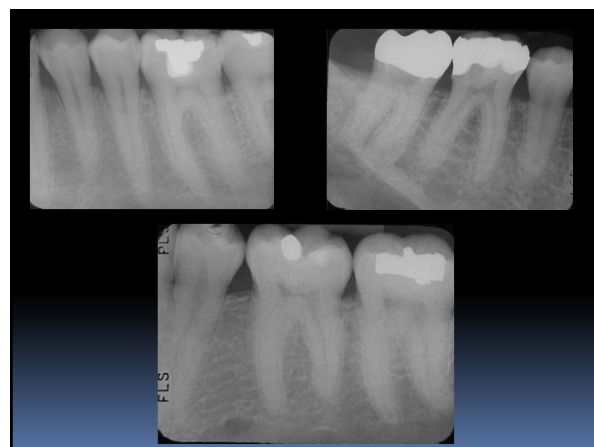
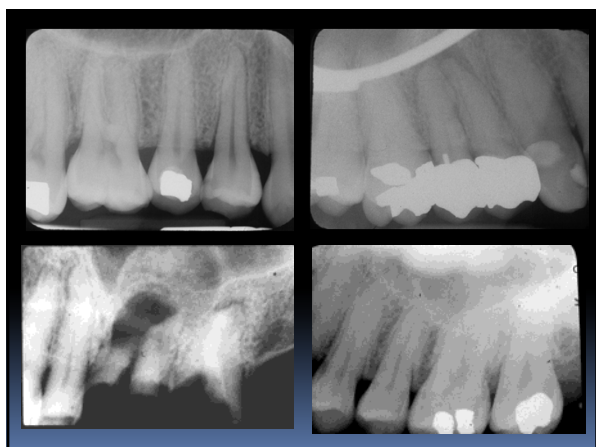
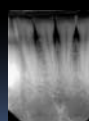


DDI Imaging Technique



Sample placements

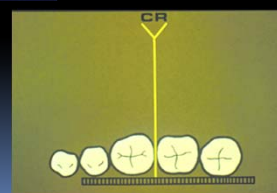
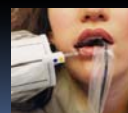
- Anterior periapicals
 - Use size 1 or 2 sensor; size 1 preferable
 - Maxillary central incisor view
 - Mandibular central incisor view

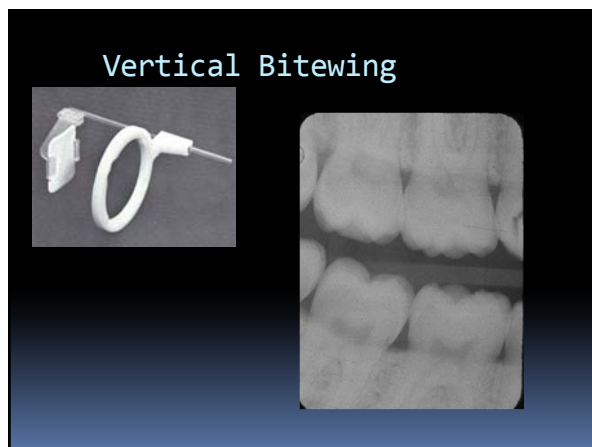


DDI Imaging Technique

Sample placements

- Posterior periapicals
 - Use size 2 sensor
 - Maxillary premolar view
 - Mandibular molar view





DDI Imaging Technique

Sample placements

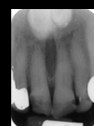
- Bitewings
 - Tab premolar view
 - Holder molar view
- Place more toward the midline

Gag Reflex or Discomfort

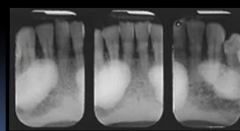
- Tissue sponges to wrap the film edge
- Topical anesthetic – place on film edge or on oral tissues
 - Salt on the tongue works too
- Distraction techniques – give patient a physical task to perform like raising one leg, flexing the toes, humming



Anatomical Challenges



- Tori
 - Place film behind torus & toward midline
 - Cover offending edge of film with tissue sponges to reduce discomfort
 - Place topical anesthetic on film and/or torus



Technique

- With regard to phosphor plates:
 - Careful handling during placement, scanning and erasure critical to avoid plate scratches
 - Plate replacement needed when artifacts interfere with diagnostics
 - Elongation may occur when the plate is not supported and bends during placement in the mouth

Technique

- Several studies have evaluated the use of digital receptors compared to film.
- *With regard to rigid receptors:*
 - Most common CCD image errors
 - Vertical angulation – incisal edges cut-off
 - Cone cutting
 - Sensor difficult to place especially in the molar region
 - More retakes needed
 - Mastering rigid sensors requires time and effort
 - Ease of retaking images may increase the number of retakes compared to film

Common Errors

Film Placement Errors

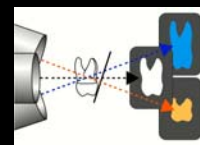
- Improper film location
 - Anatomic area not covered
 - Apices or crowns cut off
- Backwards placement
 - Foil pattern visible
 - Opposite film orientation
- Corrections
 - Place film more toward midline
 - White is Right



Vertical Angulation Errors

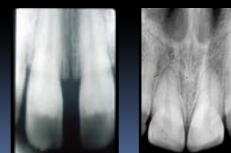
Foreshortening

- Shape distortion - image shorter than normal
- Correction
 - Decrease vertical angulation



Elongation

- Shape distortion - image a longer than normal
- Correction
 - Increase vertical angulation





Horizontal Angulation Errors

□ Overlapping

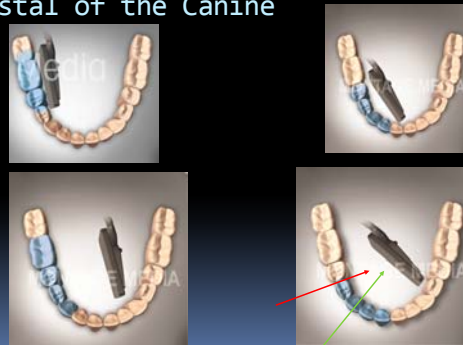
- Shape distortion - widened image
- Interproximal overlap
- Cause
 - Incorrect horizontal angle with diagonal beam entry
- Correction
 - Direct x-rays through interproximal surfaces



Overall dimensions vs active surface

- Sensor 0: Active surface 18 x 24 mm
- Sensor 0: Overall dimensions 23.6 x 32 x 7.5 mm
- Sensor 1: Active surface 20 x 30 mm
- Sensor 1: Overall dimensions 25.4 x 38.3 x 7.5 mm
- Sensor 2: Active surface 25.6 x 36 mm
- Sensor 2: Overall dimensions 31.2 x 43 x 7.5 mm

Digital Imaging and the Pesky Distal of the Canine



Central Ray-Cone Cut Errors



- Cone cut - partial film exposure resulting in a clear zone
- Common Causes
 - Central ray not directed to film center
 - Incorrect instrument assembly
- Correction
 - Direct CR to film center
 - Ring centered over film

Placement is meaningless if you don't aim the PID



Exposure Errors

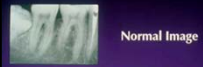
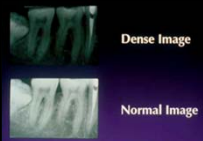
Light or low-density image

- Common Causes
 - Time set too low
 - Patient size underestimated
 - Button let go



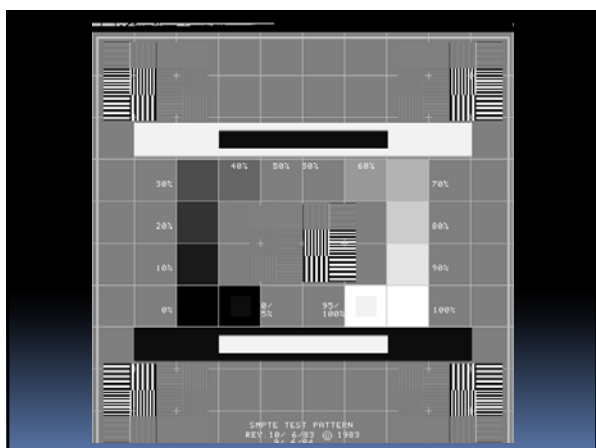
Dark or high-density image

- Common causes
 - Time set too high
 - Patient size overestimated

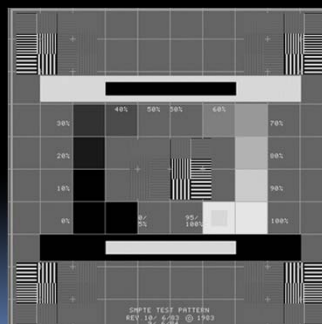


Sample Exposure Chart

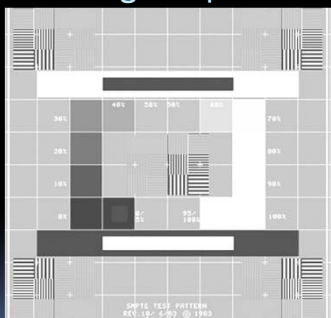
Exposures - 8" SSD	Incisor	Canine	Premolar	Molar
Adult Maxillary Arch	0.06	0.06	0.08	0.12
Adult Mandibular Arch	0.04	0.05	0.08	0.10
Adult Bitewings			0.10	0.12



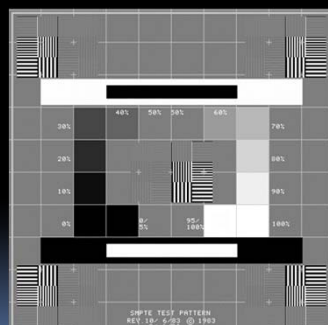
Too much exposure



Not enough exposure



Increased Contrast



Double Exposure

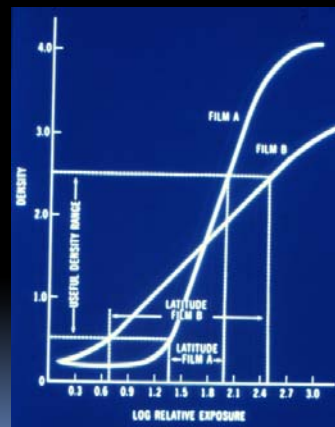
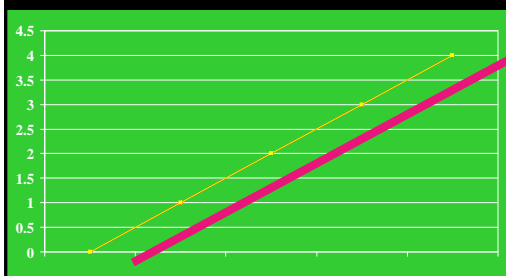
- ❑ Dark or high-density image
- ❑ Unusual image pattern
- ❑ One unused film
- ❑ Common Causes
 - Lack of organization
 - Failure to keep exposed & unexposed film separated
- ❑ Corrections
 - Use organized film layout
 - Turn film over to colored side to signal exposure



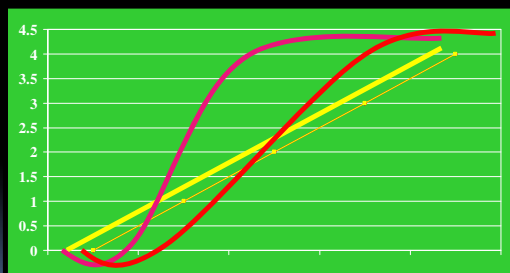
Caries Detection and Digital Imaging

- Many complaints about caries detection
- H and D curve vs. linearity
- Partial Volume Averaging
- Image Output

Dynamic Range and Linearity



H and D Vs. Linearity



Partial Volume Averaging

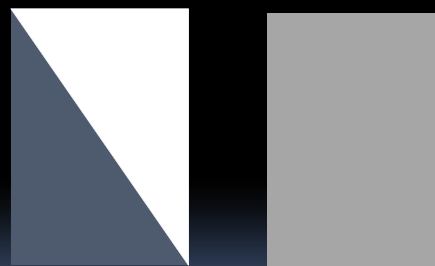
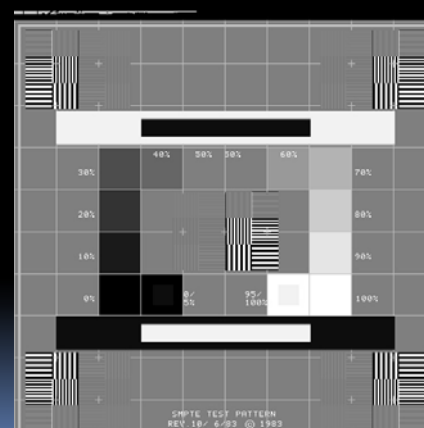


Image Output

- View-box
- Magnification
- Monitor
- Printer
- Paper

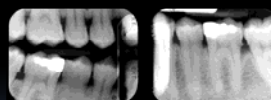


Quality Processing



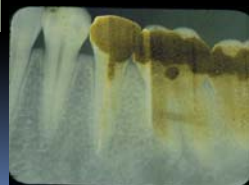
- ▣ Proper darkroom conditions and maintenance
- ▣ Optimal time-temperature
- ▣ Processing system maintenance
- ▣ Solution replenishment and replacement

Common Processing Errors



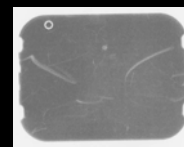
- ▣ Incomplete Washing – yellow brown stain produced
- ▣ Film Feed Errors – various artifacts
- ▣ Dark and light films – temperature, time and solution problems
- ▣ Green films – fixer exhausted, film not cleared

What about the Dark Room?



Disadvantages - PSP

- Sensors reusable after erasure – exposure to white light
- Scratching/bending plate – produces artifacts and image elongation
- Careful infection control necessary
- Scanning required to digitize image



Mini Quiz

Rectangular collimation...

1. Restricts the size of the x-ray beam
2. Decreases x-ray exposure
3. Improves image geometry
4. All the above

Your answer:

Foreshortening is corrected by

1. Centering the x-ray beam
2. Decreasing the vertical angulation
3. Redirecting the horizontal angle
4. Increasing the vertical angulation

Your answer:

Mini Quiz

How do you eliminate the overlapping on this bitewing?



1. Change the vertical angle
2. Center the x-ray beam
3. Change horizontal angle
4. Adjust patient's head

Your answer:



Panoramic Radiography Objectives

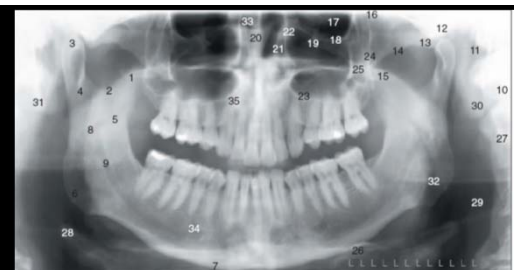
The participant will be able to:

- Apply technique to produce optimal panoramic images.
- Identify, describe and correct common errors that occur on panoramic films.



Criteria for a Diagnostic Panoramic

- ☐ Entire maxilla and mandible recorded including TMJs and sinuses.
- ☐ Symmetrical display of the structures right/left.
- ☐ Slight smile or downward curve of occlusal plane.
- ☐ Good representation of the teeth.
- ☐ Tongue is in place against the palate.
- ☐ Minimal or no cervical spine shadow visible.
- ☐ Acceptable contrast and density.
- ☐ Free of technical, preparation, exposure, film handling and processing errors.



- | | | |
|--------------------------------|---------------------------------------|---|
| 1. Coronoid Process | 13. Articular Eminence | 25. Malar Process |
| 2. Sigmoid Notch | 14. Zygomatic Arch | 26. Hyoid Bone |
| 3. Mandibular Condyle | 15. Pterygoid Plates | 27. Cervical Vertebrae 1-4 |
| 4. Condylar Neck | 16. Pterygomaxillary Fissure | 28. Epiglottis |
| 5. Mandibular Ramus | 17. Orbit | 29. Soft Tissues of Neck (Look Vertically For Carotid Artery Calcifications Here) |
| 6. Angle of Mandible | 18. Inferior Orbital Rim | 30. Auricle |
| 7. Inferior Border of Mandible | 19. Infraorbital Canal | 31. Styloid Process |
| 8. Lingula | 20. Nasal Septum | 32. Oropharyngeal Air Space |
| 9. Mandibular Canal | 21. Inferior Turbinate | 33. Nasal Air Space |
| 10. Mastoid Process | 22. Medial Wall of Max. Sinus | 34. Mental Foramen |
| 11. External Auditory Meatus | 23. Inferior Border of Max. Sinus | 35. Hard Palate |
| 12. Glenoid Fossa | 24. Posterolateral Wall of Max. Sinus | |

Panoramic X-ray Machine

- X-ray source – vertical slit aperture
- X-ray beam fixed at a -10° angle
- Time is fixed ≈ 20 sec.
- kVp and mA vary according to patient size
- X-ray beam directed lingual to labial
- X-ray head and cassette simultaneously in opposite directions
- Side closest to cassette is recorded, opposite blurred out of focus.
- Ghost images may be produced.



Focal Trough

- Predetermined layer of structures to be recorded in focus on the film
- Layer is shaped to conform to the shape of the *average jaw*
- Correct patient positioning in the focal trough is essential
- Patient's arches must be centered horizontally, vertically & anteroposteriorly
- Lack of centering will produce under or over magnification of the structures

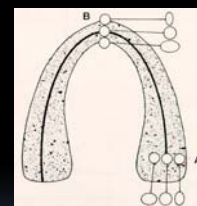


Image Receptor

- Indirect Exposure Film
- Intensifying Screens
- Film/Screen Speed
- Watch Safe Light/Film Sensitivity Mismatch
- CCD/CMOS
- PSP

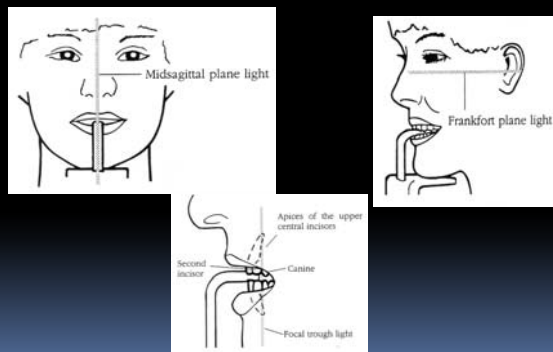
Patient Preparation

- Explain procedure
- Ask patient to remove head/neck metallic objects
 - Earrings, necklaces, facial jewelry
 - Hairpins, barrettes
 - Intraoral prostheses
 - Glasses, hearing aids
- Place panoramic style lead apron
 - Position high in front, low in back
 - DO NOT USE THYROID COLLAR
- Select exposure factors per patient size, stature and bone density

Patient Positioning

- Patient sits or stands with straight spine
- Front teeth bite end to end in bitepiece groove
- Clinician aligns the head
 - Midsagittal perpendicular to floor
 - Occlusal plane parallel to floor
 - Anteroposterior plane aligned with specific landmark

Patient Positioning



Pre-exposure Patient Instructions

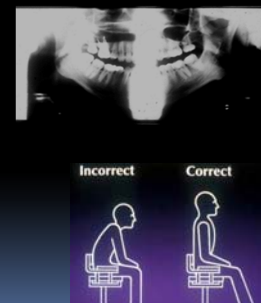
- Swallow and press your tongue against the roof of your mouth
- Close your lips around bitepiece
- Close your eyes
- Remain completely still!

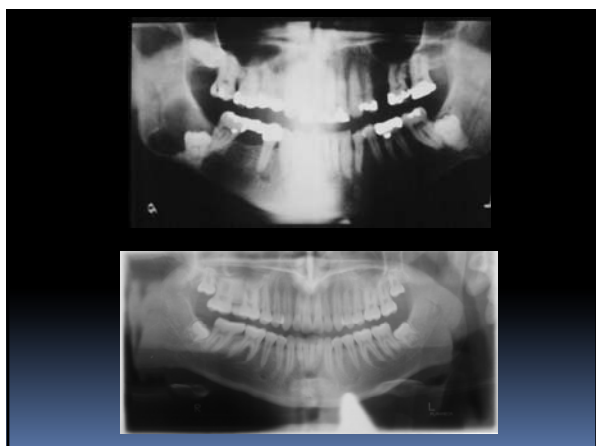


Panoramic Errors

Slumped Spine

- Creates a pyramid or column-shaped radiopacity in midline
- Correction – instruct the patient to sit or stand tall
- Make sure chin rest is placed just below the patient's chin

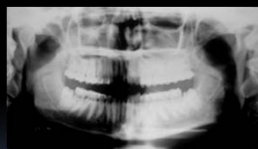




Midsagittal Error

Rotated

- Side turned toward cassette is narrow, side towards source is widened
- Severe overlapping of teeth



Correction

- Center the midsagittal plane and align perpendicular to floor



Midsagittal Error

Tilted

- Side tilted toward cassette is narrow, side towards source is widened
- Occlusal plane crooked
- One side higher than the other



Correction

- Center the midsagittal plane and align perpendicular to floor

Occlusal Plane Error

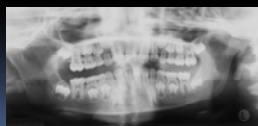
Chin up

- Upper teeth and condyles are blurred and widened
- Hard palate superimposed over maxillary teeth apices
- Occlusal plane flat or frowned



Correction

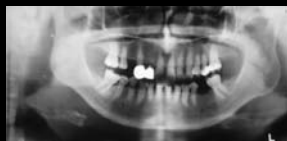
- Lower chin down so occlusal plane is parallel to floor



Occlusal Plane Error

Chin down

- Lower teeth are widened and foreshortened
- Hyoid bone superimposed over the mandible
- Condyles cut off top of image
- Occlusal plane has grin appearance



Correction

- Raise chin up so occlusal plane is parallel to floor



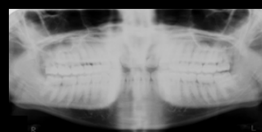


Anteroposterior Errors

- Too far forward
 - Anterior teeth are blurred and narrowed
 - Severe overlapping of teeth especially premolars
 - Spine superimposed over ramus
- Correction
 - Move patient toward x-ray source
 - Teeth end to end
 - Align landmark



Anteroposterior Errors



- Too far backward
 - Anterior teeth are blurred and widened
 - Excessive ghosting of ramus and spine
 - Image larger than film
- Correction
 - Move patient toward cassette
 - Teeth end to end
 - Align landmark

What other error is present?

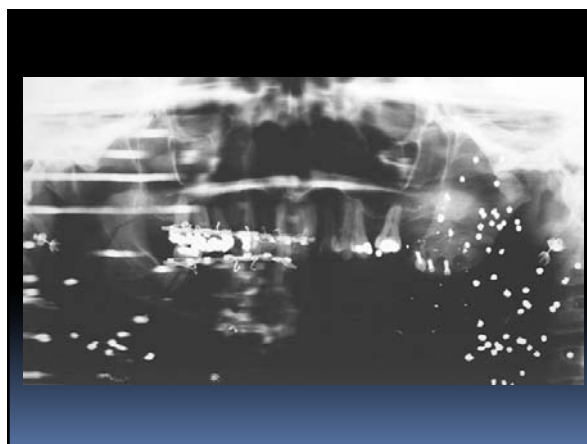


Patient Preparation Errors

- Metallic objects left in place produce radiopaque artifacts.
- Patient movement during exposure
- Tongue not pressed against palate

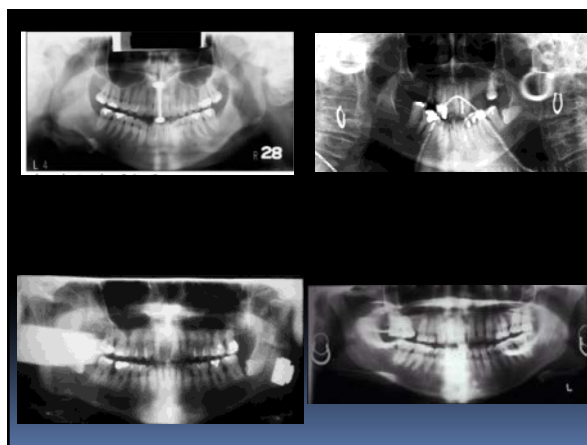


Any Metallic Objects?

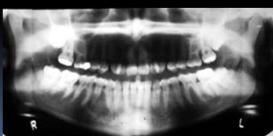
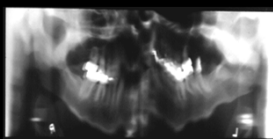


Metallic Object Artifacts

- ▣ Metallic artifacts – failure to ask patient to remove objects in head and neck region; improper lead apron placement
- ▣ Correction – instruct the patient to remove glasses, jewelry, prostheses



Patient Preparation Errors

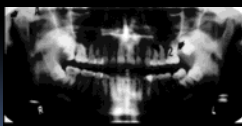


- ▣ Movement – patient incapable of remaining still or not instructed to do so
- ▣ Tongue – palatoglossal air space created when tongue not in position
- ▣ Correction – give patient pre-exposure instructions



Exposure Errors

- Low density – underestimation of patient size/stature
 - Correction – increase kVp and mA settings
- High density - overestimation of patient size/stature
 - Correction – decrease kVp and mA settings



Exposure Errors

- Double exposure – cassette used twice on two different people
 - Correction – process film immediately, do not leave on machine
- Incomplete exposure – button let go before entire cycle complete
 - Correction – Hold button down until cassette stops rotation



Exposure Errors

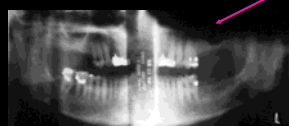


- Cassette resistance – alternating black and white lines
- Cassette rubs against or is stopped by patient's shoulder
- Correction – raise unit and have patient relax shoulders to avoid contact with cassette

No Necks

- Stand up straight
- Cross hands
- Drop right shoulder, bend left knee
- Seat
- Lateral jaw

Processing Errors



- White light exposure - black artifact from partial or complete light exposure
- Caused by cassette leaks around seams or latches or during processing
- Correction – open cassette and process the film in safelight conditions; periodically check cassette condition



Lateral Jaw

- 5X7 Cassette
- Occlusal plane parallel to floor
- Mid Sagittal plane perpendicular to floor
- Cassette parallel to mid sagittal plane
- Tilt head up and towards cassette
- 17° vertical angulation



Mini Quiz

If the panoramic image is unequal right to left, what type of error occurred?

1. Occlusal plane
2. Slumped spine
3. Midsagittal plane
4. Anteroposterior plane

Your answer:

Which of the following would produce a black artifact on a panoramic image?

1. Earrings
2. Lead apron
3. Slumped spine
4. Tongue not against palate

Your answer:

Mini Quiz

This error was caused by improper positioning of the:

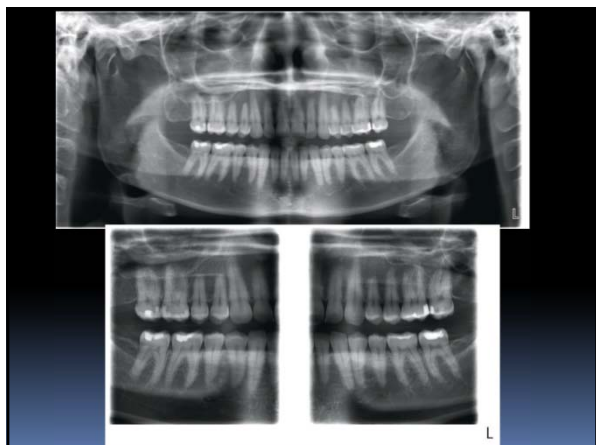
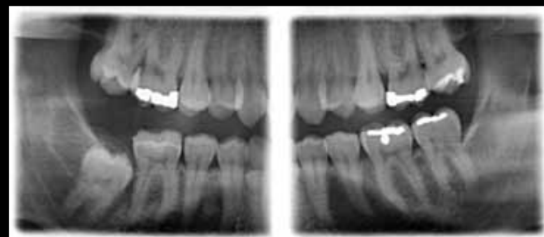
1. Midsagittal plane
2. Occlusal plane
3. Anteroposterior plane
4. Spinal column



Your Answer:

Extra-oral bitewings

- Resolution
- "challenging anatomies"
 - Tori
 - Tongue
- What about rotated teeth?
- Can't hold still for BWX; what about panoramic?



Specifications--panoramic

- CCD pixel size 33 microns
- Image pixel size
- (selectable)
 - 66 microns,
 - 99 microns,
 - 132 microns
- Image resolution Pan: 9 lp / mm
- Ceph: 5.7 lp / mm

- Technology CMOS-APS (Active Pixel Sensor)
- Pixel Size 15 μ m, image acquisition in 15 μ m
- Line Pairs 28 lp (33.3 lp - Nyquist Limiting Frequency)
- Active Sensor Area
 - Size 0 18 x 24 mm
 - Size 1 20 x 30 mm
 - Size 2 25.6 x 36 mm
- External Dimensions
 - Size 0 23.6 x 32 x 7.5 mm
 - Size 1 25.4 x 38.3 x 7.5 mm
 - Size 2 31.2 x 43 x 7.5 mm

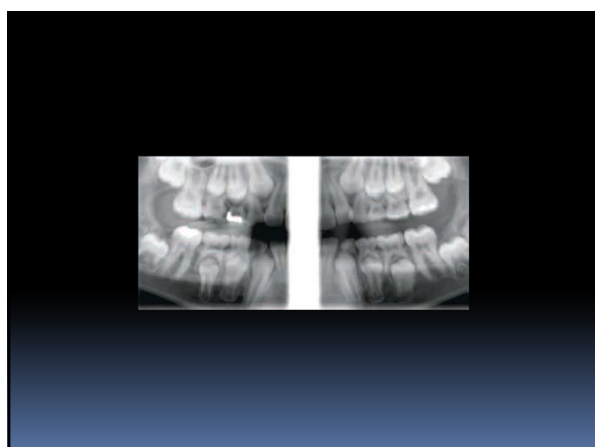
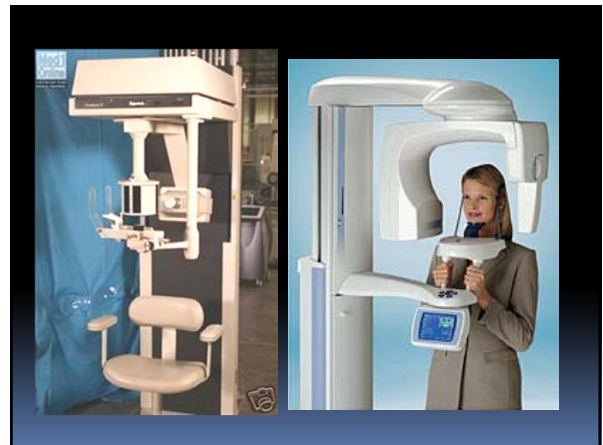
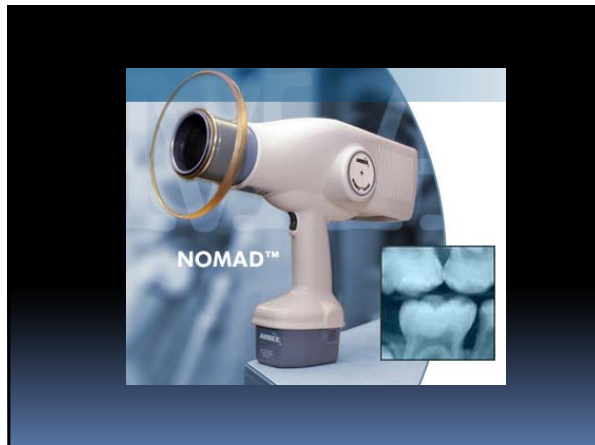


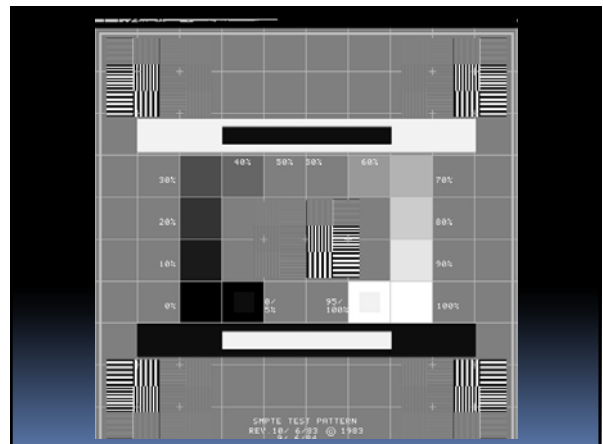
Image Enhancement

- Makes a good image better
- Can salvage a dark image
- Cannot salvage a light image
- If every image needs to be "enhanced".....



Computer Monitor

- Size
- Location
- Pitch (resolution)
- Contrast Ratio

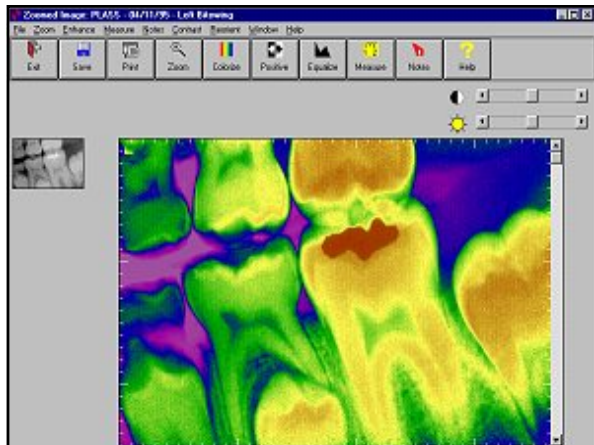


Bells and Whistles

- Zoom
- Pseudo Color Enhancement
- Measurement
- Reverse Density
- "Flashlight"
- Density Enhancement
- Contrast Enhancement
- Gamma Correction

Pseudocolor Enhancement

- Gray Scale Images
- Duuuuuuuude....The Colors.....
- What does color mean?
- Feng Shui
- Rainbow Color Table
- Temperature Color Table



Pseudo-color Enhancement

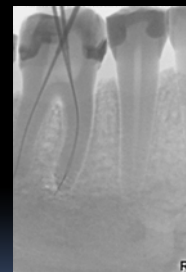


- ✓ Does not increase diagnostic efficacy. It may even lower it
- ✓ Best used in presentations to patients

Measurement



Image Inversion

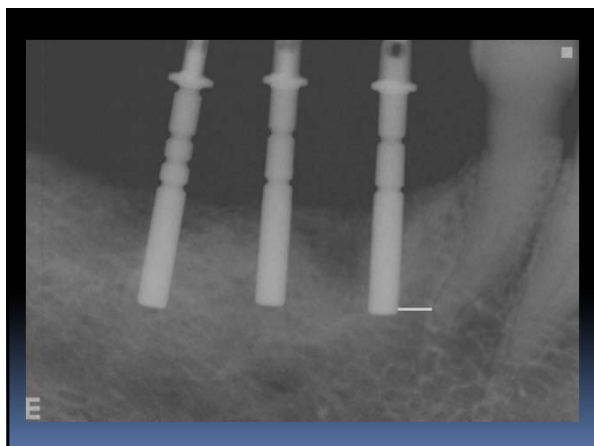
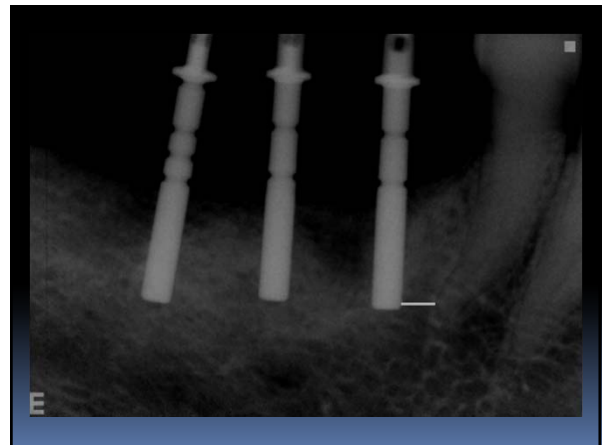
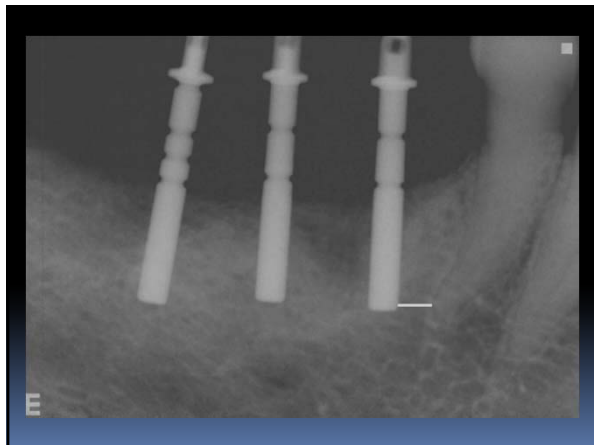


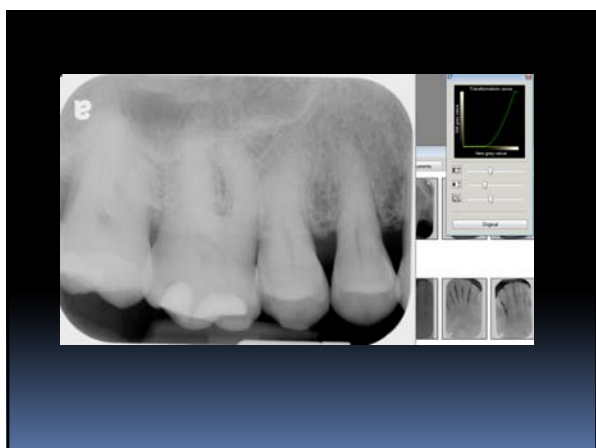
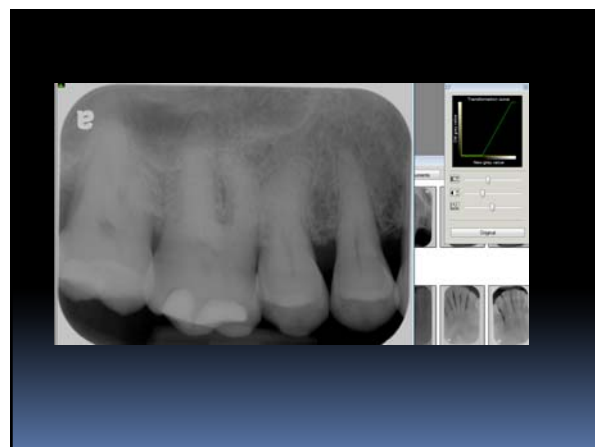
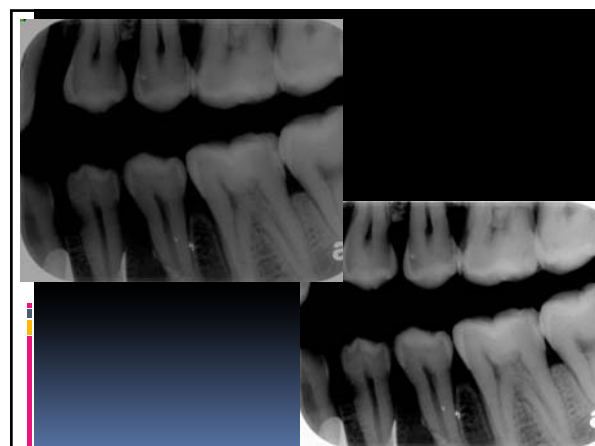
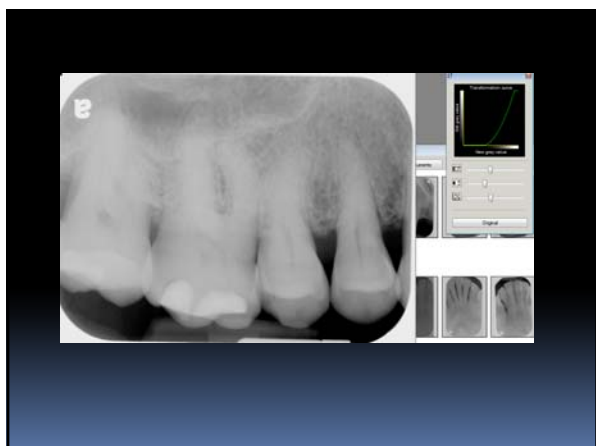
Flashlight

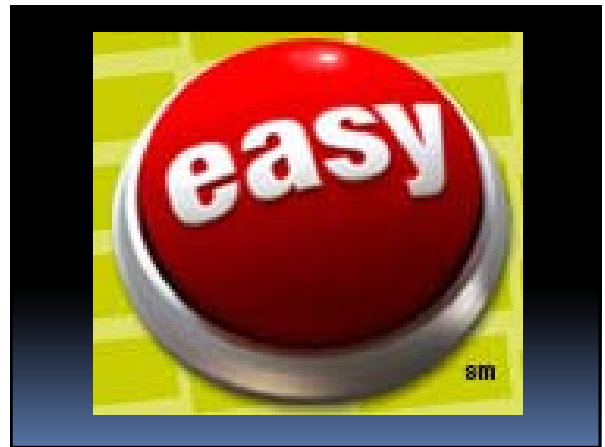


Density/Contrast Manipulation

- Density changes can border on disease creation
- Image Contrast Vs Subject Contrast Vs Output Contrast
- Don't forget about kVp







Summary

- Radiographic interpretation can be optimized by addressing any deficiencies along the imaging chain:
- Source
- Region of Interest
- Receptor
- Computer
- Output
- Evaluator