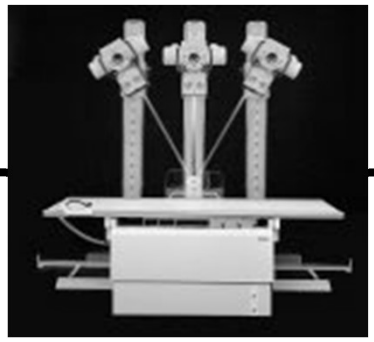
The Reading Hospital School of Health Sciences Medical Imaging Program



Linear Tomography

Mrs. Herb B.S., R.T. (R)(M)(ARRT)

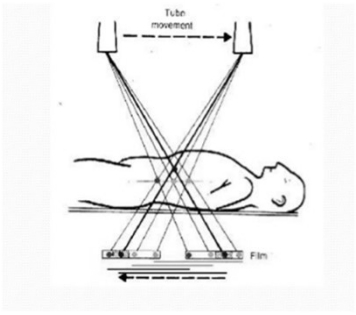
1

Tomography

Radiographic technique that employs motion to show anatomical structures lying in a plane of tissue while blurring detail in images of structures above and below the plane of interest

- Allows visualization of structure that may otherwise be superimposed over other anatomy

- Most tomography has been taken over by MRI and CT
  - Tomo- cut, section or layer
  - -graphy- the process of recording
- Developed in 1921
  - Andre Edmund Bocage- French dermatologist
  - Jean Kieffer- American radiographer
- Older terms
  - Planigraphy
  - Stratigraphy
  - Laminography
  - Section radiography



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Tomography – Advantages *vs.* Disadvantages

Advantages

- Demonstration of anatomical structure in coronal (but also sagittal and axial) while blurring out surrounding structures
- Valuable with routine kidney imaging within Radiography (Intravenous Pyelography)
- Useful when computerized modalities are to expensive or unavailable

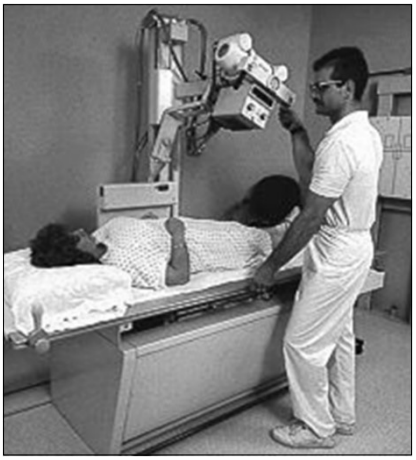
Disadvantages

- More exposure to radiation (Still within safe radiation levels)
- Equipment more expensive due to complexity of equipment

3

Tomography Basic Principles

- X-ray tube travels in an arc
- Based on the simultaneous movement of 2 or 3 parts of the imaging system
  - X-ray tube
  - The object
  - Image receptor
- Usually the tube and IR move in opposite directions during an exposure
  - Alignment is usually maintained by an attachment between the two



http://www.youtube.com/watch?v=UZNJ-1v2-f8

4

Tomography Basic Principles

- The anatomy of interest is placed in a focus point (pivot point) called a *fulcrum*
- This is accomplished by setting the fulcrum to a number that would correspond to how far the anatomy of interest is from the table top
- During the exposure the anatomy above and below the fulcrum will be blurred out by the movement of the tube and IR

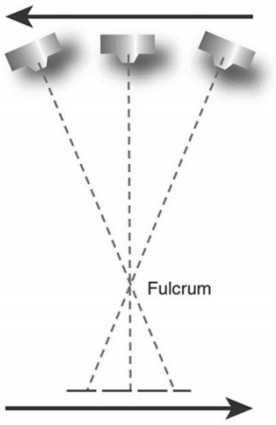


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Image Creation Basics

- Center over the anatomy of interest
- The tube and IR rotate on an axis, which corresponds to the anatomy of interest
- Severe tube angulation shoots the surrounding anatomy in both directions causing a blurred appearance
- The anatomy of interest will be projected in the same location of the IR, while the other anatomy is projected in varying locations
- The more blurring that occurs the sharper the area of interest will be

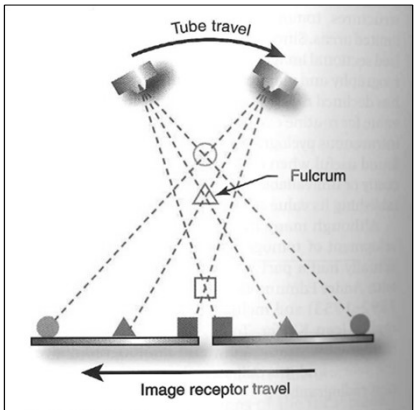

FIGURE 41-3 The tomographic concept. The ball is projected to the right of the triangle as the exposure begins but is blurred completely across the triangle to appear at the left by the end of the exposure. Also note that the box goes through the same blurring, but in the opposite direction.

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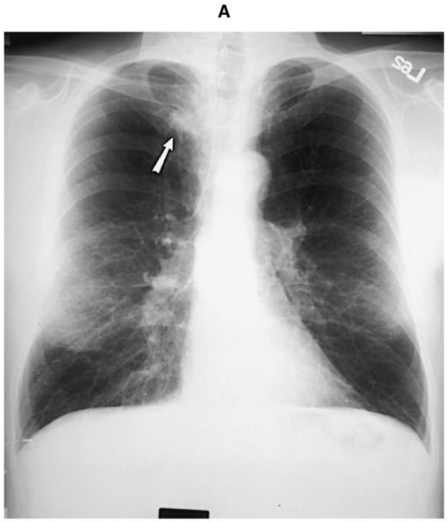

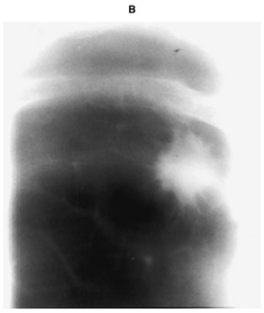

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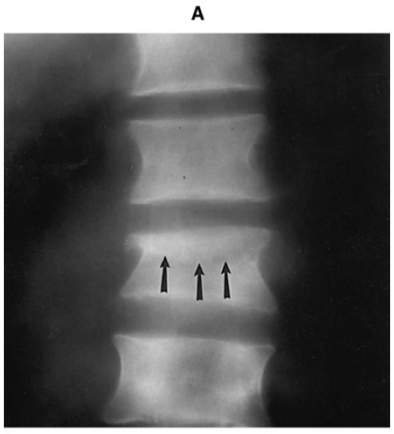

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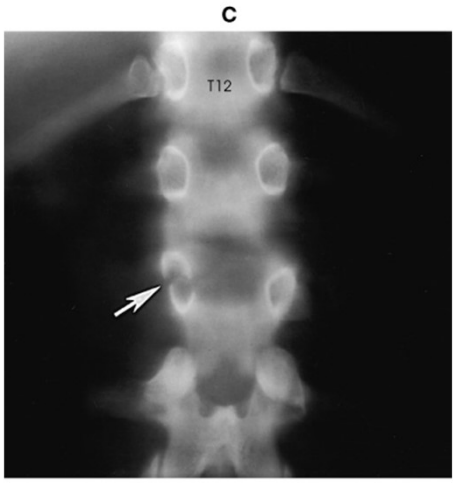

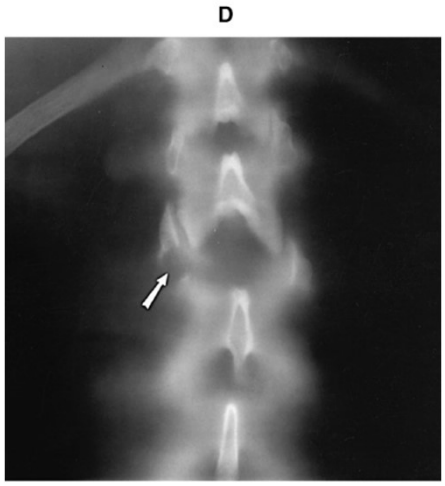

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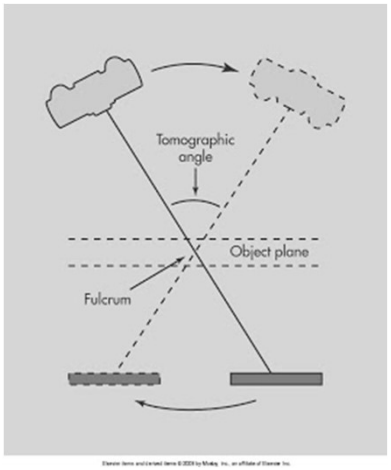
Tomographic Quality

- Tomographic Amplitude
- Exposure Amplitude
- Blur
- Phantoms
- Fulcrum
- Focal Plane
- Section Thickness
- Section Interval



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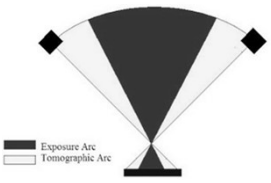
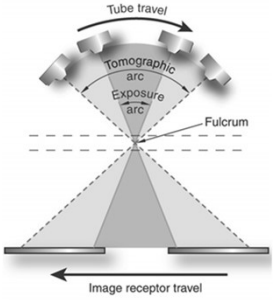
Tomographic Amplitude

- Arc or angle that the tube travels
  - Total distance from start to finish
- Exposure may or may not be on during the entire tomographic amplitude
- Tomographic amplitude is ALWAYS greater than or equal to the exposure
- Tomographic amplitude and section thickness are inversely related
  - Larger Angle= Thinner section
  - Smaller Angle= Thicker section





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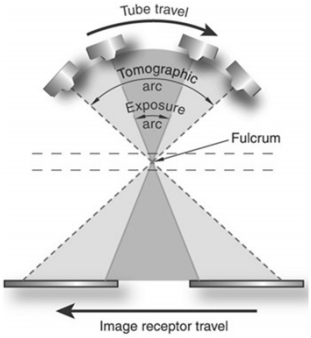
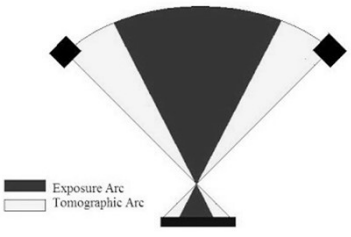
Exposure Amplitude

- Arc or angle that the tube travels while the exposure is being taken
- The exposure is active during the entire exposure amplitude
- Exposure amplitude is always equal or less than the tomographic amplitude





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Blur

Streaking/smearing that occurs outside the area of interest (focal plane) which results in a loss of all recorded detail

- This allows visualization of the area of interest through the blurred area
- Increased blurring causes decreased density – the object is more transparent
- Inverse relationship between blurring and the image receptor exposure of objects.
  - Increased blurring causes decreased exposure (making an object more transparent)
    - Objects then can be seen through the blurring

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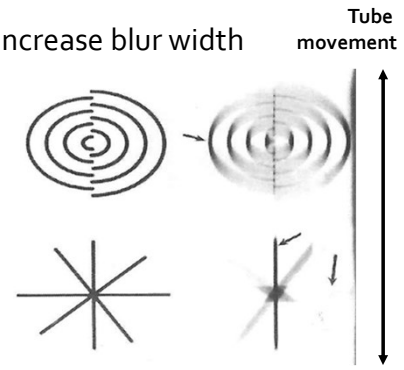
Blur

Blur is affected by:

- Tomographic Amplitude
  - Increase amplitude = increase blur width
- Distance From Fulcrum
  - Increase of object from fulcrum= increase blur width
- Distance of Object From IR
  - Increase distance from IR= increase blur width
- Orientation of tube motion
  - The more perpendicular the tube= increase blur width



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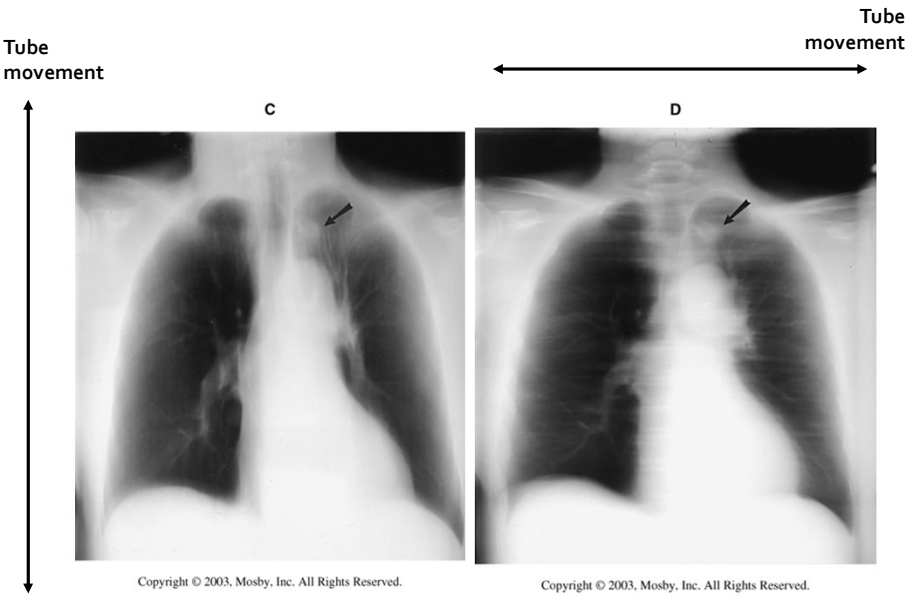

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Phantoms

Also called blurred edges or blurred margins

- Created by geometrical relationship between the tube movement and the anatomical structures in the patient
- Images do not correlate with existing structures (*false images)*
  - Dangerous to diagnostic process
- Most common types of false image is streaking
  - Streaks of density are produced when the long axis of a structure is lying parallel to the tube movement and is not sufficiently blurred
    - Perpendicular tube movement to the long axis of the part will decrease phantoms

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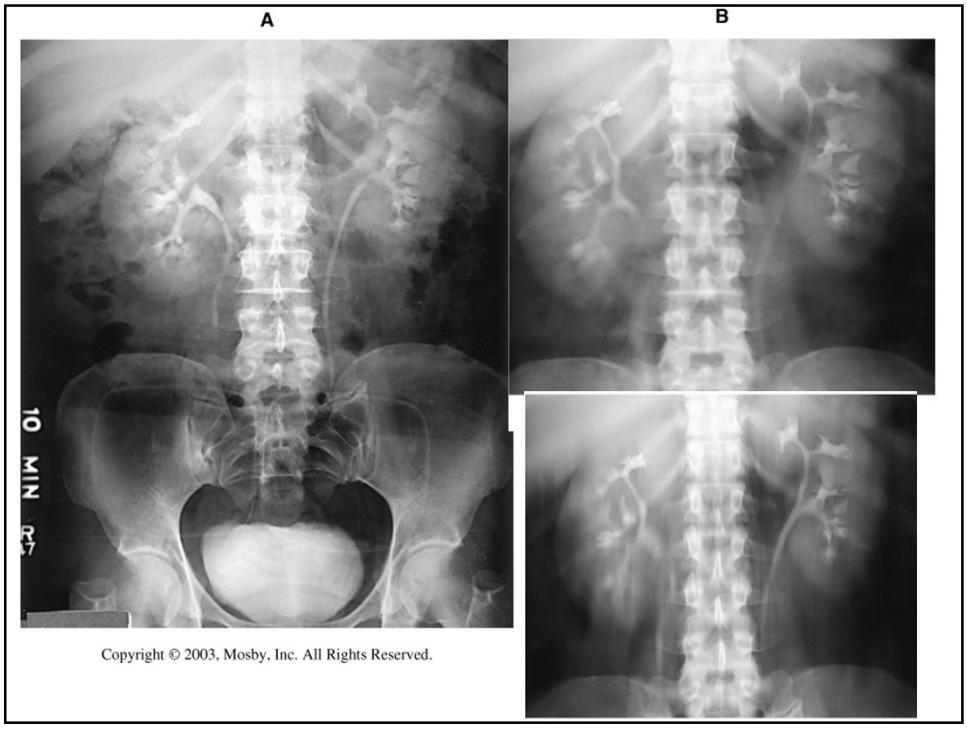

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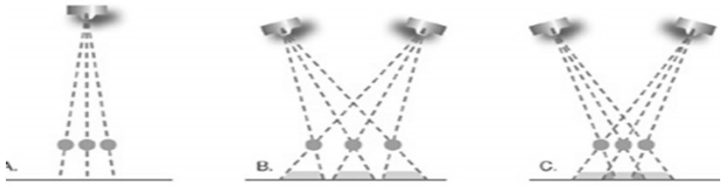
Phantoms

- Also caused by blur overlap and displacement of blur margins due to tomographic motion at smaller angles.



Perpendicular, still image | **Large exposure amplitude** | **Small exposure amplitude**

- Increased exposure amplitude + Reduced section thickness will decrease phantom images

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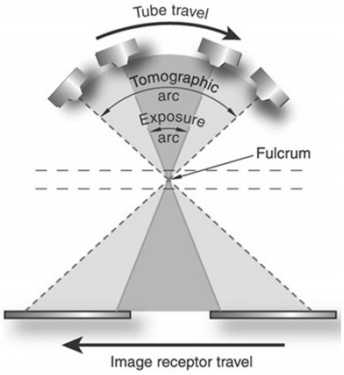
Fulcrum

- The pivot point that the tube and IR rotate around
- This is where the anatomy of interest should be located
- The fulcrum can be set and moved up or down to obtain the proper focus



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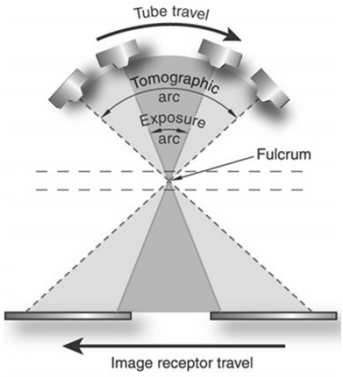
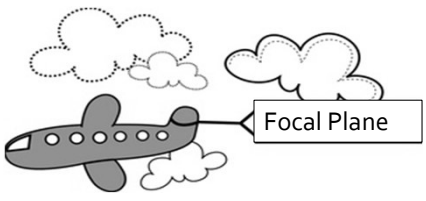
Focal Plane

Section of anatomy to be imaged

- Other terms: section level, layer height, object plane or depth of focus

- Region that allows acceptable recorded detail
- Controlled by the fulcrum
  - Measured up from table top (include the pad)
  - Anatomy near the fulcrum = less blur
  - Anatomy further away from fulcrum = more blur





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Section Thickness

Width of the focal plane and controlled by exposure amplitude (angle)

- Inversely related
  - Increase angle= thinner section thickness (detail)
  - Decrease angle= thicker section thickness (localization or survey)

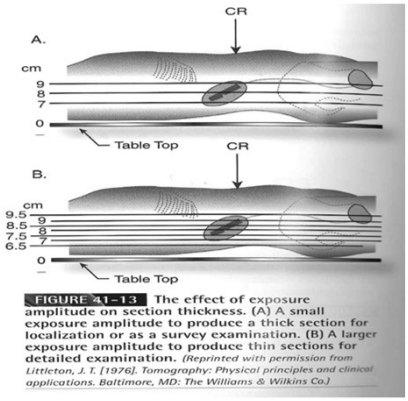

FIGURE 41-13 The effect of exposure amplitude on section thickness. (A) A small exposure amplitude to produce a thick section for localization or as a survey examination. (B) A larger exposure amplitude to produce thin sections for detailed examination. *(Reprinted with permission from Littleton, J. T. [1976]. Tomography: Physical principles and clinical applications. Baltimore, MD: The Williams & Wilkins Co.)*

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Sectional Interval

Distance between fulcrum levels

- Determined by department protocols
- Sectional interval will not exceed section thickness
  - Creates unexamined gaps of tissue if section intervals are greater than section thickness
- Should create overlap of sections to ensure all anatomy is covered

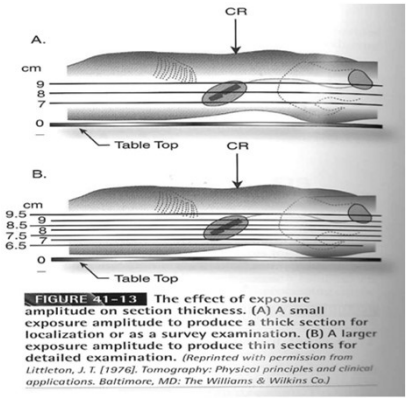

FIGURE 41-13 The effect of exposure amplitude on section thickness. (A) A small exposure amplitude to produce a thick section for localization or as a survey examination. (B) A larger exposure amplitude to produce thin sections for detailed examination. *(Reprinted with permission from Littleton, J. T. [1976]. Tomography: Physical principles and clinical applications. Baltimore, MD: The Williams & Wilkins Co.)*

https://www.youtube.com/watch?v=qKHMnwTwEgI

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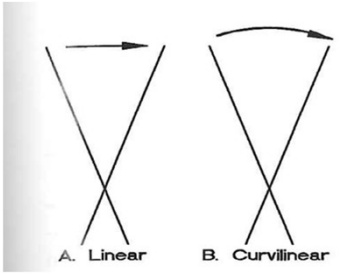
Types of Motion

Simple Motions

- Linear- Tube and IR movement along a straight line
  - Advantage: Inexpensive addition to a diagnostic x-ray unit compared to more complex moving equipment
  - Disadvantage: Has increase SID and OID at both ends of the motion
- Curvilinear - Maintains SID and OID at the ends of the motion



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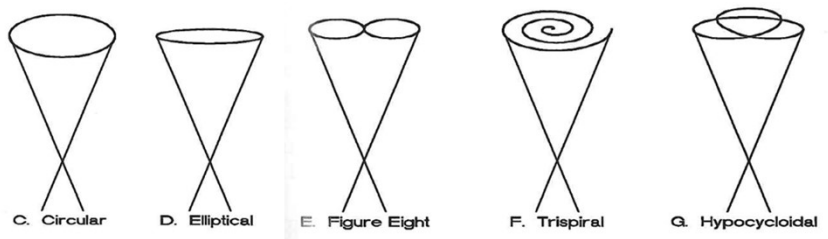
Types of Motion

Complex Motions

- More advanced motions require specialized equipment
- Requires 3-6 second exposure times
- As complexity increases – thinner sections are possible and more phantoms eliminated



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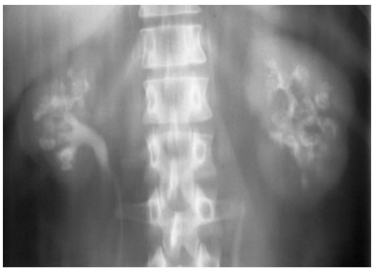
Examples of Tomography Exams

- IVU/ IVP
- TMJ's
- Hips
- Shoulders
- Spines



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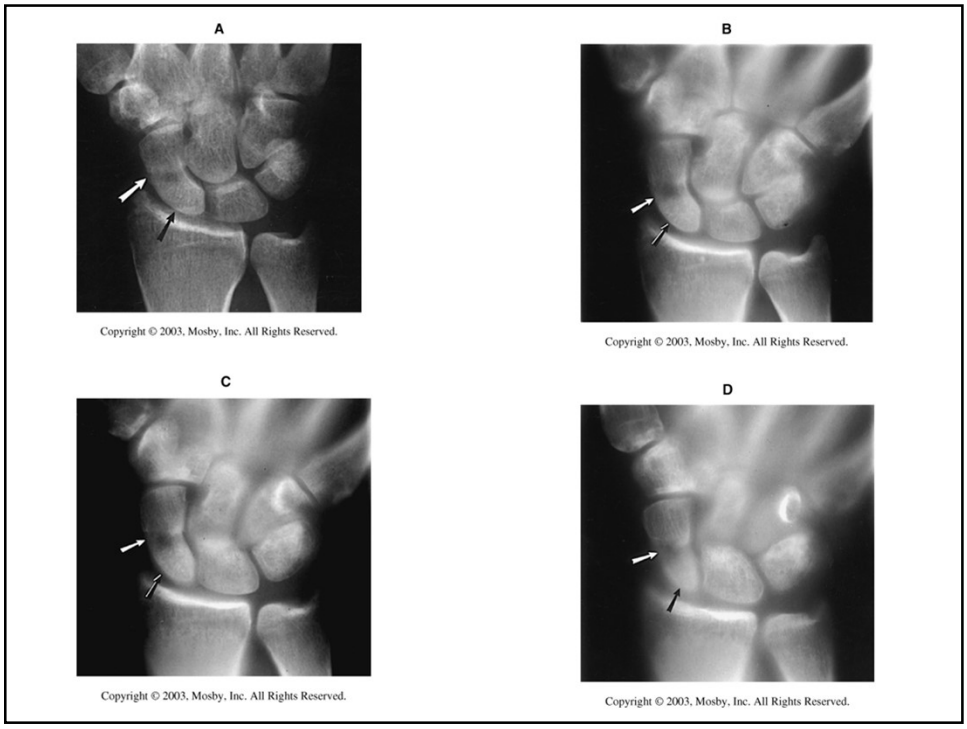
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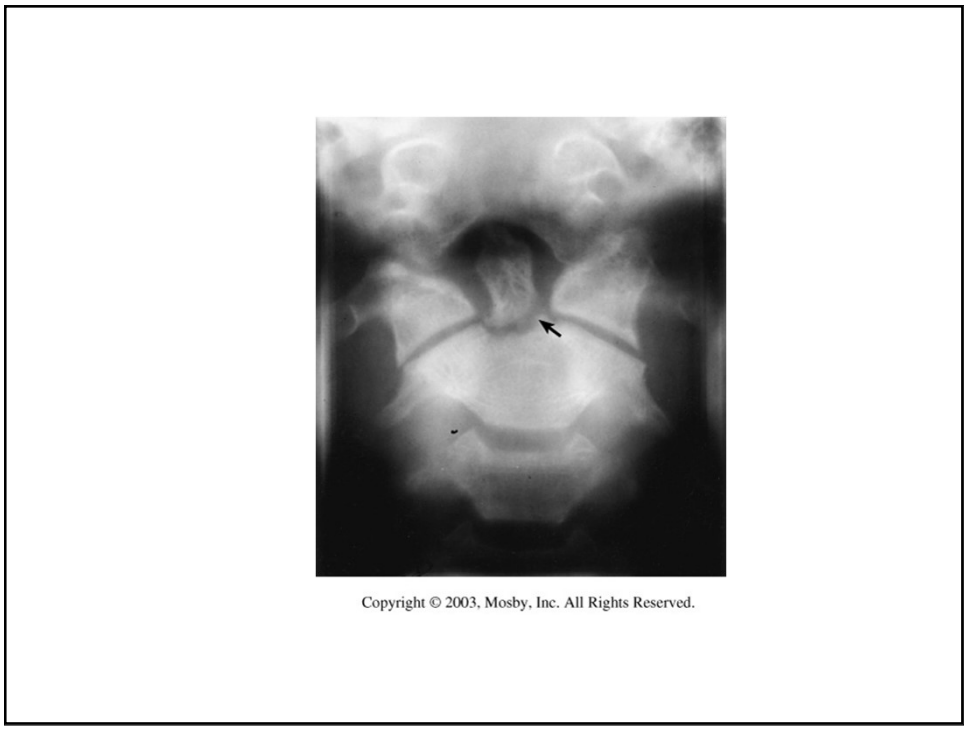
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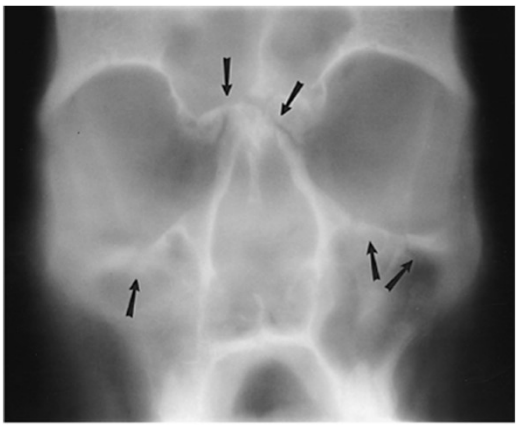

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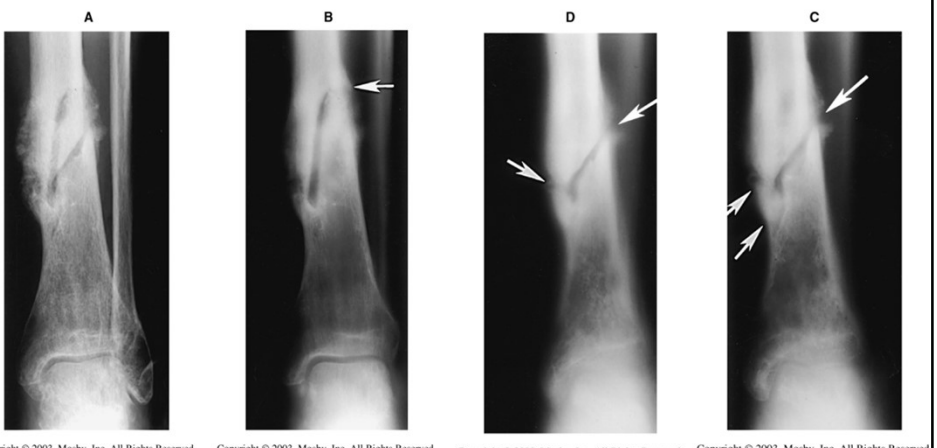

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Digital Tomosynthesis

Term used for digital radiographic tomography

- In one exposure, multiple images are created
- Reprocessing can done and manipulated to recreate various planes without re-exposing patient

GE Difinium 8000

https://www.youtube.com/watch?v=dIxARb7ossA

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Breast Tomosynthesis

3 dimensional mammography

- Tube moves across the breast tissue in an arc
- Captures multiple images at different angles
- Images are reconstructed to create 3D mammography
  - Helps to minimize tissue overlap

http://www.breastimagingvictoria.com.au/news/introducing-the-new-3d-mammogram-machine-with-tomosynthesis

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Tomographic Exposure Factor

Time- most important factor

- Time must be set properly in order to allow the full exposure amplitude
  - Too short (not exposing for the full exposure amplitude= less blur and random phantoms
  - Too long (beyond exposure amplitude) = decrease the density at each end of the exposure amplitude= increase detail=less blur outside of the focal plane
- Must depress exposure switch for full length of exposure

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Tomographic Exposure Factor

mA

- With more complicated motion, low mA stations are necessary to compensate for longer times (stations below 100mA)
  - Lower mA stations: 10, 15, 20, 25, 30, 40, 50

kVp

- Modifications in kVp utilized in making changes with image exposure (since there are essentially more fixed time settings due to the exposure amplitude)
- Decrease scatter – contrast may be a problem; utilization of scatter reducing techniques

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Specialized Techniques

Narrow Angle Tomography (Zonography)

- Utilizes less than a 10 degree angle (exposure amplitude)
- Produces thick sections with good contrast but poor recorded detail
- Useful for identification of structures in which location is unknown (a survey)
  - Example: Lesion on the lung or kidney
- Reasonable contrast but poor recorded detail because of thick section

Wide Angle Tomography

- Produces thinner sections
- Used for good recorded detail but poor contrast
- Useful for small bone structures such as bones of the inner ear

Panoramic Tomography

- Slit scan images of curved surfaces
- Useful with the face, head, and mandible

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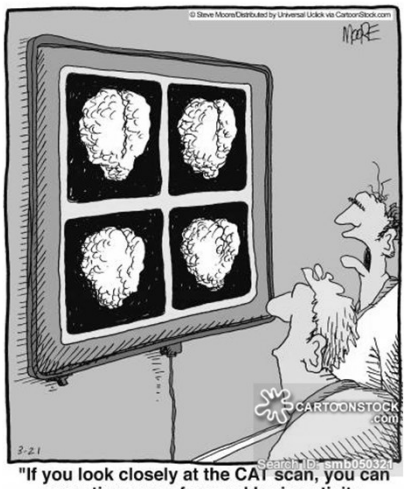

"If you look closely at the CAT scan, you can see a tiny area of normal brain activity. Otherwise, he's got nothing but a headful of useless sports statistics."

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