CT Theory

Introduction to CT Scanning

MRT Program

MRAD 281 – CT Theory

Course Objectives

- Apply your knowledge of anatomy to cross-sectional images.
- Build your knowledge of relational anatomy.
- Identify anatomical structures on CT images.
- Learn about CT imaging techniques and prepare to perform CT procedures in clinical practice.

MRAD 281 – CT Theory

Course Objectives

- Outcome-based learning
  - In clinical practice, time spent in CT
  - Perform exams, achieve clinical competence for basic, entry-level procedures
  - Use textbooks as a guideline, but clinical practice always varies based on Radiologists' preferences

MRAD 281 – CT Theory

- Course Structure
  - Textbook readings
  - Power Points and accompanying presentations
  - Separate Anatomy & Procedure presentations (for most modules)
  - Additional web-based anatomy learning activities
  - Anatomy worksheets
  - CT Procedures case studies
  - Additional Review worksheets before assessments
  - All answer keys will be posted!

MRAD 281 – CT Theory

- Check email often
- Check the course schedule and make note of:
  - Review Class dates (via Blackboard) – bring a second device like a smartphone or tablet
  - Exams
- The following app is strongly recommended…

MRAD 281 – CT Theory

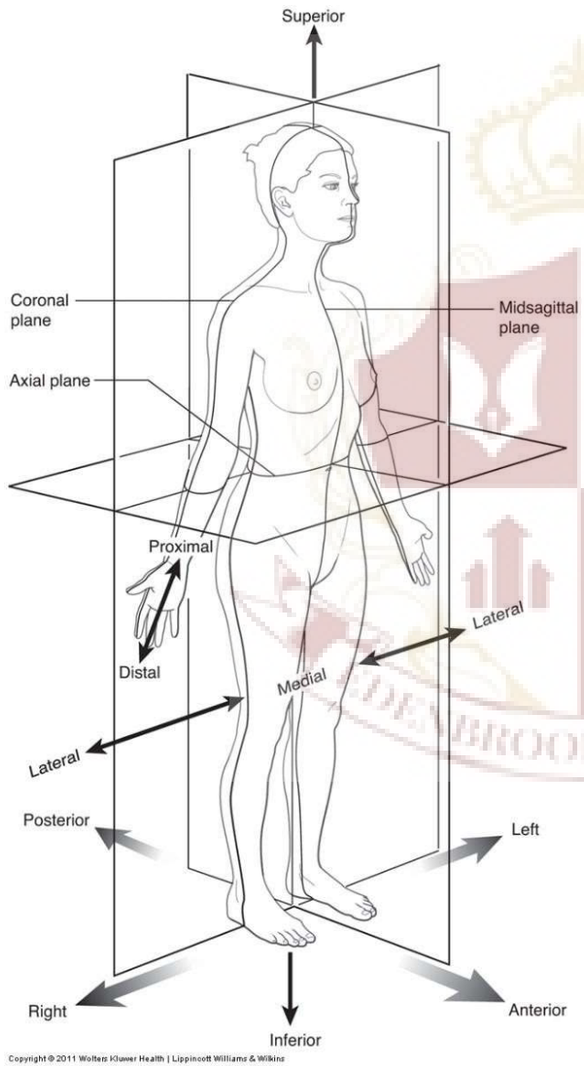


Introduction to CT Scanning

Module Objectives

- Review planes of the body and CT terminology
- Viewing CT images
- A CT procedure: start – finish
- Review important elements of a CT protocol
- Patient communication & preparation
- Post-Processing CT images

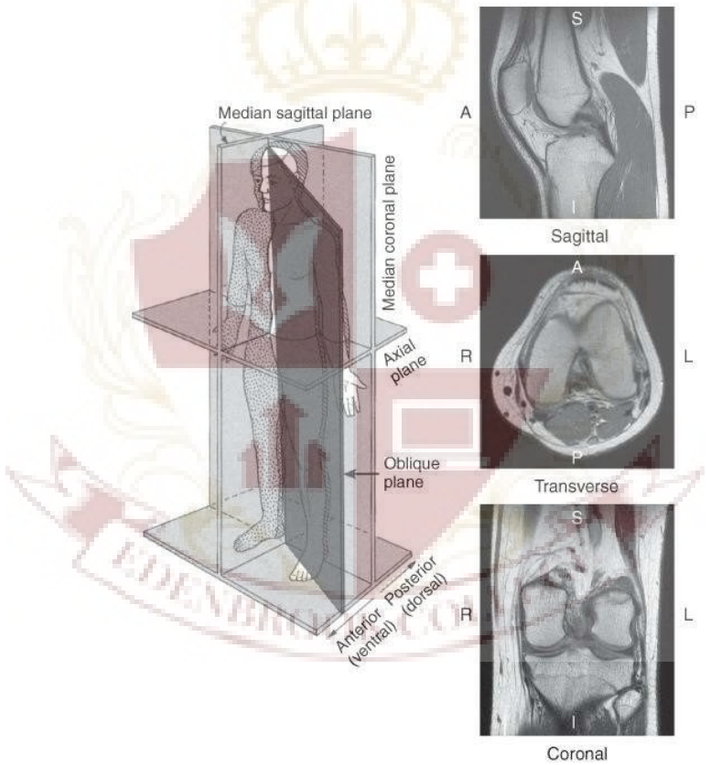
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- Superior / Cephalad
- Inferior / Caudad
- Medial
- Lateral
- Anterior
- Posterior

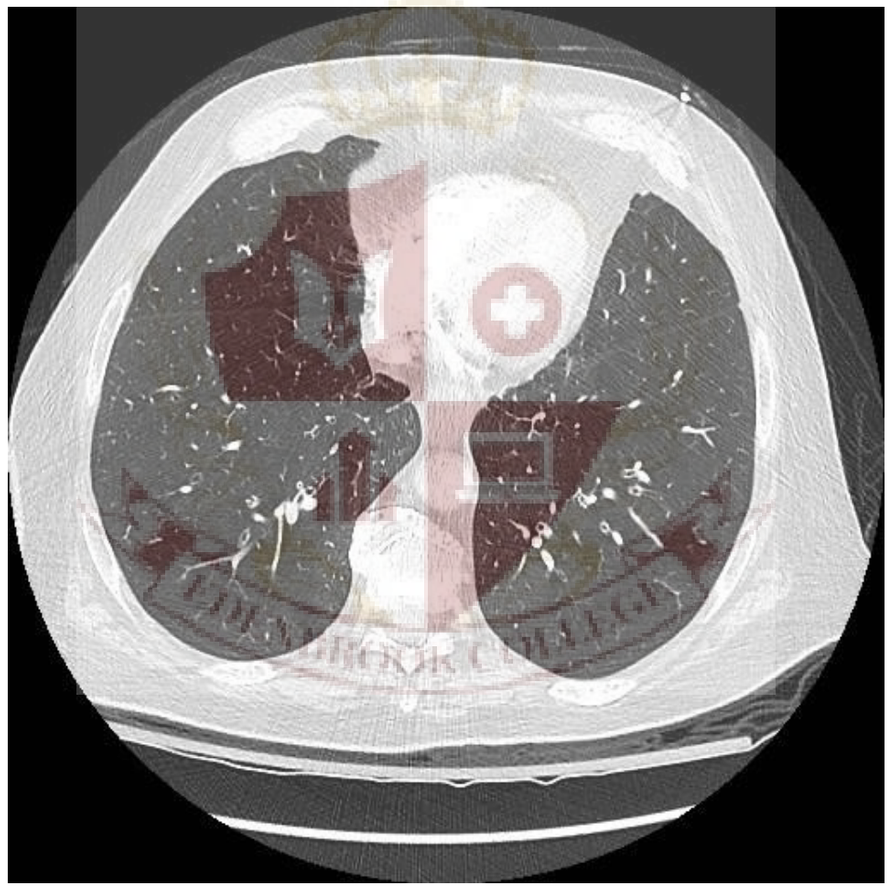
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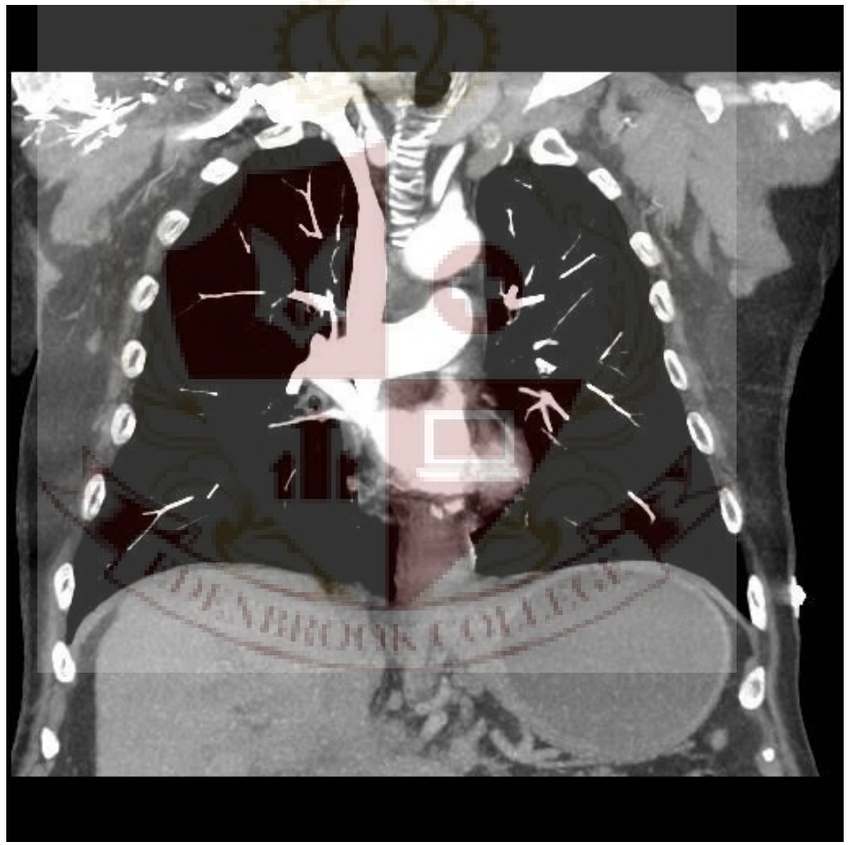


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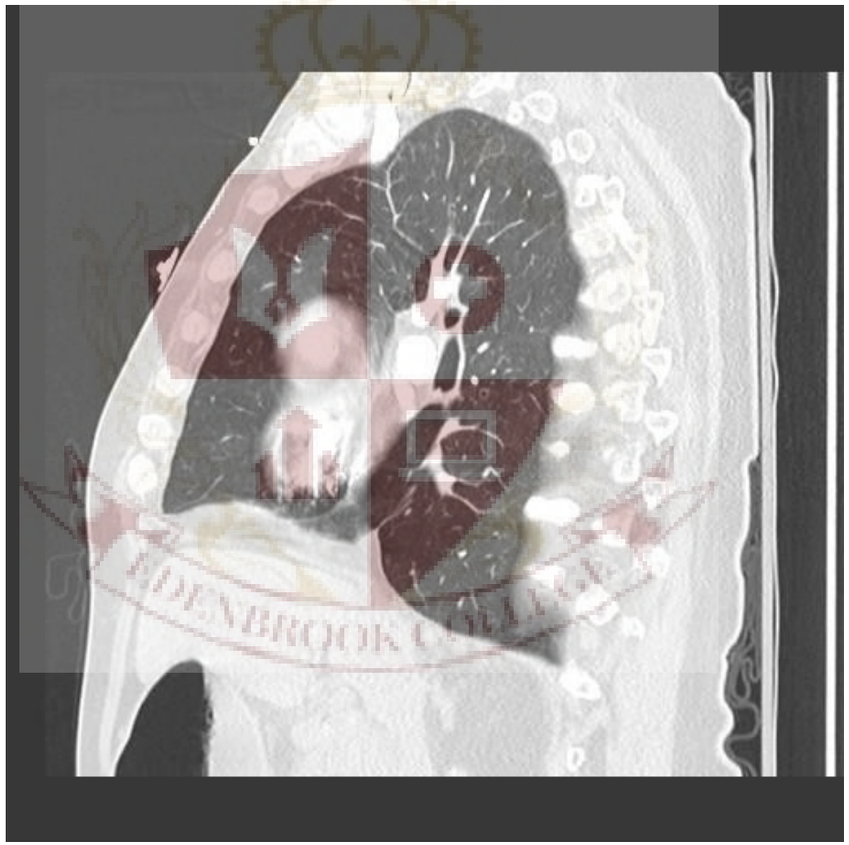
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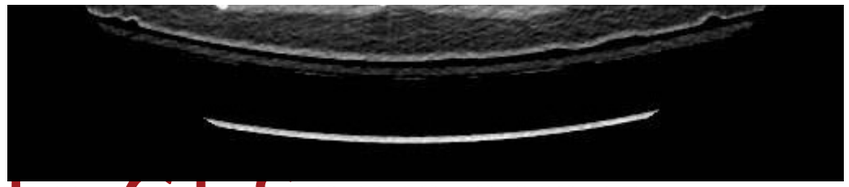
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Anterior

Right

Left



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Posterior

Anterior

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A CT Procedure start – finish

- Patient and/or requisition arrives. Assess clinical information and "protocol" is assigned
- Patient is prepared for appropriate protocol
  - Lab work, suitability for contrast protocol
  - Previous exams, any artifacts?
  - Communication & consent
  - Prepare for IV contrast administration (if applicable)

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A CT Procedure start – finish

3. Position patient in CT scanner and select correct CT procedure



Image Source: https://www.phillymag.com/be-well-philly/05/08/new-heart-disease-screenings/

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A CT Procedure start – finish

3. Position patient in CT scanner and select correct CT procedure



Image Source: http://www.radtechonduty.com/

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Image Source: https://www.healthcare.siemens.com/computed-tomography/

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4. Acquire the Scout Image



Image Source: https://radiopaedia.org/cases/16292/studies/15969

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5. Use the scout image(s) to set up scan parameters.

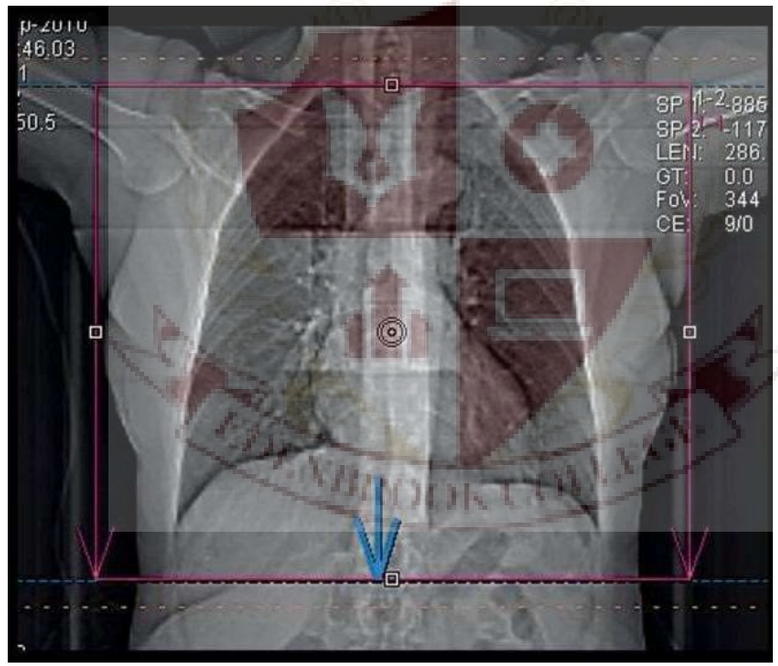
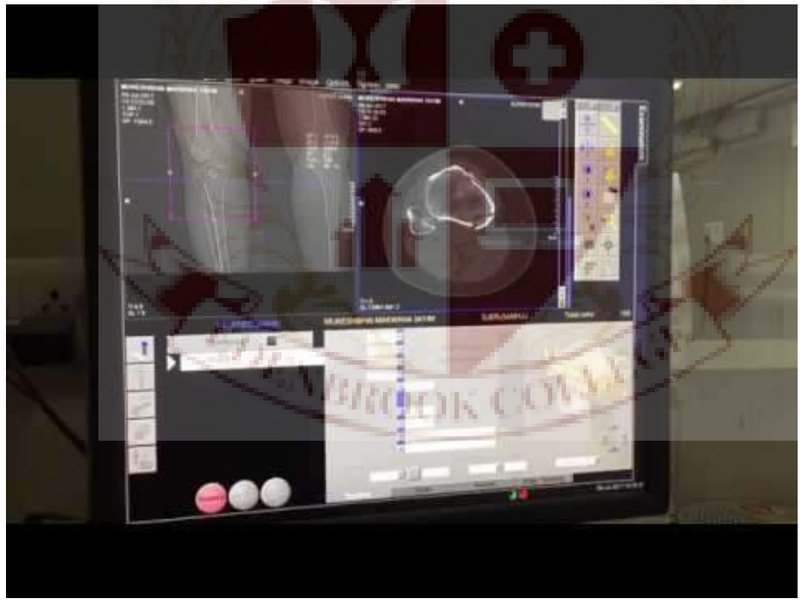


Image Source: https://www.healthcare.siemens.com/computed tomography

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6. Perform the scan, including contrast administration, if required.
7. View images, and ensure scan is complete.



https://www.healthcare.siemens.com/computed

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6. Dismiss & counsel patient
7. Post-processing & storage of images
   - MPR & 3D image reconstruction
   - Retrospective recons
   - Adjust window settings

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Image Source: https://static.healthcare.siemens.com/

Introduction to CT Scanning

CT Protocols – Important Elements

- Clinical Indications
- Scout Position
- Anatomy included
- Contrast
- DFOV & SFOV
- Window Setting
- Reconstructions – MPR, Algorithms, Thickness, etc.

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b. Chest (NECT) (MSH)			
Clinical Indications			
	Cancer screening	F/U lung metastases Contrast media allergies Increased creatinine	
Positioning			
Scout film:	AP		
Position:	Supine, feet first, no gantry angle		
Alternate position:	Supine, head first, no gantry angle		
Area scanned:	Apices → adrenals		
Contrast Media			
IV contrast volume:	N/A	Scan delay:	N/A
IV contrast rate:	N/A	Oral contrast:	N/A*
Scanning Technique			
Slice collimation:	64 x 0.5 mm	kV:	120 kV
Pitch:	0.8	Auto mA range:	100 - 120 mA**
Interpolation:	360^0	Gantry rotation time:	1 sec
Scan FOV:	L / 400 mm	Table speed:	25.6 mm/rot
Zoom FOV:	Fit to patient	Breath hold:	Inspiration
Reconstruction thickness:	3 mm	Algorithm:	Standard
Reconstruction increment:	2.5 mm	2^{nd} algorithm:	Lung
Reconstruction thickness for 3D	N/A	Filter:	Per protocol
3D technique:	N/A	MPR:	Coronal
Image Storage			
Window level (standard):	50	2^{nd} window level (lung):	-600
Window width (standard):	400	2^{nd} window width (lung):	1200
Comments			
* *Esopho-Cat* may be indicated if esophagus to be examined.			
**Decrease mA if scan is for cancer screening			

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Activity – Review Worksheet

Pause here and complete the Review Worksheet posted in theIntroduction to CT Scanning module.

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<u>Patient Preparation</u>

- Lab Work - what tests?

  ✓ BUN (blood urea nitrogen)
  ✓ GFR (glomerular filtration rate)
  ✓ Creatinine

- Why are these tests important in CT?

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Patient Preparation

- Medical History & Consent
  - ✓ Renal Function
  - ✓ Allergies
  - ✓ Surgeries
  - ✓ Thyroid Conditions
  - ✓ Diabetes
  - ✓ Hypertension / Heart Condition
  - ✓ Pregnancy & Breastfeeding

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Patient Preparation

- Explanation of the procedure
- You will find efficient and effective phrases to explain to your patient.
  - ✓ Explain what you're going to do, and how it's going to feel.

  Example: I am going to inject contrast into your IV, and it is going to give you a warm, flush sensation. That is normal.
  - ✓ Give the patient an approximate time frame.

  Example: That warm feeling will be intense for about 15 seconds, and you should feel normalagain in a few minutes.

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Patient Preparation

- Explanation of the procedure
  - ✓ Speak clearly and concisely
  - ✓ Ask questions to ensure your patient understands
  - ✓ Be a good listener, nod and make eye contact
  - ✓ Use language your patient can understand
  - ✓ Answer questions, and seek clarification when needed
  - ✓ Be aware of fears and claustrophobia
  - ✓ Explain as you go

Introduction to CT Scanning

NECT – Non-Enhanced CT

CECT – Contrast-Enhanced CT

- Scan Delay is important!
- Arterial Phase
- Venous Phase
- Delayed Venous Phase
- Multi-phase scans
- How do you decide if a scan is done in arterial or venous phase?

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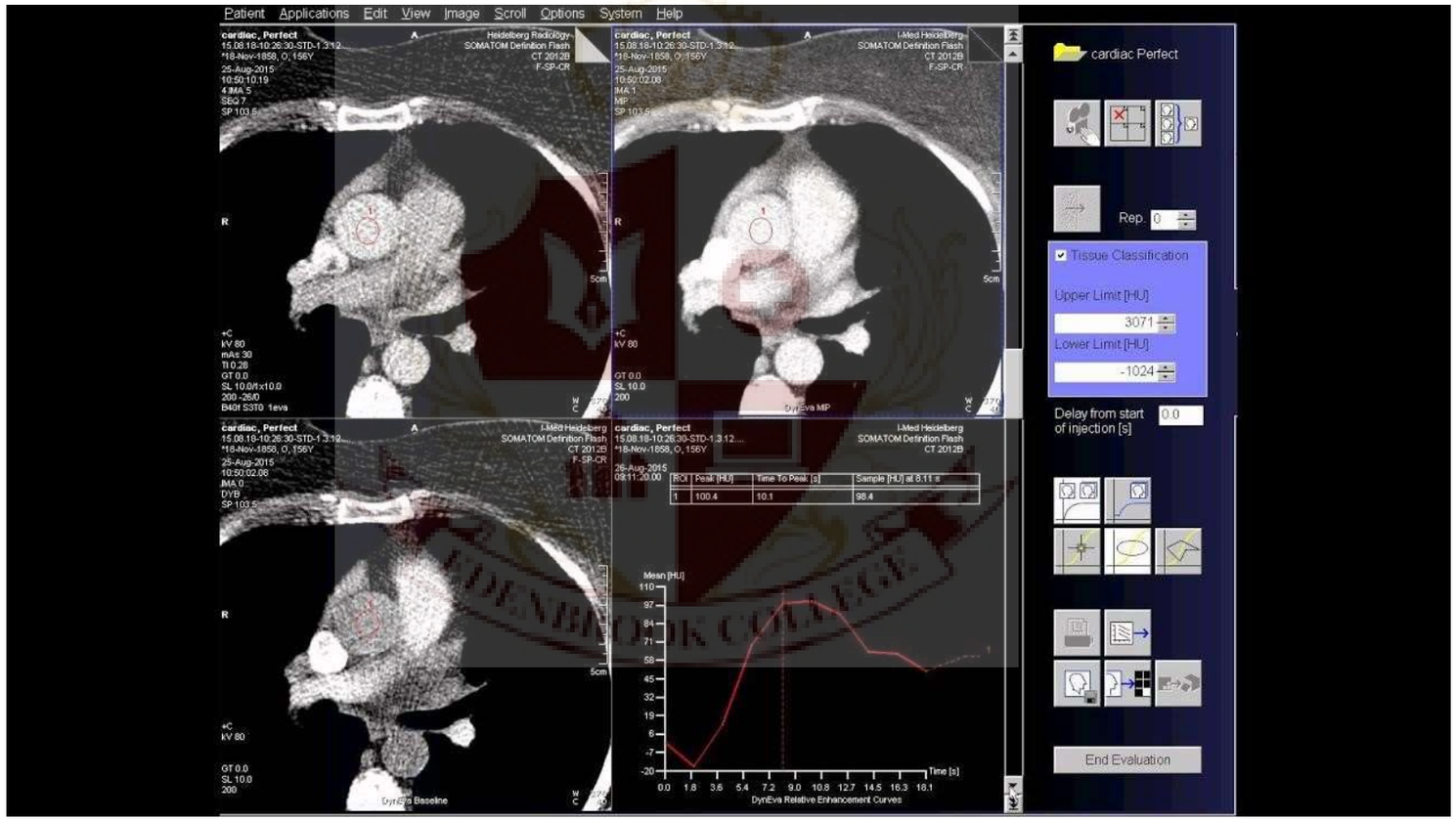
- Refer to Table 13-1 in Romans Textbook (page 156) for general rules regarding scan delay:
  - Early arterial
  - Late arterial
  - Portal Venous
  - Excretory
- How does a technologist determine how to time a scan?

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Scan Timing Methods

- <u>Bolus Triggering</u>
- Aka Bolus Tracking or Smart Prep
- Select target location from the scout image (example – at the level of the carina)
- Acquire Reference image
  - Set ROI on the vascular structure of interest
- Inject entire contrast bolus
- Acquire low-dose scans at selected level (usually 2 s apart).
- Monitor attenuation within the ROI
- Scan is triggered when HU threshold is reached.

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- Scan Timing Methods
  - Test Bolus
  - Aka Timing Bolus, Tracking Bolus, Sample Bolus
- Select target location from the scout image (example – at the level of the carina)
- Acquire reference image
  - Set ROI over vascular structure of interest
- Administer a small amount (10-20 ml) of contrast while acquiring several low-dose scans.
- Determine the time required for peak enhancement within the ROI.
- Perform the scan, injecting entire contrast bolus using the calculated scan delay required for peak enhancement.

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- Bolus-Triggering
- Advantages
  - Efficient - One injection of contrast
  - Lower radiation dose (less images acquired)
- Drawbacks
  - Patient monitoring for extravasation
  - Lag time (3-9 seconds for table to move into start position)

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- Test Bolus
- Advantages
  - Tailored to individuals' cardiac output
  - Peak contrast enhancement (best image quality)
  - Patient monitoring for extravasation
- Drawbacks
  - Higher radiation dose (more images acquired)
  - 2 injections required
  - Less efficient
    - Potential for patient motion

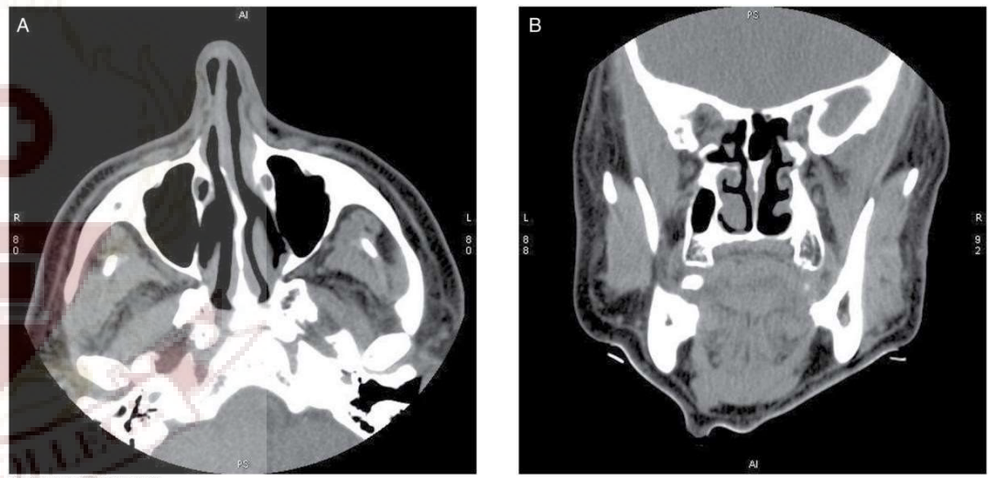
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Post-Processing

- According to department protocols, the technologist must ensurethe correct images are sent to PACS to aid in diagnosis.
- MPR – create series in new imaging planes
- Adjust technical parameters
  - WW and WL
  - Slice thickness & increment
  - Reconstruction Algorithms
  - Retrospective reconstructions (alter DFOV/target)
  - 3D imaging

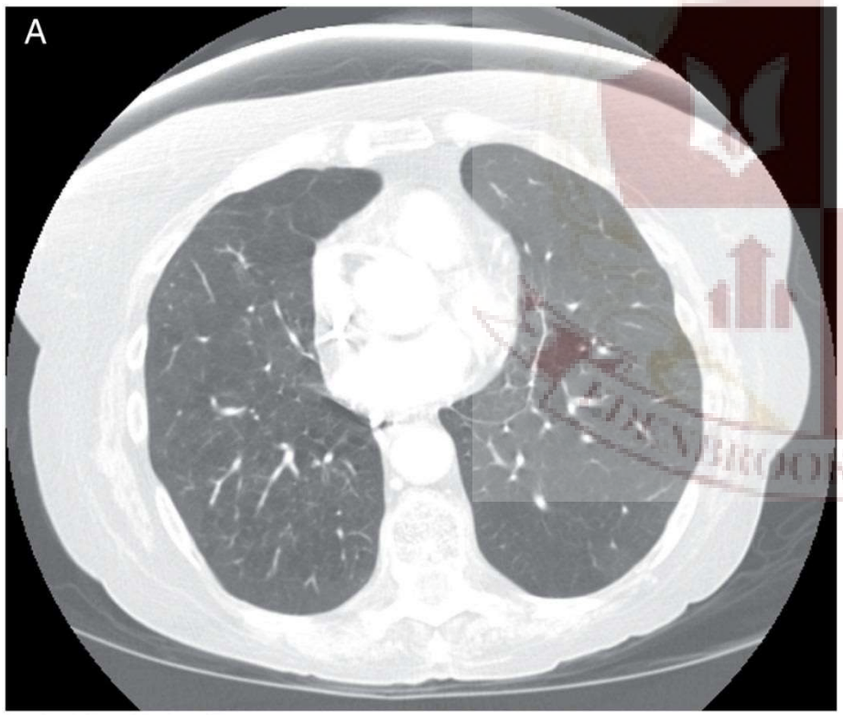
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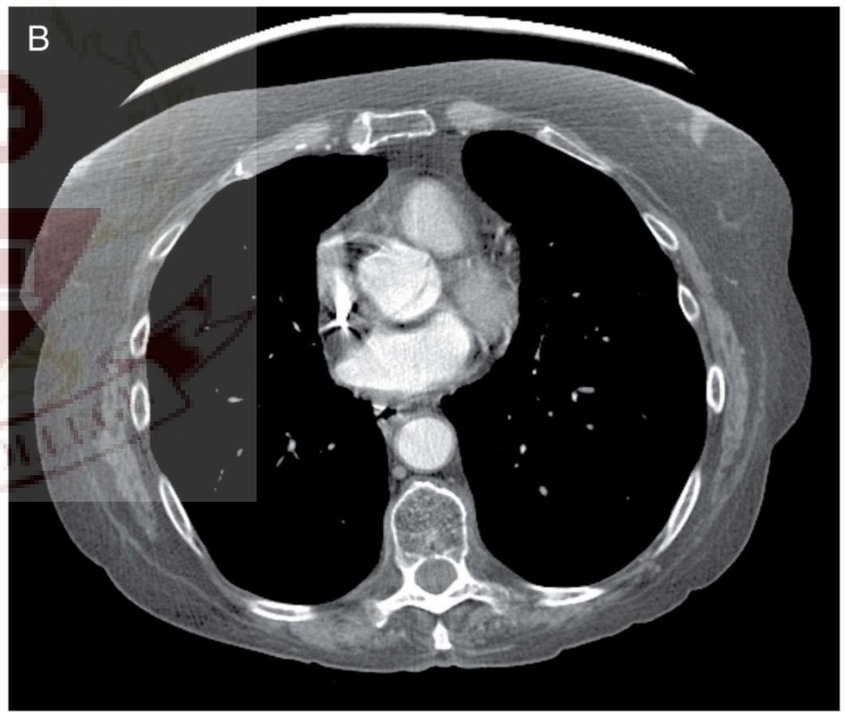
- MPR - Create Coronal, Sagittal, Oblique series from the axial raw data acquired.



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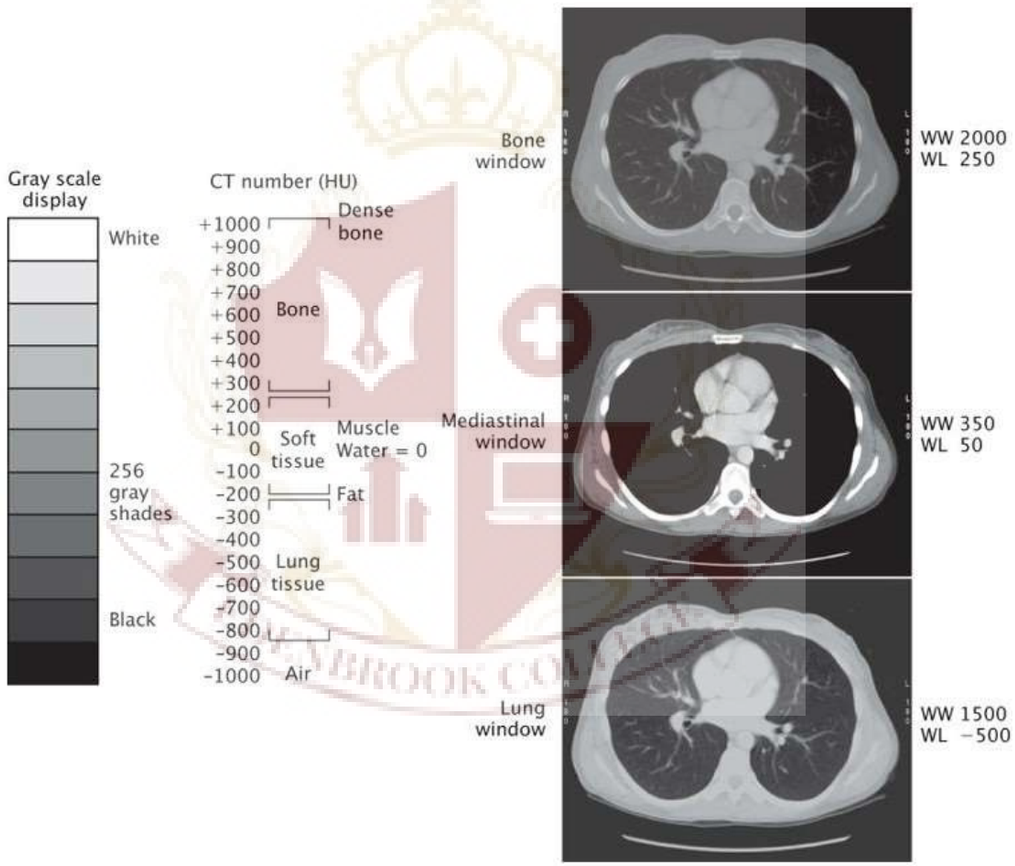
- Adjust WW and WL
- What's the difference below?





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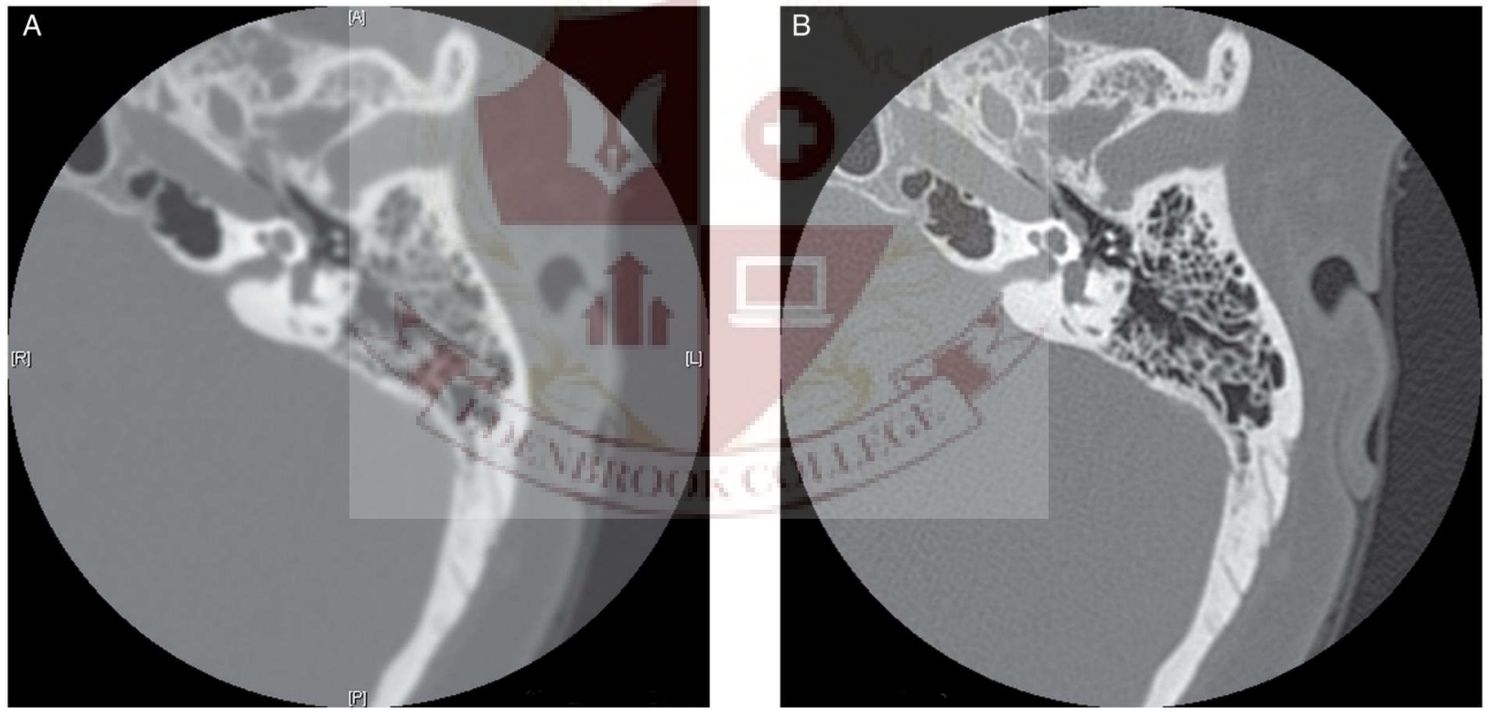
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- Adjust slice thickness and/or apply reconstruction algorithm
  - Done by computer software – often built into the program / protocol selected
- Some examples:
  - Smooth data – reduce the difference between adjacent pixels (reduce artifacts) which improves contrast resolution
  - Sharpen data – accentuate the difference between adjacent pixels which optimizes spatial resolution

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- Internal Auditory Canal
- Bone filter applied to Image B to optimize spatial resolution



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- Retrospective Reconstructions
  - Change DFOV and/or target to produce image series from within raw data acquired.
- Some examples:
  - SFOV is large, to include all of abdomen
  - Post-processing, change isocenter and DFOV to produce image series of theL-spine.

Introduction to CT Scanning

- Summary

1. Apply knowledge of CT physics and instrumentation to elements of a CT protocol.
2. Technologist is responsible for obtaining a thorough medical history, informed consent, and patient communication to ensure a safe outcome and high quality images.
3. Apply knowledge of CT physics and post-processing tools to optimize image quality to aid in diagnosis.

Introduction to CT Scanning

- Additional Learning Activities
  - ✓Online Activities for Introduction module
  - ✓Module Self-Test

