

CHEST IMAGING: CT Studies

LONG H. TU & AMI RUBINOWITZ

CT Chest

Chest CTs requested for numerous indications inclusive of pleural, lung parenchymal, and mediastinal processes. The overall organization of my process is to do the usual pre-evaluation checks, look at the localizer images, then move on to the airway/pleura/lungs. I then use a structured approach through the mediastinal structures, lower neck, upper abdomen, and chest wall. Common blind spots include the airways, diaphragmatic pleura, incidental neck, abdomen, and chest wall structures. Basically, remember to look at *all* non-cardiopulmonary structures.

1. Quickly form a gestalt of the study.

- a. Scroll through the thicker (5mm) sections once or twice, comparing the study to your internal model of what a normal patient looks like.
- b. This is also an opportunity to triage a study if largely unremarkable or grossly abnormal on first pass.
- c. Look at the area(s) of concern.
- d. Remember to compare to prior studies when available and to mention if there were prior abnormalities that have resolved, improved, are similar, or have worsened.

2. Always check the scout (localizer) images.

- a. This is often skipped on cross sectional imaging and leads to misses which may affect management or else open you up to liability. You are responsible for every finding here too, even if not included on the acquired CT images.
- b. Quickly go through the anatomy as if you were looking at a plain film of the chest.
- c. Pay special attention to parts of the body that are imaged on the localizer images that may not be seen on the cross-sectional images.
- d. The localizer images also provide a good first look at support devices and any free air or obvious large pathology.

3. Check the history, indication, and priors.

4. Assess adequacy (of the cross-sectional images provided).

- a. Be aware of the technique and any limitations.
- b. Do you have thin reconstructions, MIPs, sagittal and coronal reformats?
- c. Is the entire thorax included?
- d. Is the study motion degraded?
- e. Are there other artifacts?

5. Start with the visceral chest.

6. Assess any support devices.

- a. Check that the ends and any side holes of tubes are appropriately positioned.
- b. Look for complications of support devices.
- c. Make sure that intravascular devices/lines still have soft tissue density around each portion of its course. If you cannot see this, consider chronic thrombosis.

7. Check the airways.

- a. Is the trachea patent, normal in caliber and course? Is the tracheal wall thin and smooth? Is the patient in inspiration or expiration?
- b. Follow the airways to the segmental and subsegmental level, looking for a filling defect, stenosis, or extrinsic compression. It can be useful to name the segmental bronchi to each lobe, in case the patient has had prior resection or if one is obstructed.
- c. Endobronchial lesions are easy to miss and constitute a disproportionate share of undetected cancers.
- d. Assess the bronchi for caliber and wall thickness. Is there bronchiectasis or bronchial wall thickening?

8. Examine the pleura.

- a. Look for effusion and pneumothorax. What is the density of any effusion? Does the effusion layer dependently or is it loculated? Is there pleural thickening? Are there pleural nodules, masses, plaques, or calcification?
- b. Look closely at the diaphragmatic pleura, where multiple planes can be helpful. This is a common blind spot.

9. Examine the lungs.

- a. Check for obvious processes first, such as consolidation, masses, ground glass opacities.
- b. Look for tubular densities which may represent abnormal vessels, vascular lesions, or mucous impacted bronchi.
- c. Look for abnormal lucencies (emphysema, lung cysts, honeycombing, mosaic attenuation/air trapping).
- d. Look at the interstitium for septal thickening, scarring/atelectasis, reticulation. Make sure the peripheral surface (or “cortex”) of the lung is clear, and make sure the bronchovascular bundles and the fissures are smooth.
- e. Look for nodules and masses (solid as well as ground glass).

- f. If available or producible, use MIPs to search for small nodules. These improve both efficiency and sensitivity.
- g. Common blind spots are central areas (next to vasculature and the hila), as well as the lung bases near the diaphragm.

10. Examine the heart.

- a. Check the pericardium for effusion, thickening, calcification, or any mass lesion.
- b. Assess the overall size of the heart, as well as the size of each chamber.
 - i. Look for wall thinning, abnormal contour, or evidence of prior infarct.
- c. Check each of the chambers for a mass lesion, thrombus, or abnormal calcification.
 - i. Pay special attention to the left atrial appendage, posterior left atrial wall, left ventricular apex, and any area seen to have evidence of prior infarct.
- d. Check for aortic valve calcifications.
- e. Check if there are artificial valves, and if there are any abnormal densities associated with them which potentially could represent vegetations.
- f. If any devices are present, make sure their location is appropriate (ie: LVAD, pacemaker/AICD wires).
- g. If an indwelling catheter is present, make sure there is no catheter-associated thrombus along its course, including in the right atrium.

11. Assess the vasculature.

- a. Take a quick look at the SVC and its tributaries in the neck. Take a quick look at the hepatic veins and IVC.
 - i. Clot/mass, web, and non-visualization are the major things you are looking for.
 - ii. This may be most efficiently done on the coronal reformats.
 - iii. Note any abnormally prominent collaterals.
- b. Assess the pulmonary arteries.
 - i. Look for filling defects (bland thrombus, webs, tumor emboli) in the main, lobar, segmental, and subsegmental branches.
 - ii. Use coronal reformats, and look very carefully at the small, inferior most branches – this is where subtle emboli can be missed.
 - iii. Assess the overall size and caliber of the pulmonary arteries (too big, too small, focal aneurysms or stenoses).

- c. Take a quick look at the pulmonary veins.
 - i. Note their number, caliber and configuration.
 - ii. Check if they are dilated (nondependent veins larger than dependent veins).
 - iii. Look for filling defects or mass lesions.
- d. Assess the coronary arteries.
 - i. Is there abnormal origin, course, or caliber?
 - ii. Be especially vigilant for inter-arterial coronary artery courses.
 - iii. Is there calcification out of proportion to age?
- e. Assess the aorta.
 - i. Look for aneurysm, dissection, and pseudoaneurysm.
 - ii. Assess the branching pattern at the aortic arch and quickly follow the arch vessels to the edge of the study, looking for dissection, aneurysm, and stenosis/cutoff.
 - iii. Check the wall, looking for calcification, irregular plaque, or protruding atheroma.
 - iv. Check for evidence of prior surgery.
 - v. Check the great vessels arising from the aorta: brachiocephalic artery, subclavian and common carotid arteries.
 - vi. Look for circumferential thickening and perivascular inflammatory changes.

12. Assess the visualized lower neck.

- a. Check the thyroid for nodules/masses, atrophy or enlargement.
- b. Check the supraclavicular fossae, cervical levels, and any other visualized neck anatomy for adenopathy and masses.
- c. Check the IJ veins for thrombus.

13. Search the thoracic lymph nodes sites.

- a. Look at the axillary/subpectoral regions, mediastinum, and hila.
 - i. Mediastinal lymph nodes may be separated into superior, anterior (prevascular), middle (visceral) and posterior (paravertebral) mediastinum. Search each site one by one.
 - ii. Another approach would be to go from top to bottom, then in an anterior to posterior direction in the mediastinum.
- b. The sites could be more specifically enumerated.
 - i. They include axillary, subpectoral, internal mammary, prevascular, right and left paratracheal, pretracheal, AP window, precarinal, subcarinal, azygoesophageal recess, paracardiac/cardiophrenic, paraaortic, paraesophageal, and hilar.

14. Assess the remaining mediastinum.

- a. Look for mass lesions or soft tissue thickening around vessels or other structures.
- b. Also check for fluid or air in the mediastinum.

15. Examine the esophagus from its cervical portion through the diaphragmatic hiatus.

- a. Look for thickening/mass lesions (fluid/debris, foreign body), dilation, hiatal hernia, and postsurgical changes.

16. Examine the visceral abdomen/pelvis.

- a. Check for free/extraluminal air.
- b. Look at the liver, biliary tree, gallbladder, pancreas, stomach, bowel, spleen, adrenal glands and visualized kidneys.
- c. Check the vascular structures in the upper abdomen (for aneurysms, clot, thrombosis, etc.)
- d. Look for enlarged lymph nodes, ascites, mesenteric stranding or soft tissue nodules.

17. Assess the osseous structures.

- a. A quick look on the coronal/sagittal reformats will allow you to assess overall bony morphology and density, look for lytic or sclerotic lesions, degenerative change, spinal compression fractures, and the overall distribution of pathology.
- b. First, assess any hardware that may be present.
- c. Check the mandible and hyoid if they are visible.
 - i. Assess any other incidentally imaged osseous structures in the head/neck.
- d. Examine each humerus, scapula, and clavicle separately.
 - i. Check the glenohumeral and sternoclavicular joints for abnormalities (fluid, abscess, degenerative changes, and alignment).
- e. Examine the sternum in multiple planes.
 - i. Look for peristernal fluid collections which may indicate abscess or be a tip off that a fracture is present.
- f. Examine the ribs.
 - i. Coronal and sagittal reformats are helpful here.
 - ii. This may be done one by one, or in groups – the anterior aspect of each rib first, then the lateral, then posterior. The costosternal junctions are a potential blind spot, as they are normally irregular in appearance. Fractures and other osseous lesions are easily missed if you do not look carefully.

- g. Check any incidental upper extremities (arms positioned over a patient unable to lift them) or other accidentally imaged body parts.
- h. Assess the spine
 - i. Look at the posterior elements (posterior arch and spinous process) separately. Assess for cortical disruption/fracture, sclerotic/lytic lesion, soft tissue mass, and erosion.
 - ii. On the sagittal images, look for alignment of the anterior vertebral, posterior vertebral, and spinolaminar lines. Look for preservation of bony mineralization at each vertebral body. Again, assess for cortical disruption/fracture, sclerotic/lytic lesion, soft tissue mass, and erosion.
 - iii. Look for preservation of vertebral body and disc height.
 - iv. Quickly assess the spinous processes on the sagittal images, and evaluate the pedicles on both the axial and coronal views.
 - v. Look for congruence of the facet joints.
- i. Assess the spinal canal, which is easily done on the sagittal reformatted images.
- j. Quickly assess the neuroforamina on axial and parasagittal images.
- k. Check the paraspinal soft tissues for any fluid collections or abnormal soft tissue.

18. Evaluate the musculature.

- a. Look for mass lesion, abnormal calcification, asymmetry, atrophy and expansion. These may reflect denervation, neoplasia/hematoma, or congenital abnormality. Look for subtle loss normal fibrillar architecture, which may be the only sign of an infiltrative mass.
- b. First, assess the rotator cuff muscles and other muscles associated with the upper extremity (latissimus dorsi, trapezius, teres major, serratus anterior, etc.)
- c. Then, look at the remaining muscles of the upper back and chest wall. Pay special attention to the fibrillary pattern.
- d. If IV contrast was given, check the muscles for any enhancing lesions (metastases, vascular malformations, etc.)

19. Assess the remaining subcutaneous soft tissues, i.e. breasts, subcutaneous fat and skin.

- a. This is another common blind spot.
- b. Look for nodules/masses or abnormal thickening.
 - i. This is especially important in the work-up of the oncology patient.
 - ii. Also look for collections, edema/anasarca, soft tissue defects, subcutaneous emphysema, calcification, foreign bodies.

- iii. Subtle skin lesions can often be picked up when viewing the bone windows.
- iv. Check the breast tissues specifically for the same.
- c. If you see collateral vessels along the chest wall, then go back and search for a potential cause (is there venous thrombosis or stenosis?).
- d. Findings at the edges of the study are easy to miss, especially areas where the patient comes up against the FOV margins.

20. Perform a few last checks and proofread.

- a. Are the findings explained by one or a few underlying etiologies? Is there congruence between the clinical history and imaging findings?
- b. It can be useful to take one last overall look at the study once you've completed your more systemic search.
 - i. Did you miss any potentially life-threatening findings (PE, acute aortic pathology, other vascular catastrophe, large infectious/inflammatory process, air where it shouldn't be)?
 - ii. Did you evaluate for etiologies relevant to the clinical question?
 - iii. Did you compare the study to any prior exams (if available)?

An Abbreviated Checklist for the CT Chest

- 1. Triage/gestalt**
- 2. Scout/localizer images**
- 3. History, indication, priors**
- 4. Adequacy, technique, limitations**
- 5. Support devices**
- 6. Visceral Chest**
 - a. Airways/pleura/lungs.
 - i. MIPS
 - b. Heart.
 - i. Size, myocardium, chamber lumen
 - ii. Pericardium
 - iii. Coronary arteries, valves
 - c. Vessels
 - i. SVC, IVC, tributaries
 - ii. Pulmonary arteries, pulmonary veins
 - iii. Aorta, aortic branches.
 - d. Lymph nodes stations
 - i. Axillary, mediastinal, hilar
 - e. Mediastinum, esophagus
- 7. Extrathoracic viscera**
 - a. Lower neck/supraclavicular fossae
 - b. Upper abdomen
- 8. Other**
 - a. Bones, bone reconstructions
 - b. Spinal canal
 - c. Musculature
 - d. Remaining subcutaneous tissue
- 9. Last checks**