Body CT Protocol Guide

Basic Protocol Guidelines

- Check if indication is appropriate.
- Check prior studies (if available) for recommendations.
- Check renal function.
- Confirm patient has no allergy to iodinated contrast. Transplant surgery or transplant nephrology approval needed in patients with transplant kidney for IV contrast administration.

Image acquisition techniques following IV contrast administration

- Fixed timing
    - Scan after a delay following contrast injection.
        - Used for standard CT abdomen and pelvis with IV contrast, venous CTA.
- Bolus tracking
    - Timing for phases (arterial and portal venous) determined by when trigger fires.

IV contrast phases

- Arterial phase
- Portal venous phase
- Corticomedullary phase: 60-80 sec
- Nephrographic phase: 90-120 sec
- Excretory: 3min +
- Venous phase: 130 sec

*Please note there will be some variation based on injection rate.

*The timing is relative to the start of injection.

*Timing of phases also depends on scanner detector array, rotation and table speed.

- "CTA" means additional post processing is done in 3D lab.

PO contrast:

- Need to specify oral contrast for all studies.

Standard Arterial CTA Abdomen / Abdomen and Pelvis

Indications (examples):

- Abdominal aortic aneurysm, acute aortic syndromes (eg: dissection, mural thrombus, and ulcerated plaque).
- Mesenteric ischemia.
- Preoperative suitability for endovascular aortic aneurysm repair (EVAR), aortic or branch vessel anatomy.

Protocol:

- Can be single arterial phase or multiphasic (in which case the specific phases must be designated).
- No oral contrast.
- Coronal and sagittal MIPs and MPRs, volume rendered 3D.

Considerations:

- See if non-contrast images are needed.
    - In suspected acute aortic syndromes, non-contrast images are needed to detect intramural hematoma particularly in the chest.
    - If the patient is status post aneurysm repair, need non contrast images. *See CTA aortic stent graft protocol below
    - In case of suspected dissection include pelvis.
- Check if study is to evaluate IVC. *See venous CTA below
- Determine if chest should also be included.

High yield tips and common pitfalls:

- If pathology involves the common, internal and external iliac arteries, study should be “Standard Arterial CTA Abdomen **and** Pelvis”.

- In time sensitive acute situations such as suspected aortic rupture, a non-contrast CT would suffice.

Aortic Stent Graft CTA

Indications (examples):

- Evaluate for complications post *endovascular repair* such as endoleaks, increased size of the aneurysm, stent migration, kinking.
- Evaluate for complications post *graft repair* of aneurysm such as anastomotic pseudoaneurysms or suture dehiscence.
- This protocol can also be used for acute bleeds emergently.

Protocol:

- Similar to standard arterial CTA abdomen / pelvis but also includes non-contrast images.
    - To differentiate hyperdensities such as calcifications or thrombus from contrast.
- Often includes delayed phase images.
    - These are venous phase and need to be specifically stated in the comments section of the protocol in EPIC.

Considerations:

- In a patient with known aortic aneurysm, determine if they already underwent repair as well as type of repair (eg: *endovascular stent* or open surgical *synthetic graft*).
- For evaluating complications of endovascular stent repair (eg endoleaks), non-contrast images and delays are necessary.
- Determine which parts of aorta and its branch vessels the repair involves.
- If repair involves thoracic aorta, will need gated images of chest.

Renal Donor CTA

Indication:

Evaluation of potential kidney donors including vascular anatomy, kidney morphology, and incidental findings in that would affect donor status.

Protocol:

- Multiphasic
    - Non contrast images from top of kidneys to iliac crests.
    - Arterial phase.
    - Nephrographic phase (90-100 seconds after start of contrast injection)
        - From diaphragm to symphysis pubis.
    - Excretory phase (10 minutes after arterial phase).
        - From diaphragm to symphysis pubis.
- Patient is prone for excretory phase (if able).
- 3D post processing images
    - Coronal and Sagittal MIP reconstructions of each phase.
    - Volume rendered reconstructions of excretory phase and arterial system.
    - Renal volumes
- No oral contrast.

CT Angio Abdomen and Pelvis with Runoff

Indications (examples):

- Global evaluation of abdominal and peripheral vascular disease.
- Aide vascular surgeons in treatment / pre-operative planning.

- Evaluate vascular injury in trauma.

Protocol:
- Single arterial phase
    - Scan through feet.
- No oral contrast.
- 3D post processing.

Considerations:
- If only one leg is of interest (eg in the case of penetrating trauma) abdomen, pelvic and contralateral leg can be omitted.
    - Smaller FOV can be used to for better detail of the extremity which is of interest

GI Bleed CT

Indication:
Detect active GI bleeding (> 1.0 cc/min).

Protocol:
- Multiphasic
    - Non contrast.
    - Arterial phase.
    - Portal venous phase.
- No oral contrast as this can obscure bleed within GI tract.

Considerations:
- Check recent studies for residual contrast within GI tract which can obscure bleeds.
- Slow GI bleeds (<1.0 cc/min but >0.1 cc/min) are undetectable on CT and may need tagged RBC study.

Venous CTA

Indication:
Assess abdominal or pelvic venous pathologies (this includes IVC).

Protocol:

- Single phase.
    - Scanned at 120 seconds following injection of IV contrast (no PT3 bolus tracking).
    - Aim is to allow all veins to opacify.
- Use 150cc IV contrast and 1.5cc/sec injection.

Considerations:

- Do not need arterial phase if study is only to evaluate venous disease.

CT Enterography

Indications (examples):

- Evaluate for inflammatory bowel disease.
- Detect occult GI bleeding.

Protocol:

- Single portal venous phase.
    - From diaphragm to symphysis pubis (essentially CT abdomen pelvis with IV contrast).
- Low density oral contrast (volumen).
- Patient must be NPO for at least 4 hours prior to study.

Considerations:

- In evaluating inflammatory bowel disease, the low density oral contrast distends intestines and highlights mural enhancement.

Triphasic Liver CT (HCC protocol)

Indications (examples):

- Detection and characterization of hypervascular liver tumors such as HCC.
- Characterization of indeterminate liver lesions greater than 1cm in size.
- Evaluate treatment response following TACE or SIRT.
- Triphasic CT is specifically designed for screening and follow up of known or suspected HCC in patients with cirrhosis.

Protocol:

- Three phases.
    - Late arterial.
    - Portal-venous.
    - Delayed (2 minutes).
- Pelvis may be included on venous phase.
- 5mm and 1.5mm reconstructions.

Considerations:

- Read the indication carefully and determine whether need to include pelvis on portal venous phase.
- If unsure, look for ordering physician's note or prior imaging reports for specific recommendations (i.e. an MR may have been recommended instead of CT).

- In case of doubt, do not hesitate to ask someone with more experience (upper level resident or attending).

High yield tips and common pitfalls:

- **Triphasic vs Biphasic liver CT.**
    - In **triphasic liver CT,** delayed phase images (2 min) are also obtained.
        - Allow for better delineation of tumor washout which is crucial information.
    - The ordering clinician may not know the difference so this is where we can add value. Plus, ordering the right test will make our jobs easier and potentially save time, resources, and money.

Biphasic Liver

Indications:

Detection and characterization of hypervascular liver tumors such as neuroendocrine tumors that do not need a delayed phase.

Protocol:

- Two phases.
    - Late arterial
    - Portal-venous.
- Pelvis may be included on venous phase.
- 5mm and 1.5mm reconstructions.

High yield tips and common pitfalls:

- If indication is for evaluation of neuroendocrine tumor,
    - Should be biphasic CT of the abdomen and venous pelvis, with water for oral contrast.
- Do not confuse **CT Angiography Biphasic (CTA Biphasic)** with **CT Biphasic Liver.**
    - The difference is the addition of 3D reconstructions for CTA biphasic.
- **Triphasic Liver vs Biphasic Liver CT.**
    - In **triphasic liver CT,** delayed phase images (2 min) are also obtained.
    - Delayed images allow for better delineation of tumor washout which is crucial information.

CT Urogram

Indications:

- Microscopic and macroscopic hematuria.
- Chronic hematuria.
- Malignancy involving the upper urinary tract of renal or of urothelial etiology.

*Small bladder masses are best evaluated by cystoscopy.

Protocol:

- Multiphasic:
    - Non-contrast images.
        - From upper pole of kidneys to iliac crests.
    - Nephrographic phase.
        - From diaphragm to symphysis pubis 90-100 sec after start of contrast injection.
    - Excretory phase.
        - From diaphragm to symphysis pubis 10 minutes after nephrographic phase.
        - Patient prone (if able).
- No oral contrast.
- 3D post processing images of kidneys, ureters and bladder.

Considerations:

- In young patients (<40 years-old) consider split bolus protocol to reduce dose.

* (see related protocols below)

High yield tips and common pitfalls:

- CT urogram allows evaluation of a primary collecting system lesion or cortical lesion with secondary involvement of the collecting system.
- CT urogram is appropriate for evaluating hematuria or suspected malignancy.
- In cases of suspected kidney stones renal stone protocol (non-contrast CT) is appropriate.

CT Urogram (split bolus)

Indications:

Reduce radiation dose in younger patients (<40 years).

Protocol:

- Multiphasic
    - Non-contrast images
        - From upper pole of kidneys to iliac crests.
    - Combined nephrographic/excretory phase images.
        - From the diaphragm to symphysis pubis.
- The contrast bolus is split and administered as two smaller boluses separated by a delay.
    - Combined nephrographic/excretory phase images obtained after injecting the second half of the contrast bolus.
- Compared to standard CT urogram, patient is scanned only twice instead reducing radiation dose.
- No oral contrast.
- 3D post processing images.

CT Renal Mass

Indications:

Detect and characterize renal masses.

Protocol:

- Similar to *CT urogram* but without excretory phase images.
- Two phases.
    - Non contrast images.
    - Nephrographic images (90-100 sec after contrast injection).
- No oral contrast.
- Usually does not include pelvis.

Considerations:

- Renal mass CT does not evaluate for urinary tract involvement.
- Identify if pelvis needs to be included.
    - If included, then usually on nephrographic phase.
- If there is a renal lesion on prior imaging, check for macroscopic fat.
- Thin slices (1.5mm) may be necessary to characterize lesion better.

CT Renal Stone

Indications:

- Evaluate for renal or ureteral stones.
- Painful hematuria.
- Acute flank pain.

Protocol:

- Non contrast images.
- Field of view includes kidneys, ureters and bladder.
- No oral contrast.
- 3 mm slice thickness to better visualize small calculi.

Considerations:

- Not appropriate for painless hematuria, in which case should be CT Urogram.

Adrenal CT

Indications:

Evaluate and characterize adrenal masses.

Protocol:

- Non-contrast images from diaphragm to bottom of kidneys.
    - Pelvis not included.
- Review non-contrast images as soon as they are performed.
- If lesion measures > 20 HU then obtain **venous** and **delayed** images.
- No oral contrast.

Considerations:

- Once non-contrast images are obtained, techs will call to have them checked.
    - If lesion measures < 10 HU then no further imaging.

        - If lesion measures >10 but <20 HU decide next step on case by case basis.
- Check for macroscopic fat.

High yield tips and common pitfalls:

- Measure density of lesion and for macroscopic fat on prior exams, if available.

CT Biphasic Pancreas

Indications:

- Detection and staging pancreatic cancer.
- Follow up of pancreatic cancer.

Protocol:

- Two phases:
    - Arterial phase.
        - For optimal pancreatic parenchymal enhancement.
        - To optimize tumor detection, a slightly longer delay is used compared to arterial phase used in biphasic liver CT.
    - Portal venous phase.
- Water is used as negative oral contrast agent (~4 cups).
    - Will not interfere with depiction of enhanced vessels.

Considerations:

- Decide if pelvis is needed on portal venous phase.
- Will not need biphasic CT if;
    - Looking for complications of pancreatitis such as collections, pseudocysts
    - Following up cystic pancreatic tumors.
    - **Unless**;
        - If evaluating for pseudoaneurysm.
        - Or looking for active bleeding in cases of hemorrhagic pancreatitis.

Disambiguation of “Routine Pancreas” and “Pancreas Protocol”

- There is NO “routine pancreas” protocol. This is a misnomer and refers to a **conventional CT abdomen with IV contrast** (portal venous phase).
- To further clarify, a standard CT abdomen and pelvis is appropriate *to evaluate for complications of pancreatitis* such as pseudocyst, peri-pancreatic fluid collections, necrotizing pancreatitis or pancreatic abscess.
    - +/- oral contrast.
    - Thin slices may be obtained for better anatomic detail.
- “Pancreas protocol” means a biphasic pancreas.
    - If someone says “pancreas protocol” please clarify this with them.
- A standard CT abdomen pelvis is NOT appropriate for evaluating pancreatic masses.