CT Protocols for Common Primary Care Diagnoses

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CT Protocols – IV Contrast

• **Indications**
  – Mass/malignancy/staging
    • May require a special multiphase protocol
  – Infection/Inflammation
  – “Pain”
  – Unsure
  – Angiograms

• **Contraindications**
  – Allergy
  – GFR>30 (>45)
  – Caution in hypertension, diabetes, renal transplant, single kidney, CRD

• **Not needed**
  – Organ size
  – Follow renal stones
  – Hernia
  – Retroperitoneal hemorrhage

• **Imaging Phases**
  – Arterial phase
    • Contrast has not yet reached the organ, in arteries only
  – *Portal venous phase*
    • Organ has perfused, contrast returning through venous system
  – Delayed phase
    • Equilibrium state where contrast has returned to venous system, beginning to be renally excreted

• **Affected by cardiac function, anatomy, and physiology**
Renal Function Guidelines

• In the outpatient setting, the following patient population will require renal function screening within 30 days of contrast administration:
  • Age >65 years
  • History of renal disease, including
    – Kidney transplant
    – Single kidney
    – Kidney cancer
    – Kidney surgery
    – History of renal insufficiency
  • History of hypertension requiring medical therapy
  • History of diabetes
  • Metformin (or metformin-containing drug combinations)

<table>
<thead>
<tr>
<th>eGFR &gt; 60 (very low risk)</th>
<th>No restrictions</th>
</tr>
</thead>
<tbody>
<tr>
<td>eGFR 45-60 (low risk)</td>
<td>If acute renal failure, consider IV hydration. Otherwise, encourage oral hydration and salt loading as clinically appropriate.</td>
</tr>
<tr>
<td>eGFR 30 – 44 (moderate risk)</td>
<td>Consider alternative exams (MRI/Ultrasound). Otherwise IV hydration required (see below) unless documented that medical emergency precludes hydration. Iodixanol (Visipaque) contrast is suggested.</td>
</tr>
<tr>
<td>eGFR &lt; 30 (high risk)</td>
<td>No IV contrast unless approved by nephrology or deemed a medical emergency, which must be documented. Iodixanol (Visipaque) contrast is suggested in the event of a documented medical emergency/override authorizing the administration of IV contrast.</td>
</tr>
</tbody>
</table>

CT Protocols
Organ evaluation
Indication: “stone”

Pyelonephritis  Normal
Mass evaluation
Indication: “early satiety”

Additional adrenal
Pheochromocytoma
CT Protocols – Oral Contrast

• **Indications - Body**
  – Mostly for us to identify bowel
    • From other structures
    • Evaluate wall
      – Volumen
  – Functional
  – Evaluate gastric bypass
  – Post surgical is a must!
    • Gastrograffin

• **Contraindications**
  – Intolerance
  – Will obscure your finding

• **Not needed**
  – Angiograms
  – Organ specific exams

• **Bladder Contrast**
  – Fistula
  – Bladder wall integrity

• **Rectal Contrast**
  – Fistula
  – Post surgical
  – Penetrating trauma

• **“Size Matters”**

• **Things are different in the ER setting**
Early Acute Appendicitis
No Oral Contrast
Early Acute Appendicitis
With Oral Contrast
Late Acute Appendicitis
With Oral Contrast
+ “Internal Contrast”
CT Abd/Pelvis I+ “Routine”

- 1 scan: Portal Venous
- **Indications:**
  - Evaluate visceral organ
  - Pain
  - Unsure
- **NOT optimal for looking at arterial anatomy or for occlusion (mesenteric ischemia)**

**Acute Pancreatitis**
**Necrosis**
**Splenic Vein Thrombus**
Acute, Uncomplicated Diverticulitis
Complicated Diverticulitis with Gas-Containing Abscess
Acute Cholecystitis
CT Abd/Pelvis I- or KUB

- 1 scan: Noncontrast

- **Indications:**
  - *Contrast is not necessary to see the findings*
    - Retroperitoneal hemorrhage
    - Kidney stones
    - Organ size
    - Hernia
  - *Contrast might obscure your finding*
    - Hepatic steatosis
  - *Patient cannot have contrast*

  Splenomegaly (Lymphoma)
CT Liver I-/I+

- 4 scans: Noncontrast, Arterial Portal Venous, Delayed

- **Indications:**
  - *Should be considered in any patient with cirrhosis*
    - HCC detection or follow up
    - Characterization of previously detected liver mass (seen on US, Routine CT A/P)
    - Follow up ablation or TACE
  - *Consider including pelvis if first time or looking for ascites*
Hepatocellular Carcinoma
Massive Infiltrating Hepatocellular Carcinoma
CT Protocols

Cholangiocarcinoma

Noncontrast

Arterial

Portal Venous

Delayed

18

18

Portal Venous

Delayed
Hemangiomas

Arterial

Portal Venous

Delayed

CT Protocols
CT Pancreas I-/I+

- 3 scans: Noncontrast, Arterial, Portal Venous

- **Indications:**
  - *Not appropriate for screening for pancreatic mass or for acute pancreatitis*
    - To characterize a previously detected uncharacterized pancreatic lesion, surgical planning
  - **Resectability**
    - Involvement of regional arteries and veins

Pancreatic carcinoma
With encasement of the SMA
CT Renal Mass I-/I+

• 3 scans: Noncontrast, Arterial, Portal Venous

• Indications:
  • Not appropriate for screening
    – To characterize a previously detected renal lesion
  • Does not include a delayed phase, so it is not optimal for looking at collecting system abnormalities or detecting TCC

Renal Cell Carcinoma
CT Urogram I-/I+

- 2 scans: Noncontrast, Combo Nephrographic/Excretory

- **Indications:**
  - Optimized study to look at renal parenchyma AND collecting system
    - Microscopic hematuria
    - Detecting transitional cell carcinoma (TCC)
  - Not good for looking at renal (parenchymal based) mass or indeterminate cysts

Transitional Cell Carcinoma
Other Body CT Protocols

- CT Enterography I+O+ Volumen
  - 1 scan: Portal Venous
  - *Indications:*
    - Crohns/IBD
    - Malabsorption
- Renal Donor Protocol I-/I+
  - 3 scans: Noncontrast, Arterial, Venous
- Liver Donor Protocol I-/I+
  - 3 scans: Arterial, Venous, Delayed
- CT Colonography I-/O+/CO2+
  - 2 scans: O+ prone and supine after previous day bowel prep
Thoracic Imaging
CT Chest I- “Routine”

• 1 scan: Noncontrast

• **Indications:**
  • Pneumonia/Atelectasis
  • Emphysema
  • Pulmonary nodules
  • Pleural effusions

• **Special scenarios:**
  • Low dose nodule f/u
  • High resolution for interstitial lung disease
    • More scans (supine/prone, inspiratory/expiratory)
CT Chest I+ “Routine”

- 1 scan: Portal Venous

- **Indications:**
  - Mass/Malignancy
    - Especially lymphadenopathy
  - Initial sarcoid
  - Empyema
  - Pulmonary artery size

- *Not good for looking for PE (too late)*

Empyema
Hilar Lymphadenopathy in Small Cell Lung Carcinoma
Lymphoma
Carcinoid Tumor
Metastatic Anaplastic Thyroid Carcinoma
CT Chest I+ PE Protocol

• 1 scan: Late Arterial (often done by bolus tracking)

• *Indications:*
  • Pulmonary embolus

• *Not good for looking at organs – contrast has not made it there yet*
Saddle Pulmonary Embolism
Other Thoracic Protocols

- Cardiac studies (depending on availability)
  - *May be gated*
  - *May require beta blocker tx*
    - Valves
    - Anatomy
    - Coronary Artery Evaluation
CT Angiograms

• No oral contrast

• CTA Aneurysm I-/I+
  – 2 scans: Noncontrast, Arterial
  – *Indications*:
    • Aortic aneurysm evaluation
    • Acute bleed (liver, bowel, spleen, etc)

• CTA Dissection I-/I+
  – 3 scans: Noncontrast, Arterial, Portal Venous
  – *Indications*:
    • Aortic dissection
  – *Portal venous phase is included to assess organ perfusion*

• CTA Stent I-/I+
  – 3 scans: Noncontrast, Arterial, Delayed
  – *Indications*:
    • Evaluate endovascular repair
  – *Delayed phase to look for delayed leak*

• CT Extremity Runoff I-/I+
  – 2 scans: Noncontrast, Arterial
  – *Indications*:
    • Cold limb, extremity ischemia
  – *Large field of view gives poor special resolution*
  – *Usually ordered by vascular surgery*
CT Head I-

- 1 scan: Noncontrast

- **Indications:**
  - Almost always the first line evaluation
  - Acute trauma, suspected hemorrhage, stroke
  - Seizures, apnea, syncope, ataxia

- **Workhorse of head CT**

MCA Infarct
Traumatic Hemorrhage
Venous Sinus Thrombosis
CT Head I+

• 2 scans: Noncontrast, Contrast
  – Almost always do in ADDITION to I-

• Indications:
  – Mass
  – Infection

• Can obscure small hemorrhage

• Different from CTA Head (stroke)

Abscess
CT Cervical Spine I-

- 1 scan: Noncontrast

- *Indications (bone):*
  - Neck pain (DJD)
  - Post trauma
  - Post operative

- *Not good for looking at the soft tissues of the neck*

Compression Fracture
CT Neck I+

• 1 scan: Portal Venous

• **Indications:**
  – Mass
  – Malignancy
  – Infection
  – Lymphadenopathy

• **Still see cervical spine**
• **Different from CTA Neck (for stroke or dissection)**

Branchial Cleft Cyst
CTA Head and Neck I+

• 2 scans: Noncontrast head; Arterial through the head and neck

• Indications:
  – *Stroke
  – Dissection
  – Post traumatic

• Different from CT Head and Neck I+
Other Misc Neuro Exams

- **CT Nasal Bones I-**
  - Trauma
- **CT Sinus/Maxillofacial I-**
  - I+ if looking for infection/abscess, neoplasm
- **CT Temporal Bones I-**
  - Hearing loss, cholestatoma, post surgical
- **CT Parathyroid I+**
  - 4D parathyroid CT for parathyroid adenoma
Musculoskeletal Protocols

- For bone, contrast doesn’t add much
  - Only use I+ if planning to evaluate soft tissues or soft tissue component
- CT is best for bone
  - If concerned for soft tissues, MRI is far superior
    - Ultrasound may be a good place to start (insurance issues)
Thank You!

• Please feel free to contact me with any questions about this presentation, CT protocols, or radiology in general!

• lacey.mcintosh@gmail.com
Helpful References

- ACR Appropriateness Criteria
  http://www.acr.org/Quality-Safety/Appropriateness-Criteria

### American College of Radiology
ACR Appropriateness Criteria

**Clinical Condition:** Right Lower Quadrant Pain—Suspected Appendicitis

**Variant 1:** Fever, leukocytosis, and classic clinical presentation for appendicitis in adults.

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>RRL *</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT abdomen and pelvis with contrast</td>
<td>8</td>
<td>Oral or rectal contrast may not be needed depending on institutional preference.</td>
<td>☀ ☀ ☀ ☀</td>
</tr>
<tr>
<td>CT abdomen and pelvis without contrast</td>
<td>7</td>
<td>Use of oral or rectal contrast depends on institutional preference.</td>
<td>☀ ☀ ☀ ☀</td>
</tr>
<tr>
<td>US abdomen</td>
<td>6</td>
<td>Perform this procedure with graded compression.</td>
<td>○</td>
</tr>
<tr>
<td>US pelvis</td>
<td>5</td>
<td>This procedure is appropriate in women with pelvic pain.</td>
<td>○</td>
</tr>
<tr>
<td>MRI abdomen and pelvis without and with contrast</td>
<td>5</td>
<td>See statement regarding contrast in text under “Anticipated Exceptions”</td>
<td>○</td>
</tr>
<tr>
<td>X-ray abdomen</td>
<td>4</td>
<td>This procedure may be useful when there is concern for perforation and free air</td>
<td>☀ ☀</td>
</tr>
<tr>
<td>CT abdomen and pelvis without and with contrast</td>
<td>4</td>
<td>Oral or rectal contrast may not be needed in this procedure depending on institutional preference</td>
<td>☀ ☀ ☀ ☀</td>
</tr>
<tr>
<td>MRI abdomen and pelvis without contrast</td>
<td>4</td>
<td></td>
<td>○</td>
</tr>
<tr>
<td>X-ray contrast enema</td>
<td>2</td>
<td></td>
<td>☀ ☀ ☀ ☀</td>
</tr>
<tr>
<td>Tc-99m WBC scan abdomen and pelvis</td>
<td>2</td>
<td></td>
<td>☀ ☀ ☀ ☀</td>
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</table>

**Rating Scale:** 1-2.5 Usually not appropriate; 4.5-6 May be appropriate; 7.5-9 Usually appropriate

*Relative Radiation Level*