Introduction to CT Imaging

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Session Objectives

• Understand the optimal imaging modality for common thoraco-abdominal indications and their associated risks and benefits
• Discuss thoracic and abdominal protocol selection
• Review CT findings in common thoracic and abdominal pathologies
Quick Overview:
CT Basics and Anatomy
Standard CT and MRI Orientations

AXIAL or TRANSVERSE
Standard CT and MRI Orientations

**AXIAL or TRANSVERSE**
Looking at patient lying down on their back from feet first

**CORONAL**
Looking at patient standing in front of you face to face

**SAGITTAL**
Looking at patient from the side view
Anatomy Quiz: Find the aorta and pulmonary arteries
Anatomy Quiz: Find the liver, gallbladder, pancreas, spleen, adrenal glands and appendix
Anatomy Quiz: Find the kidneys, aorta and renal arteries
Anatomy Quiz: Find the transverse colon, duodenum, portal vein, IVC and renal veins
Anatomy Quiz: Find the celiac artery, SMA and IMA
CT Hounsfield Units: anatomic information

High numbers = white (bone > blood vessels)
Low numbers = dark (air < fat < fluid)

Liver w/contrast in the arterial phase
50-75 HU

Aorta with contrast in the arterial phase
200-500 HU

Fat is < 0 HU
-50 to -100 HU in all phases

Fluid
Simple 0-10 HU
Complex 10-30 HU

Arterial phase

Liver
Spleen
Fat
Fluid
Spleen
CT Hounsfield Units: anatomic information
High numbers = white (bone > blood vessels)
Low numbers = dark (air < fat < fluid)

Liver w/contrast in the venous phase
100-150 HU

Aorta with contrast in the venous phase
100 HU

Air < -100 -1000 HU
In all phases

Fluid
Simple 0-10 HU
Complex 10-30 HU

Fat is < 0 HU
-50 to -100 HU
in all phases

Bone
500-3000 HU
In all phases

Stomach
IVC
Fluid
Simple 0-10 HU
Complex 10-30 HU

Liver
Spleen
Fat
Venous phase

CT Hounsfield Units: anatomic information
High numbers = white (bone > blood vessels)
Low numbers = dark (air < fat < fluid)
Imaging Modalities and Protocol Selection
Abdominal Imaging: Modalities

- **Ultrasound**
  - Widely available
  - Operator and patient dependent

- **CT**
  - Ionizing radiation
  - Iodinated IV contrast
  - Very fast exam (performed in seconds)

- **MRI**
  - Gadolinium contrast
  - Long exam time limits anatomic coverage
  - Motion artifact degrades image quality
Abdominal Imaging: Patient Safety

- **Start with US** in children and thin young adults with RLQ pain as well as all women with pelvic pain
- **B-HCG** for all women of child bearing age before CT
- **Consider hydrating** patients prior to IV contrast
- **Patients with allergy to iodinated contrast**
  - Mild to moderate: pre-medicate with prednisone and benadryl **beginning 24 hours in advance and with 3 doses of prednisone 40 mg (24, 12 and 2 hours prior)**
  - Severe: risk/benefit
  - Anaphylaxis: avoid iodinated contrast

http://www.aafp.org/afp/2015/0401/p452.html
IV Contrast for CT Imaging

- Iodine based contrast agent
- Infused intravenously (i.e. in the vein)
- Enhances (“lights up”) anatomy to improve tissue discrimination
- Contraindications
  - severe allergy
  - renal insufficiency
- In general, with contrast is preferred
CT Ordering: Contrast or No Contrast?

• CT with contrast – with IV contrast
• CT without contrast – no IV contrast
• CT with & without contrast
  – One scan before infusing IV contrast
  – One or more scans after IV contrast
Alternatives to CT Contrast: IV Contrast for MRI

- Gadolinium based
- Group II agents can be used in patients with CKD
- Evolving data about brain deposition
- Do not administer to pregnant patients
Alternatives to CT Contrast: IV Contrast for Ultrasound

- Microbubbles
- Useful in patients who can not get iodinated CT contrast or gadolinium

From the case: Amoebic hepatic abscesses - contrast enhanced ultrasound

contributed by Dr Teresa Fontanilla on September 09, 2014

System: Hepatobiliary  Tag: cases  hepatic abscess  contrast-enhanced ultrasound

Modality: Ultrasound (contrast enhanced ultrasound)
- “Findings in contrast enhanced ultrasound of liver abscesses depend mainly on the degree of liquefaction and of the size and shape of the liquefied...”

Used in the following article:
- Amoebic hepatic abscess - “Amoebic hepatic abscesses are a form of hepatic abscess resulting from Entamoeba histolytica infection. Clinical presentation Patients may exper...”

View full size version of Amoebic hepatic abscesses - contrast enhanced ultrasound

https://radiopaedia.org/images/8201170
Noncontrast Chest CT

- Lung cancer screening
- Lung nodule follow up
- Interstitial lung disease
- Immunocompromised pt w/ fever
- Coronary artery calcium screening
Chest CT with IV Contrast

- Mediastinal mass
- Adenopathy/lymphoma
- Lobar atelectasis
- Suspect lung cancer
- Lung cancer staging
- Metastatic work up
- Pleural disease
- Chest wall disease
# Abdomen CT: Protocol Selection

<table>
<thead>
<tr>
<th>CT with IV contrast</th>
<th>CT with &amp; without IV</th>
<th>CT without IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>most indications</td>
<td>&lt;10% of your orders</td>
<td>contraindication to IV contrast</td>
</tr>
<tr>
<td>abdominal pain</td>
<td>2-4x radiation dose</td>
<td>select indications</td>
</tr>
<tr>
<td>trauma</td>
<td>adrenal nodule work up</td>
<td>renal colic</td>
</tr>
<tr>
<td>acute abdomen</td>
<td>(indeterminate)</td>
<td>dropping Hgb</td>
</tr>
<tr>
<td>surgical follow-up</td>
<td>renal mass vs cyst or</td>
<td>– prefer IV contrast</td>
</tr>
<tr>
<td>oncology</td>
<td>hematuria</td>
<td>neutropenic fever</td>
</tr>
</tbody>
</table>

ACR Appropriateness Criteria

The ACR Appropriateness Criteria® (AC) are evidence-based guidelines to assist referring physicians and other providers in making the most appropriate imaging or treatment decision for a specific clinical condition. Employing these guidelines helps providers enhance quality of care and contribute to the most efficacious use of radiology. Learn more »

CMS has designated ACR as a Qualified Provider-Led Entity »

https://acsearch.acr.org/list?_ga=2.261572618.608402332.1583254931-545960587.1514898705
Case Vignettes
Case 1

64-year-old with history of colon cancer status post recent resection presents with two days of inspiratory chest pain and shortness of breath

Vitals: HR 120, BP 140/90, RR 18.
D-dimer is positive. CXR is normal.
What is the most appropriate imaging study for this patient?

A) CT chest without contrast
B) CT chest with contrast
C) CTA chest
D) CTA chest, abdomen and pelvis
E) V/Q scan
Diagnosis?
25-year-old with 12-hour history of abdominal pain and loss of appetite. Began as periumbilical pain, now RLQ. Vitals: T38.1, HR 110, BP 125/70, RR 12 Labs: WBC 15, Cr 0.7
What is the most appropriate imaging study for this patient?

A) CT abdomen and pelvis without contrast
B) CT abdomen and pelvis with contrast
C) CTA abdomen and pelvis
D) CT abdomen and pelvis with and without contrast
E) RLQ US before CT
Diagnosis?
Case 3

38-year-old presenting with colicky abdominal pain radiating to the right flank. No significant PMH. Vitals WNL. UA notable for microscopic hematuria.
What is the most appropriate imaging study for this patient?

A) CT abdomen and pelvis without contrast
B) CT abdomen and pelvis with contrast
C) CTA abdomen and pelvis
D) CT abdomen and pelvis with and without contrast
E) Renal ultrasound
F) Abdominal radiograph
Diagnosis?
Case 4

45-year-old patient with history of alcohol abuse presenting with nausea, vomiting and abdominal pain for three days.

Vitals: T37.1, HR 110, BP 100/68, RR 14.

Labs: WBC 14, lipase 5000
What is the most appropriate imaging study for this patient?

A) CT abdomen and pelvis without contrast
B) CT abdomen and pelvis with contrast
C) CTA abdomen and pelvis
D) CT abdomen and pelvis with and without contrast
E) Abdominal ultrasound
F) MRCP and GI consult
Diagnosis?
Case 5

65-year-old patient presenting with 48 hours of diffuse abdominal pain, cramping and diarrhea. History of mild hypertension and asthma. Vitals WNL. Labs WBC 13, Hb 12, Cr 0.8 (GFR>60). Lactate 1.0.
What is the most appropriate imaging study for this patient?

A) CT abdomen and pelvis without contrast
B) CT abdomen and pelvis with contrast
C) CTA abdomen and pelvis
D) CT abdomen and pelvis with and without contrast
E) Nuclear medicine tagged RBC scan
Diagnosis?
Diagnosis?
Success on the Wards: Tips from a Radiologist

• Look at the images for every patient you care for – try your hand then read report
• Identify the appendix and adrenal glands on every CT of the abdomen and pelvis
• Write thoughtful indications for your orders (“SOB” vs. “18 yo M fever and cough x 3 days, concern for pneumonia”)
Success on the Wards: Tips from a Radiologist

- Accompany your patient to their imaging study (x-ray, CT, US, MRI) at least once and watch the technologists perform exam.
- Educating your team and sharing what you learned can count toward your rotation score.
Success on the Wards: Tips from a Radiologist

• Ask yourself: am I ordering the best study for my patient in the best setting?
  – Modality and protocol
  – Radiation dose
  – Cost to the patient
  – Inpatient vs. defer to outpatient
Summary: Intro to Body CT

- Selecting the correct imaging modality and protocol is key to accurately diagnosing pathology.
- IV Contrast: In general, more is more.
- Look at images for every patient – you will get better and better at identifying classic diagnoses.
- Call a Radiologist when you are uncertain.
Thank you!

Questions?

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