Cardiac Findings on CCTA

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Disclosures

• None
Outline

• Approach to Evaluating the heart on CCTA
• Search pattern for assessment of pathologies seen on CCTA
  – Shunts
  – Valvular Lesions
  – Thrombus
  – Masses
  – Pitfalls
• Not discussed:
  – Functional assessment with CCTA
  – Complex adult congenital heart disease
Approach to Evaluating the Heart

• A “foreign” structure to many radiologists
• The quality of CT imaging is such that even non-ECG gated, “non-cardiac” studies can reveal normal and abnormal cardiac structures in great detail
• How does one look at the heart...
Approach to Evaluating the Heart

• Employ a patterned approach
• Following blood flow from venous return to systemic arterial output
Approach to Evaluating the Heart

- **Chambers**
  - Luminal size, luminal filling defects (masses and thrombus), wall thickness, wall defects and attenuation
- **Valves**
  - Thickness, attenuation (calcification), size
- **Pericardium**
  - Thickness, attenuation (calcification), fluid
Approach to Evaluating the Heart

• Much of this evaluation can be done with transaxial images only; however, a workstation with 3-D reformatting capabilities is essential for proper evaluation of valvular structures.
Search Pattern

- Follow the IVC up and the SVC down into the right atrium
  - Assess for size and patency of these structures
  - Assess for abnormal vessels joining the SVC (PAPVR?)
Transvenous route of extension in a patient with metastatic renal cell carcinoma.

Sinus Venosus ASD- with PAPVR
Search Pattern

- Examine the right atrium
  - Assess size
  - Attempt to identify the sulcus and crista terminalis (separation of the appendage from the atrium proper)
  - Assess for intraluminal filling defects
  - Assess the inter-atrial septum (ASD?)
Crista terminalis. Can be very mass like, do not confuse with right atrial clot.
Types of Atrial Level Defects

Three classic types of ASDs

1. **Secundum** types are the most common occur in the region of the foramen ovale
2. **Ostium Primum**- typically not percutaneously closable
3. **Sinus venosus Defects**- located high in the region of the incorporation of the SVC into the RA
   - Commonly associated with **PAPVR**
   - Inferior Sinus Venosus ASD and unroofed coronary sinus are less common
Secundum ASD
Patent Foramen Ovalle (PFO)
Secundum ASD
Lipomatous Hypertrophy of the Interatrial Septum (LHIS)

Note sparing of the fossa ovalis.
LHIS!
Search Pattern

• Examine the tricuspid valve
  ▫ Not well seen for a number of reasons
    • Thinner than the mitral valve (lower pressure system)
    • Contrast opacification of the right sided chambers is often poor due to double or triple bolus technique
Search Pattern

• Examine the tricuspid valve cont...
  ▫ Look for thickening/masses (especially in the right clinical context) i.e. IVDU query endocarditis
  ▫ Best evaluated in a 4-chamber view
“4 chamber view”

Right sided chambers, especially tricuspid valve may not be well assessed, depending on technique.
Search Pattern

- Examine the right ventricle
  - Attempt to identify the moderator band
  - Assess for size and wall thickness
  - Assess for intra luminal filling defects
  - Assess the interventricular septum (VSD?)
Moderator Band
Search Pattern

- Examine the pulmonic valve
  - Assess for leaflet number
  - Assess for thickening
  - Thin structure often difficult to assess (similar to tricuspid valve)
  - Will require axial oblique reformat for assessment
Quadricuspid Pulmonic valve
Search Pattern

• Examine the left atrium
  ▫ Examine the pulmonary veins for number and insertion anatomy (variable)
  ▫ Assess atrial size (SCCT guidelines suggest reporting of chamber size as optional)
    • Axial or three chamber diameter measure of greater than 4 cm is considered abnormal
    • Ideally this number should be indexed based on patient size

Raff et al. JCCT 2009.
Search Pattern

• Examine the left atrium:
  ▫ Assess for intraluminal filling defects (masses and clots)
  ▫ Assessment of atrial appendage clot is fraught with pitfalls due to the phase (arterial) of contrast. A CT study dedicated to assess for atrial clot will require a delayed phase as well
Atrial Appendage Pseudothrombus

? Clot. Echo normal
Myxomas

- Most common primary cardiac tumor (25-50% of all primary neoplasms)
- 78% in the left atrium commonly arising from a stalk from the fossa ovalis
- Mobile, irregular, pedunculated masses
Myxomas

- Can occur elsewhere in the left atrium and other cardiac chambers (22%)
- Heterogeneous, calcification
- Enhancement is usually mild, and patchy
- Prolapse through the AV valve is a very helpful finding differentiating myxoma from clot
## Myxoma vs. Clot

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<thead>
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<th>Myxoma</th>
<th>Thrombus</th>
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<tbody>
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<td>Enhancement</td>
<td>mild</td>
<td>None*</td>
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<tr>
<td>Calcification</td>
<td>rare</td>
<td>common</td>
</tr>
<tr>
<td>Location</td>
<td>LA, attached to septum</td>
<td>Appendage</td>
</tr>
<tr>
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<td>larger</td>
<td>smaller</td>
</tr>
<tr>
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Scheffel et al. AJR 2008
Atrial Myxoma
Atrial Myxomas and Thrombi: Comparison of Imaging Features on CT

Myxoma av. Attenuation 42 Hu vs. 57 Hu for clot  
Scheffel et al. AJR 2008
Cardiac Masses

- A brief word:
  - Metastatic lesions are up to 40X more common than primary cardiac masses
  - Of primary cardiac tumors 80% tend to be benign tumors, with 20% of primary lesions representing malignancy
  - Benign Lesions:
    - Myxoma, lipoma, fibroelastoma, paraganglioma
  - Malignant Lesions:
    - Sarcomas: angiosarcoma
Cardiac Masses

- Key differentiating features between benign and malignant lesions

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<tr>
<th>Feature</th>
<th>Benign</th>
<th>Malignant</th>
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<tbody>
<tr>
<td>Location</td>
<td>Left sided chambers</td>
<td>Right sided chambers</td>
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<tr>
<td>Size</td>
<td>Small</td>
<td>Large</td>
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<tr>
<td>Invasion</td>
<td>No</td>
<td>Myocardium/pericardium/extracardiac</td>
</tr>
<tr>
<td>Pericardial effusion</td>
<td>No</td>
<td>Suspicious</td>
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Rajiah, P et al. JCCT 2011.
Search Pattern

• Examine the mitral valve
  ▫ Assess for thickness, calcification and leaflet location
CT Protocol:

SAO
CT Protocol:

- Assess on 4-chamber, short axis, 3 chamber
Mitral Stenosis

- Patient with rheumatic mitral valve and mild mitral stenosis (valve area 1.6 cm²)
Mitral Regurgitation
Compared 64-slice CT to TEE in 56 consecutive patients

Assessed for AS and MS (valve area <2.0 cm²), AR and MR (any regurgitant orifice on both long- and short-axis views)

Two independent blinded readers with a third reader to achieve consensus

LaBounty, AJC 2009
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### Diagnostic performance of cardiac computed tomographic angiography for valve abnormalities

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Take Home Points for Functional Valve Evaluation on CT

- It can be done
- No one does it routinely
- In most instances echo is a far better test
- In general CT performs better for detection of stenotic valvular lesions
Search Pattern

• Examine the left ventricle
  – Assess myocardium for
    • Thickness (septum normally <1.5cm, free wall <1.2cm at end diastole)
    • Attenuation: areas of fatty metamorphosis can be a sign of prior infarction (subendocardial, in a coronary artery distribution)
  – Assess intraluminal contents for
    • size (chamber dilatation). In general endiastolic mid chamber luminal diameter as measured on a short axis image should be less than 6cm
    • Filling defects: clot (often adjacent to areas of wall thinning) and mass lesions
Search Pattern

- Examine the left ventricle:
  - Use of a short axis reformat is very helpful for wall thickness and attenuation assessment.
  - Also useful for separation of clot from normal papillary muscle
Short Axis

Anterolateral papillary muscle
Posteromedial papillary muscle
Apical thrombus
Apical HCM
Apical HCM
Small muscular VSD
Search Pattern

• Examine the aortic valve
  ▫ Assess for leaflet attenuation, and thickening
  ▫ Assess for leaflet number and anatomy
  ▫ Assess for coaptation (residual orifice at end diastole)
Search Pattern

- Examine the aortic valve
  - Use of multiplanar reformat to ensure assessment parallel to the valve plane is essential for accurate interpretation
Aortic Valve: Stenosis and Regurgitation

- Using multiplanar reformatting tool perpendicular to valve in coronal and sagittal obliques will yield images parallel to the Ao valve (image C).
- This is a case of aortic stenosis (taken from 35% of the R-R interval).
Bicuspid Aortic Valve Disease

- Most common variant (70%) is right coronary and left coronary cusp fusion (anteroposterior phenotype)
- Associated with coarctation
- Fusion of the right coronary and noncoronary cusps (right-left phenotype) is found in 28%
- More commonly associate with valvular stenosis and regurgitation

*AJR* 2012; 198:89–97
Fibroelastomas

- 75% of all valvular tumors
- Most commonly involving the aortic then the mitral valve
- Typically <1cm in size and filliform in shape
- Often incidentally detected in asymptomatic patients but can embolize and result in stroke and myocardial infarction
- Occur on the “outflow”/aortic side of the valve
Fibroelastoma
Search Pattern

• Examine the thoracic aorta
  ▫ Assess for size: ascending, arch, and descending
  ▫ Assess for burden of atherosclerotic disease
  ▫ Assess for dissection
Search Pattern

- Examine the pericardium
  - Assess for fluid, thickening and calcification
  - You have already assessed the cardiac chambers, but if pericardial thickening or calcification is present assess again for signs of constriction
- Tubularization of the ventricles
- Bi-atrial dilatation
- Straightening/leftward bowing of the interventricular septum
- 20% of cases of constrictive pericarditis will have normal appearing pericardium on imaging
Search Pattern

• Examine the pericardium
  ▫ Note that assessment of abnormal pericardial enhancement is optimal on portal venous/more delayed exams than the arterial phase normally acquired for CCTA
PE CT chest, poor pericardial enhancement

CT abdo (same day) obvious pericardial enhancement
Pericardial Calcification

Straightening of the septum. Proven constrictive pericarditis
Abnormally located heart
Lung intervenes between Ascending aorta and pulmonary artery
Diagnosis?
Diagnosis?

- Congenital absence of the pericardium
Conclusion

• The heart is a complex anatomical area
• A patterned approach helps for a thorough interpretation, this can be applied both to CCTA and CT chest in general
Questions?

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