Making the Black Box of the Heart More Transparent!

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Disclosures

• No Disclosures
Introduction

- Non-gated chest CT common imaging test
- Heart is included in its field of view
- New technology (high temporal and spatial resolution) decreases cardiac motion with increased detection of cardiac findings
268 chest CT were reviewed for reportable cardiac findings by two radiologists.

61% reportable cardiac findings - 22% not mentioned in the radiology report.

Incidental cardiac findings are common but usually not reported.

G Choy et al. Acta Radiologica 2013;396-400
Greater cardiac imaging training correlates with increased sensitivity and stable specificity to detect cardiac findings on chest CT.

Cardiac findings should be noted on chest CT report.

Cardiac radiology training should be encouraged.

Verdini D et al. JACR 2016 Mar 30 (in press)
Introduction

- Heart often regarded as a “black-box” on chest CT
- Cardiovascular and pulmonary diseases may overlap in their presentation
- Cardiac/pericardial diseases may alter patient’s clinical course
Objectives

✓ Learn a stepwise approach to the examine the heart on CT chest

✓ Review clinically significant cardiac findings through cases

✓ Tips and Take Home Messages
REFERENCES

- RV myocardium < 4mm
- Pericardium <4 mm
- Pulmonary Artery <29 mm
- PA/Ao ≤1
Right Ventricular Enlargement
- RV displacements inferiorly (below the level of the LV)
- RV/LV ratio >1

- Left Ventricle Enlargement > 5.6 cm
  - Sens 78%, Spec 100%

- Left Atrium Enlargement > 4.5 cm
  - Sens 53%, Spec 94%

- Atria smaller than ventricles
  - Valvular or Congenital Disease

Stepwise Approach to Examine Heart

Left Sided Chambers, Mitral & Aortic Valves, Aorta
• 56-year-old male with abdominal pain. Rule out bowel ischemia
LV Apical Aneurysm & Calcification

Intra-Cavitary thrombus (*)

Filling Defect Superior Mesenteric Artery

Non Enhancing Small Bowel Loops

Non Enhancing Small Bowel Loops

LV Apical Aneurysm & Calcification
Intra-Cavitary thrombus (*)
Small Bowel Ischemia due to Superior Mesenteric Artery Embolism from LV thrombus

• In the presence of systemic embolism inspect the heart to look for sources of embolism

 ✓ Intracardiac thrombus needs to be reported and communicated to the referring physician
Interventricular
Interatrial septa
Pulmonary Veins
68-year-old man with heart failure.
Rule out PE
Enlarged MPA (>29 mm)
Ao/MPA > 1

RV/LV ratio > 1 - RV enlargement
Contrast extending from RA to LA-ASD

Pulmonary Vein draining into the RA (Shunt)
Secundum ASD with associated Partial Anomalous Pulmonary Venous Return

✓ Increased flow in right heart results in Pulmonary Hypertension. Over time increased pressures in the PA may reverse the shunt from L-R to R-L (Eisenmenger Syndrome)
Enlargement of MPA (>29 mm)  
MPA/Ao ratio > 1

Hypertrophy of RV (> 4mm)  
Enlargement of RV (RV/LV ratio > 1)  
Flattening of the interventricular septum

**Pearls**

- Suspect a shunt in patients with unexplained PH and right cardiac enlargement
  - ASD
  - PAPVR
  - Patent Ductus Arteriosum
- May present in adulthood and may be missed on echocardiography
Right Sided Chambers, Tricuspid & Pulmonary Valves, Pulmonary Artery
51-year-old man with pleuritic chest pain and sudden dyspnea

Pulmonary Embolism

Right Ventricular Strain
RV Enlargement on CT on PE studies

- RV/LV ratio $> 1$
  - Diameter from inner wall to inner wall$^1$

- Included in the report in CTPA positive for PE$^3$

1- Reid JH, Murchison JT. Acta Radiol 1998;53(9):694-698
2- Lu M et al. AJR 2012;198:1353-1360
CT Predictors of PE Severity

- RV/LV ratio ≥ 1.0 – RV strain
  - 2.5 fold-risk all-cause mortality and adverse outcome
  - 5 fold-risk for pulmonary embolism-related mortality
  - Useful in normotensive, stable
  - Lower threshold for thrombolysis or embolectomy

56-year-old female with sudden onset of chest pain and dyspnea.
Tachycardia.
Rule out PE.
Pulmonary Embolism

Right Heart Thromboemboli
Mobile Right Heart Clot In-Transit

• Associates massive PE and increased risk of mortality (27%)
• Detection of right heart clot may have diagnostic and therapeutic implications
• May require thrombolysis

Rose PS et al. Chest 2002;121:806-814
Mobile Right Heart Clot in-Transit

• Rule out PFO - in the presence of right heart pressures may lead to systemic embolism and may need more aggressive treatment such as surgical embolectomy
  – Removal of right heart thrombus
  – PFO closure
  – Pulmonary Thrombectomy

Rose PS et al. Chest 2002;121:806-814
• 67-year-old woman presents with facial numbness and chest, back and abdominal pain.
Multiple Filling Defects in Pulmonary Arteries

Enlargement of RV (RV/LV>1)

Hypodensity in the interatrial septum

Filling Defect Superior Mesenteric Artery

Asymmetric Enhancement of kidneys
(Infarction of right kidney)
• Transesophageal echocardiogram:
  - Large PFO with right to left shunt
  - No intracardiac thrombus
  - RV dilatation and dysfunction
  - Pulmonary Hypertension

• The SMA thrombus was removed with surgical embolectomy

• Patient had an IVC filter implanted
Paradoxical Embolism

- Thrombi from venous system reaches the arterial system through an abnormal communication between heart chambers resulting in systemic embolism

58-year-old man with renal cancer

Hypodense nodules within the myocardium
Nodular contour of myocardium
Uniform thickness and contours
Homogeneous enhancement
Cardiac Metastases

- Most common cardiac neoplasm
- Myocardium, Epicardium
- Pericardium, Intracavitary
- Multifocal masses
- CMR-Delayed enhancement
- Primaries: Lung, breast, melanoma, kidney, lymphoma and leukemia
70-year-old man with metastatic esophageal cancer

Thickening of the LV apex

- Apical Hypertrophic Cardiomyopathy
- Metastatic disease

Tips:

☑ Review previous CT
☑ Cardiac MR
Apical Hypertrophic Cardiomyopathy
Pericardium
34-year-old woman with pneumonia, fever, hypotension. Rule out empyema.
• Large loculated pericardial effusion (*)
• Compression and flattening of RA and RV free wall

Concerning for Tamponade
73-year-old man with chest pain following significant vomiting. Requiring vasopressor support. Esophageal Perforation?

Collection of air in the mediastinum (*) causing compression of the left heart Chambers due to esophageal perforation. Findings concerning for tamponade.
Cardiac Tamponade

- Accumulation of fluid, gas or soft tissue resulting in elevation of intrapericardial pressure

- Intrapericardial pressure - no effective filling of ventricles ➔ decreased cardiac output ➔ cardiogenic shock

- Life threatening condition - Pericardiocenthesis

- Clinical diagnosis
CT Findings of Tamponade

- Large effusion
- SVC ≥ AAo diameter
- IVC > 2 x adjacent Ao
- Reflux of contrast into azygous vein and IVC
- Periportal edema
- Bowing of IVS towards left
- Compresion of cardiac chambers
- Flattened heart sign

Restrepo CS, et al. Imaging findings in cardiac tamponade with emphasis on CT. Radiographic 2007
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65-year-old man with lung cancer awaiting surgery. Preoperative CT staging
Calcifications in the coronaries
Do We Report Coronary Calcifications?
Calcifications in the coronaries
Do We Report Calcifications? YES!!!!

- Pathognomonic of coronary artery atherosclerosis
- No amount of calcium in the coronaries is normal
- May lead to further workup and primary preventive therapy, lifestyle modifications or statin therapy
- Can not infer the severity or coronary stenosis

Xie et al, Circ Cardiovasc Imaging 2013
Coronary Calcium Scoring

Estimates burden of atherosclerosis
Risk stratification tool
ECG-gated non-contrast
• Lesion >130 HU
• Area of ≥ 3 pixels (>1 mm²)

CAC score correlates linearly with risk of CV events
Combined Lung Cancer and Coronary Screening?

- Aging and smoking history (risk population Lung Ca and cardiovascular disease)
- Non-contrast and non-gated CT
- Large number of chest CT’s
- **Leading course of death in NLST was cardiovascular disease**
- High Ca Score patients candidates for intensive risk factor modification
- Enormous primary prevention potential if Ca Score from gated and non-gated examinations is comparable
- 2 screening in one: Lung cancer and coronary artery atherosclerosis
Do we report CAC? YES!!!!

- Meta-analysis on studies comparing Ca Score on chest CT for lung cancer screening and gated cardiac CT

- Excellent correlation ($r=0.94$) between Ca Score on gated and non-gated CT

- Visual assessment may be generated for risk assessment and comparable to Agatston Score

- CAC incidental finding with important prognostic information

- CAC identifies patients at a higher risk of cardiovascular events

Xie et al, Circ Cardiovasc Imaging 2013
Chiles C et al, Radiology 2015
Evaluating the Heart on Chest or Abdominal CT-Strategies

• Synoptic/structured reports with checklists

• Stepwise approach assessment
Take Home Messages

• Incidental cardiac findings are common and usually not reported

• Opportunity for radiologist to diagnose cardiac disease which may influence clinical decisions and management

• Incidental findings may require further work up and diagnose other conditions
THANK YOU FOR YOUR ATTENTION!

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