



MC22:



Case Based Review of MDCT: Valves, function

David A. Bluemke, M.D., Ph.D., FAHA

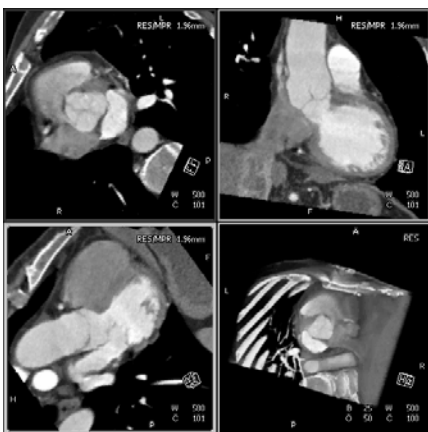
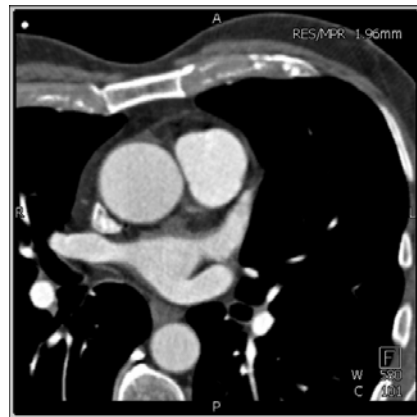
Professor, Departments of Radiology and Medicine

Clinical Director, MRI
Johns Hopkins University School of Medicine
Baltimore, Maryland

Disclosures

Consultant: GE-Healthcare

62 yo male referred for evaluation a dilated aortic root



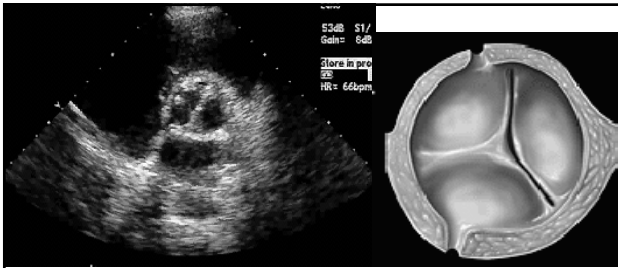
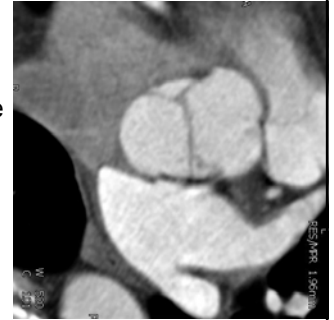
What is the abnormality of the aortic root that is present?

- 1) dilatation of the aortic sinuses
- 2) aortic regurgitation
- 3) bicuspid aortic valve
- 4) rheumatic aortic valve



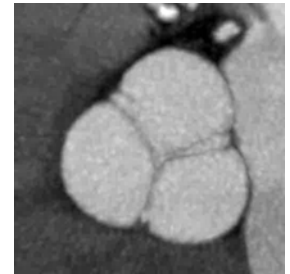
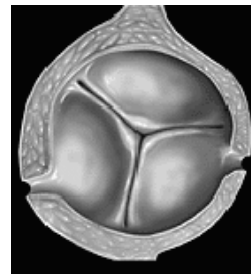
What is the abnormality of the aortic root that is present?

- 3) bicuspid aortic valve



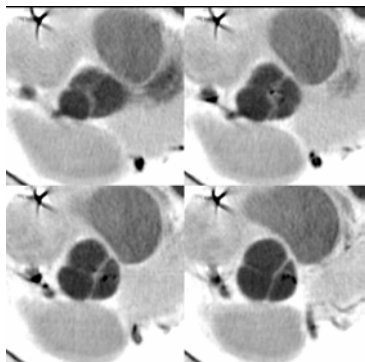
- Normal aortic valve has 3 leaflets
- Bicuspid valve has fusion of 2 valve leaflets

http://www.med.yale.edu/intmed/cardio/echo_atlas/entities/aortic_stenosis_bicuspid.html



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- Bicuspid valve has fusion of 2 valve leaflets

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2 mm reconstructions through the aortic valve

Which of these is NOT associated with bicuspid aortic valve?

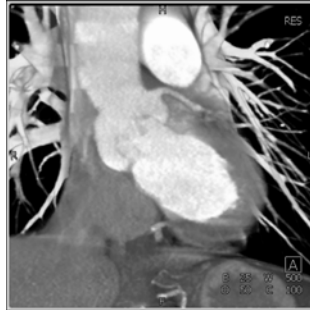
- 1) ascending aortic dilatation
- 2) coarctation of the aorta
- 3) aortic stenosis and regurgitation
- 4) 10 fold increased rate of aortic dissection
- 5) 8% incidence in the population



Which of these is NOT associated with bicuspid aortic valve?

5) 8% incidence in the population

Overall, 1-2% incidence in the population



Bicuspid aortic valve

1) Associated with dilatation of the ascending aorta.

- NOT necessarily due to hemodynamic consequences of the stenosis.

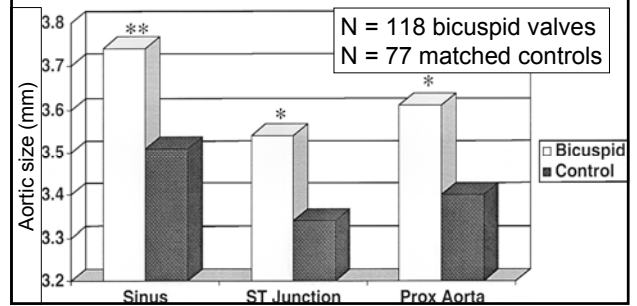
Bicuspid aortic valve

1) Associated with dilatation of the ascending aorta.

- Aortic dilatation more rapid in bicuspid valves compared to normal valves with equivalent degrees of stenosis.
- Inherent structural abnormality in the aortic wall proposed (hereditary); shorter (6 month) follow-up intervals recommended)

Bicuspid Aortic Valves Are Associated With Aortic Dilatation Out of Proportion to Coexistent Valvular Lesions

Keane, MG, et al. Circulation. 2000;102:III-35.



Bicuspid Ao valve – other associations

Coarctation of the aorta:

- Bicuspid aortic valve present in 25-50% of patients with coarctation

Aortic dissection:

- 10x increased rate compared to normal population

39-year old male with a 3-year history of highly symptomatic paroxysmal atrial fibrillation, for catheter ablation.

- Previously failed antiarrhythmic drug therapy with quinidine, and propafenone.
- CT angiography performed for assessment of pulmonary vein anatomy prior to EP ablation

The purpose of pulmonary vein ablation in this setting (afib) is:

- 1) make the pulmonary veins smaller to decrease blood flow
- 2) create a continuous scar that blocks electrical conduction pathways from the pulmonary veins to the left atrium
- 3) temporarily stabilize the patient before definitive surgery

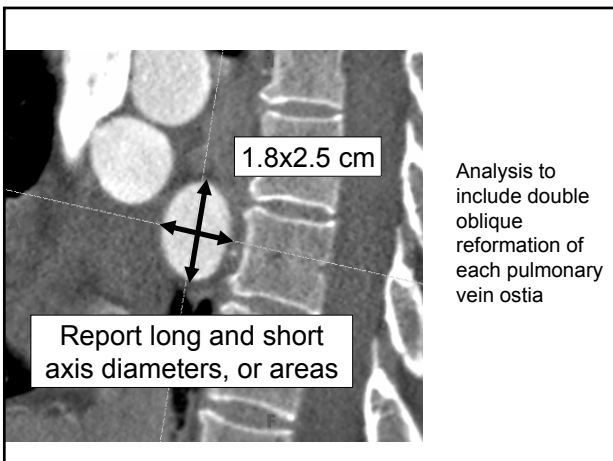
The purpose of pulmonary vein ablation in this setting (afib) is:

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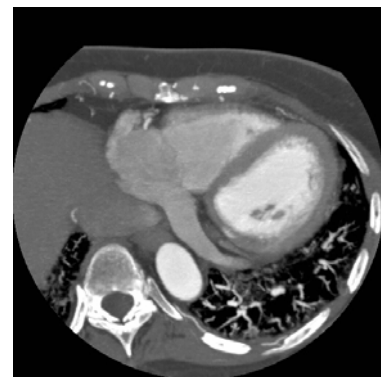
<http://www.sts.org/sections/patientinformation/arrhythmiasurgery/afib/>

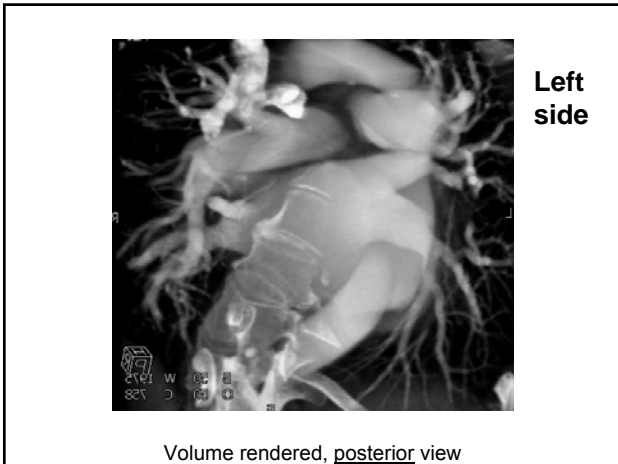
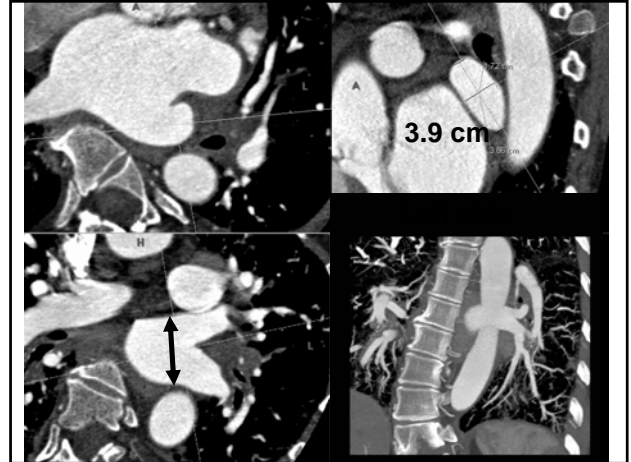
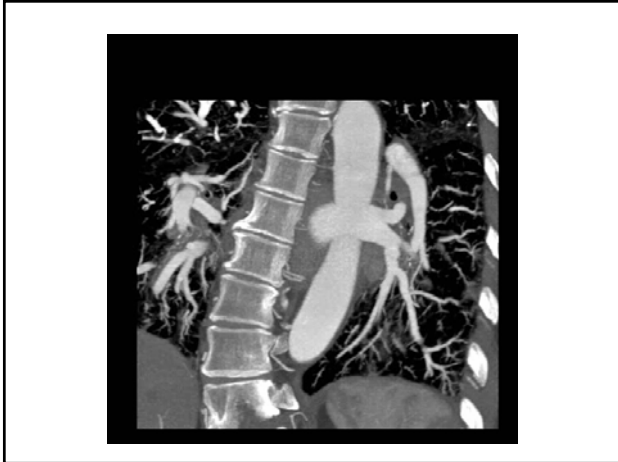
Key elements of a report for pulmonary vein analysis include:

- description of pulmonary vein size
- description of pulmonary vein variant anatomy
- evaluation for atrial clot
- description of incidental findings



Pulmonary vein variant anatomy





What anatomic variant is present for the left pulmonary veins that may affect the ablation procedure?

- 1) aneurysm of the left pulmonary vein
- 2) stenosis of the left pulmonary vein
- 3) common ostium for the left superior/ inferior veins
- 4) absent left superior vein

left

Volume rendered, posterior view

What anatomic variant is present for the left pulmonary veins that may affect the ablation procedure?

- 3) common ostium for the left superior/ inferior veins

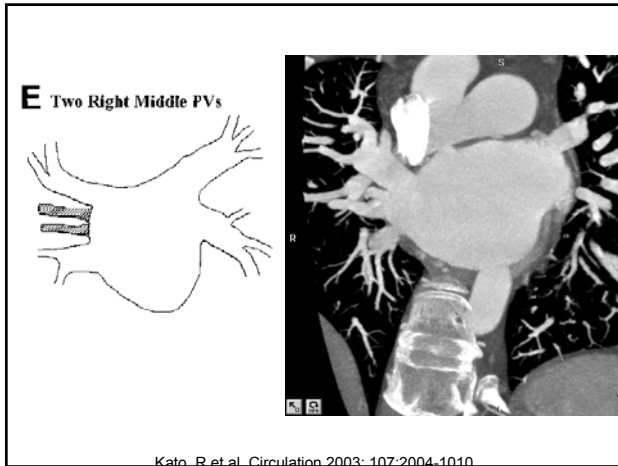
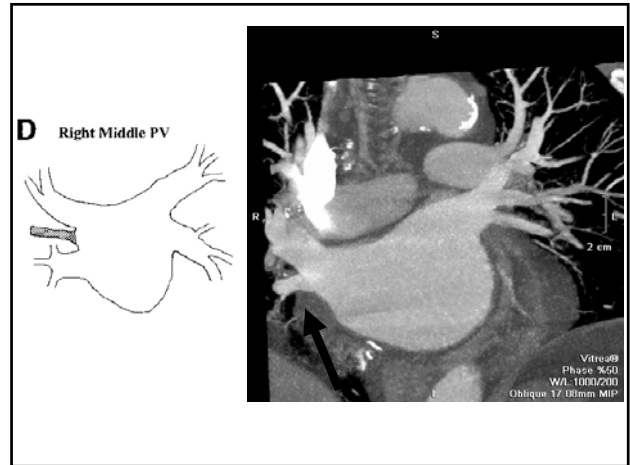
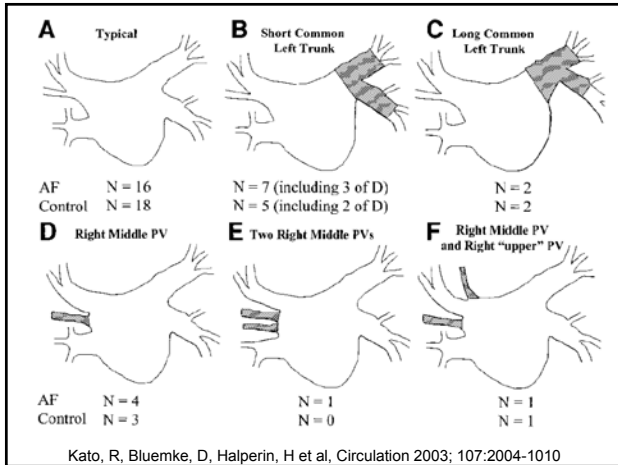
left

Volume rendered, posterior view

Pulmonary Vein Based Atrial Fibrillation Ablation Strategies

Anatomic PV Ablation

Courtesy of J Dong, Johns Hopkins



True statements regarding complications of pulmonary vein ablation:

- 1) Overall complication rate of 4%
- 2) Significant pulmonary vein stenosis is uncommon (0.4%)
- 3) Cardiac tamponade and cerebral embolus are complications
- 4) all of these

left

Volume rendered, posterior view

True statements regarding complications of pulmonary vein ablation:

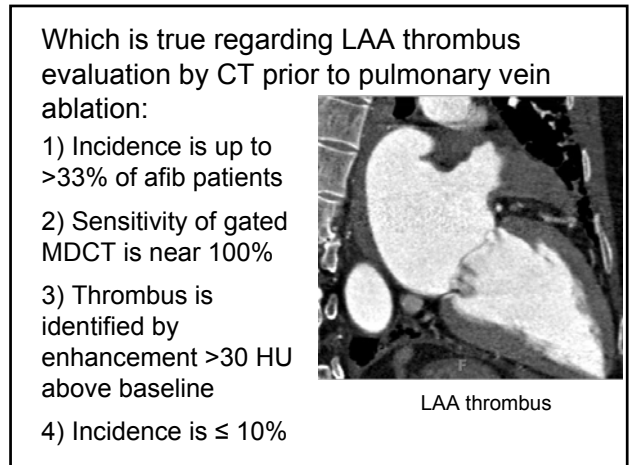
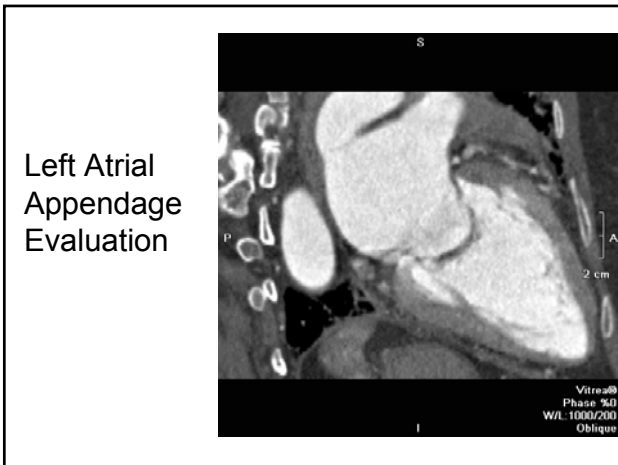
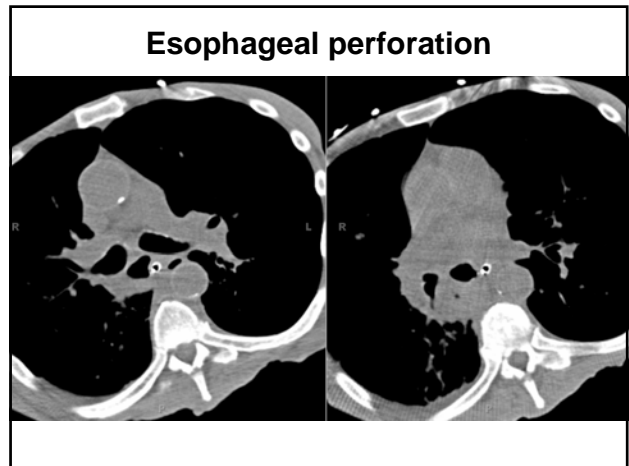
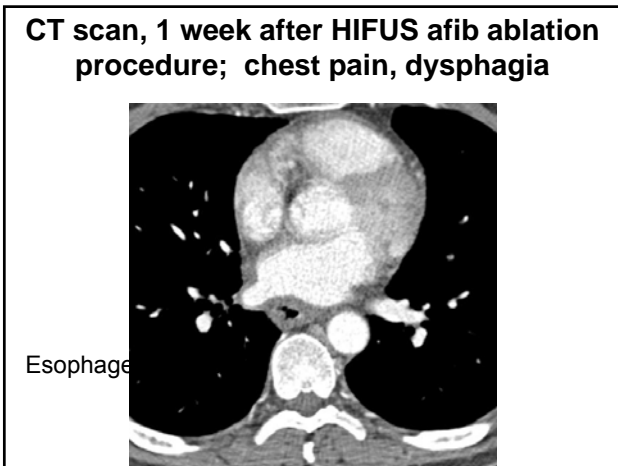
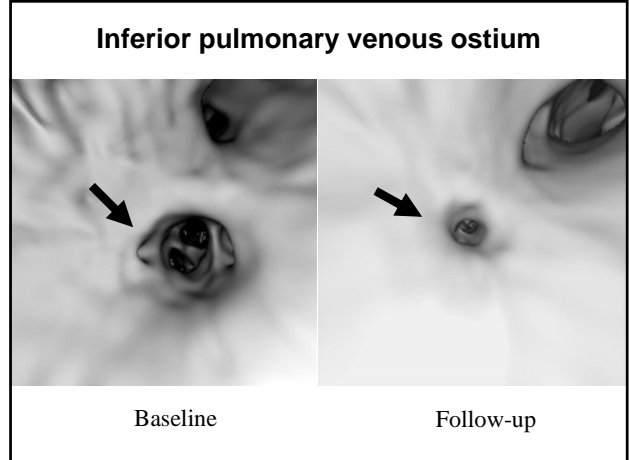
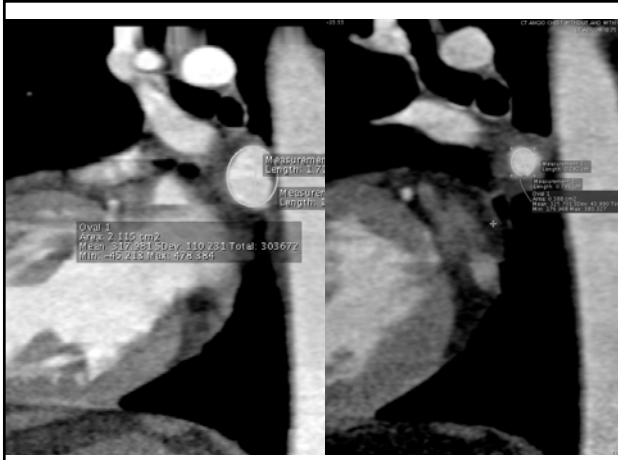
- 4) all of these

Volume rendered, posterior view

Bertaglia E, et al. Early complications of pulmonary vein catheter ablation for atrial fibrillation: A multicenter prospective registry on procedural safety. Heart Rhythm. 2007 Oct;4(10):1265-71.

1011 patients

- Overall cx rate:	3.9%
- peripheral vascular cx:	1.2%
- pericardial effusion:	0.8%
- cardiac tamponade:	0.6%
- cerebral aneurysm	0.5%
- significant pulmonary vein stenosis:	0.4%

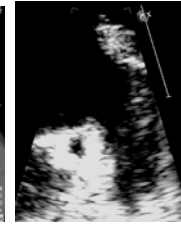


Which is true regarding LAA thrombus evaluation by CT prior to pulmonary vein ablation:

4) Incidence is $\leq 10\%$

Aora V, et al. Heart Rhythm Volume 2, Issue 5, S292-S293

- 1/178 patients had clot
- Johns Hopkins, 5/ 50 high risk patients
- routine anticoagulation, TEE screening account for low incidence rate



BASELINE

LA Clot:

- Clot enhancement not used for diagnosis
- Reported CT sensitivity: 40-100%

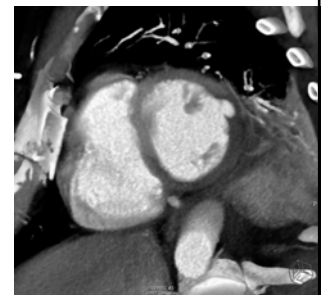
61 yo with chest pain 4 days post MI

- Referred to CT for evaluation of pulmonary embolism



Etiology of focal bulge LV wall:

- 1) subepicardial aneurysm
- 2) myocardial cleft, variant
- 3) rupture with false aneurysm

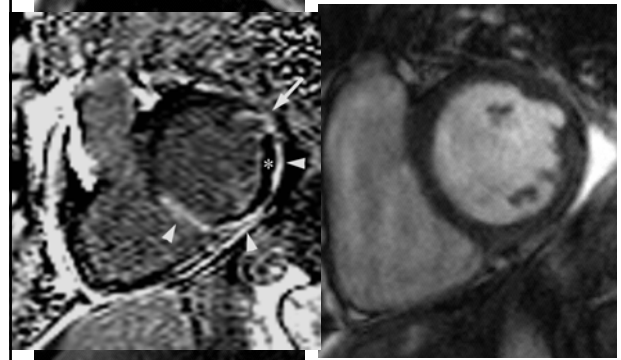


Etiology of focal bulge LV wall:

- 1) subepicardial aneurysm



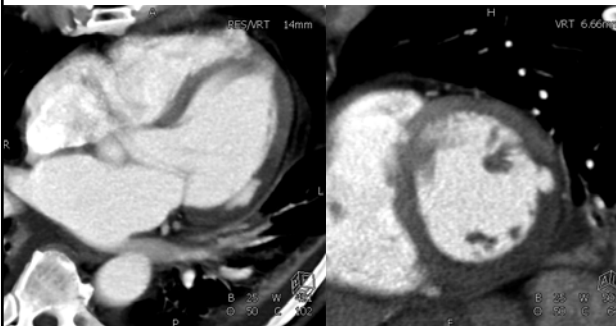
MRI performed same day



Delayed gadolinium MRI
1-pass Perfusion

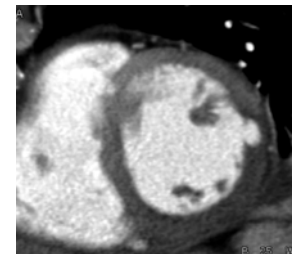
SSFP MRI Cine

In this setting, what is the reason for decreased cardiac attenuation on MDCT?



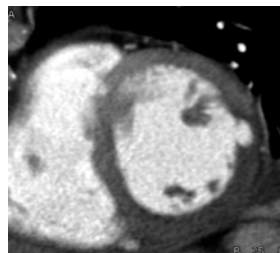
Reason for decreased cardiac attenuation (best answer):

- 1) acute myocardial infarction
- 2) inflammatory change due to pneumonia
- 3) transient perfusion, normal variant
- 4) artifact due to MDCT gating



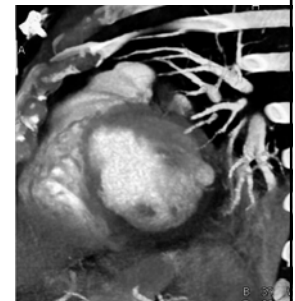
Reason for decreased cardiac attenuation (best answer):

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Appropriate management:

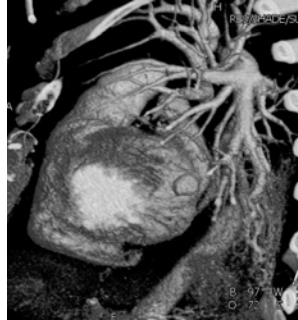
- 1) medical therapy alone
- 2) emergency cardiac catheterization
- 3) routine care
- 4) emergency cardiac surgery/ repair



Appropriate management

4) emergency cardiac surgery/ repair

- Represents an impending myocardial rupture with high likelihood of death
- Lesion was patched at surgery



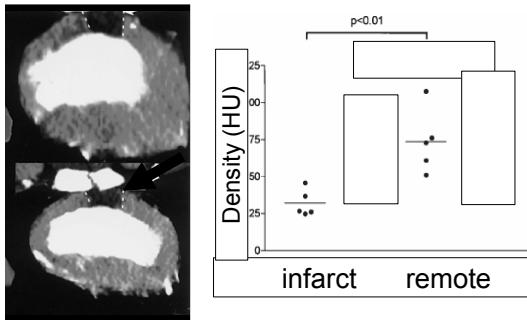
Acute Myocardial Infarction: Contrast-enhanced MDCT in a Porcine Model

Udo Hoffman, Ryan Millea, Christian Enzweiler, Maros Ferencik, Scott Gulick, Jim Titus, Stephan Achenbach, Dylan Kwait, David Sosnovik, Thomas J. Brady
Radiology, 231:697-701, 2004.

- Porcine AMI model (N=7)
- 4 slice MDCT scanning
- 3 hours post-coronary ligation – LAD or LADD
- CT Infarct size $17 \pm 6\%$ similar to TTC $14 \pm 6\%$

Myocardial Viability by MDCT

Lower density in the area of infarction

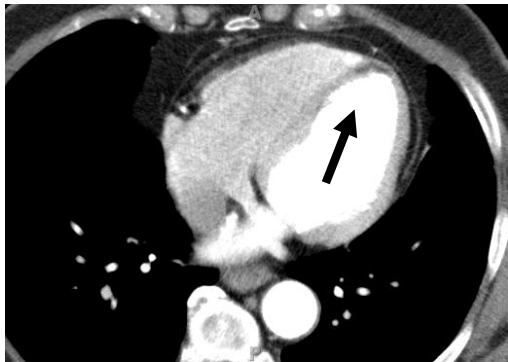


Hoffmann U, et al. *Radiology*. 2004;231(3):697-701.

LV infarct, thrombus



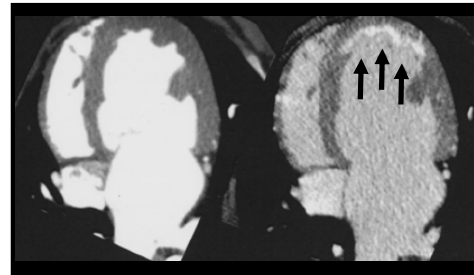
1st pass perfusion abnormality



Contrast-Enhanced Multidetector Computed Tomography Viability Imaging After Myocardial Infarction

Characterization of Myocyte Death, Microvascular Obstruction, and Chronic Scar
Circulation 2006 113:394

Albert C. Lardo, PhD; Marco A.S. Cordeiro, MD, PhD; Caterina Silva, MD; Luciano C. Amado, MD; Richard T. George, MD; Anastasios P. Saliaris, MD; Karl H. Schuleri, MD; Veronica R. Fernandes, MD; Menekhem Zviman, PhD; Saman Nazarian, MD; Henry R. Halperin, MD, MA; Katherine C. Wu, MD; Joshua M. Hare, MD; Joao A.C. Lima, MD

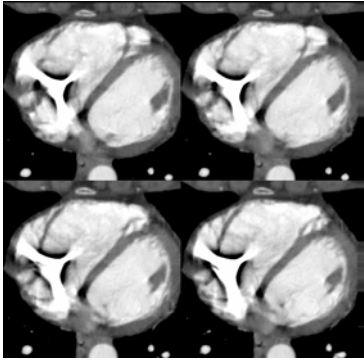




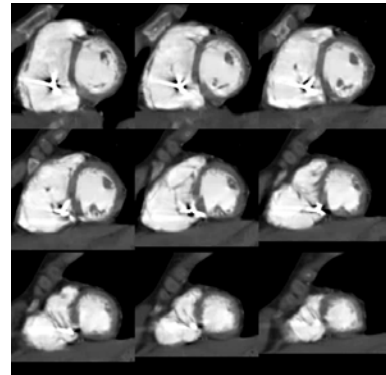
39 yo female with irregular heart rate, PVC's

- ICD placed 2 years previously
- Multiple appropriate shocks
- CT scan to assess for cardiac anatomy and function

39 yo female, irregular heart rate, PVC's

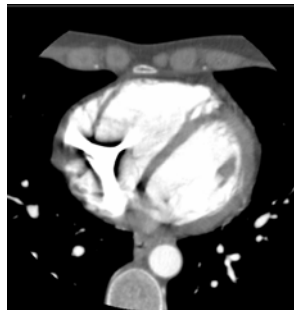


39 yo female, irregular heart rate, PVC's



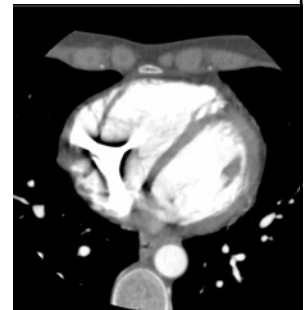
Which finding is NOT present:

- 1) Enlargement of the left ventricle
- 2) Enlargement of the right ventricle
- 3) Hypertrabeculation of the right ventricle
- 4) Dysfunction of the right ventricle



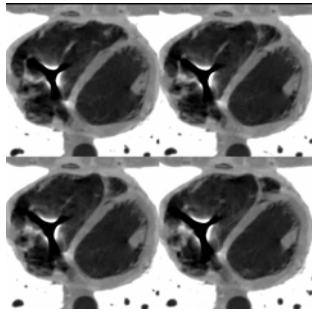
Which finding is NOT present:

- 1) Enlargement of the left ventricle
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- 4) Dysfunction of the right ventricle



Which of these does **NOT** cause RV enlargement in an adult?

- 1) ARVD/C
- 2) Pulmonary hypertension
- 3) Intracardiac L→R shunt
- 4) Extracardiac L→R shunt
- 5) Amyloidosis



Which of these does **NOT** cause RV failure and enlargement in an adult?

- 5) Amyloidosis

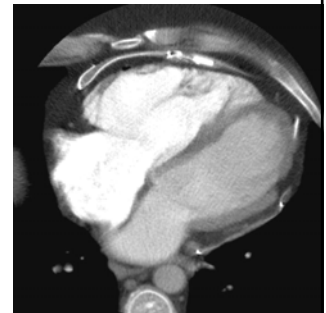
Cardiac amyloidosis causes restrictive cardiomyopathy, left-sided symptoms usually predominate

RV enlargement, differential diagnosis in the setting of suspected ARVD

- Normal variant (young age, <20)
- PAPVR
- Cardiac shunt or valve
- Other cardiomyopathy (rare)
- Pulmonary hypertension

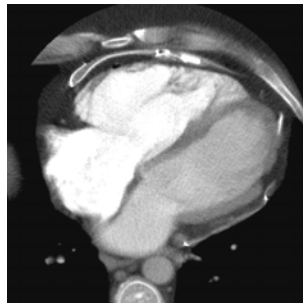
2nd patient, same hx. Best diagnosis:

- 1) ARVD
- 2) Pulmonary hypertension
- 3) Intracardiac L→R shunt
- 4) Extracardiac L→R shunt

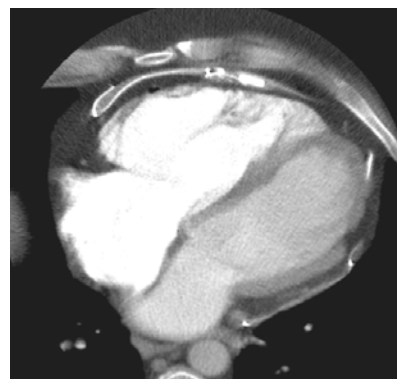


2nd patient same hx and diagnosis:

- 1) ARVD
- Arrhythmogenic right ventricular dysplasia

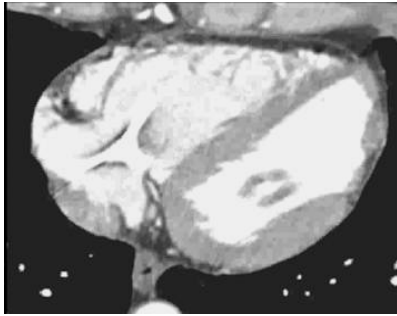


ARVD CT findings



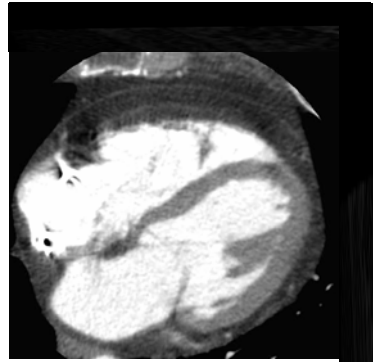
Enlarged RV (RV/ LV diameter > 1)
 Relatively preserved LV
 Very thin, atrophic RV wall
 LV fatty replacement

CT findings for ARVD



- RV fatty wall replacement
- Relatively preserved LV
- Very thin, atrophic RV wall
- LV fatty replacement

Nonspecific CT findings for ARVD



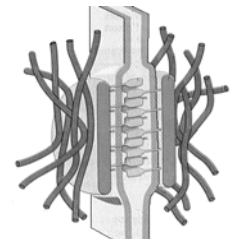
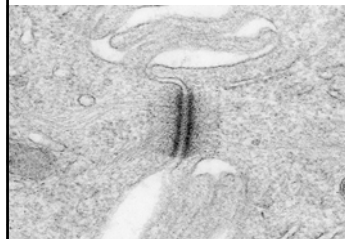
- RV fatty wall replacement

Arrhythmogenic RV Dysplasia

- Fibrofatty infiltration of RV resulting in ventricular tachycardia
- Palpitations, syncope, sudden death
- Age 20-40.
- 30-50% cases are familial (autosomal dominant). MR screening of family members common, and likely to increase with improved genotyping.

Genes identified with mutations causing ARVD

<u>Gene</u>	<u>Protein</u>	<u>Inheritance</u>
PKP2	plakophilin-2	dominant



Desmosome: mechanical cell coupling

“McKenna” Criteria:

*2 major, 1 major+2 minor, 4 minor**

<u>Criteria</u>	<u>Major</u>
Abnormal structure/function	<ul style="list-style-type: none"> •Severe dilatation and reduction of RV EF •Localized RV aneurysms •Severe segmental dilatation of the RV
ECG repolarization or depolarization abnormalities	
Arrhythmia	QRS prolongation
Family history	Confirmed at autopsy or surgery

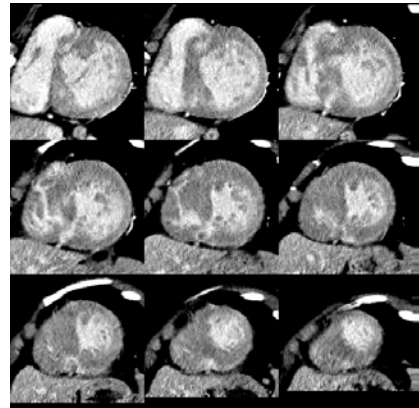
Br Heart J 1994;71

35 yo female, recurrent palpitation and syncope

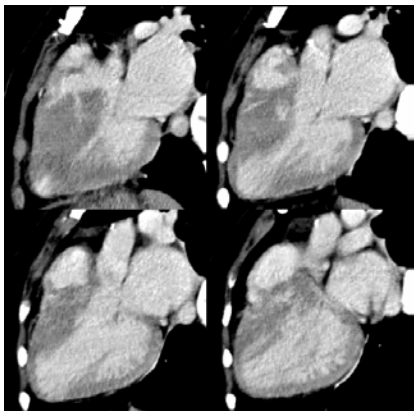
- Mother – sudden death at age 38
- 2 brothers: cardiac disease
- MDCT after 150 ml iodine contrast



Courtesy: C. Rochitte, MD



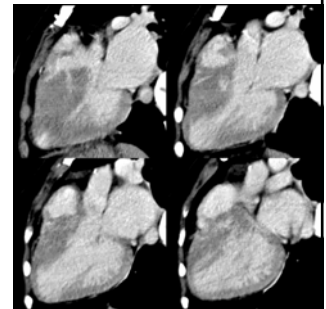
Courtesy: C. Rochitte, MD



Courtesy: C. Rochitte, MD

Best diagnosis:

- 1) hypertrophic cardiomyopathy
- 2) anterior wall infarction
- 3) sarcoidosis
- 4) myocarditis



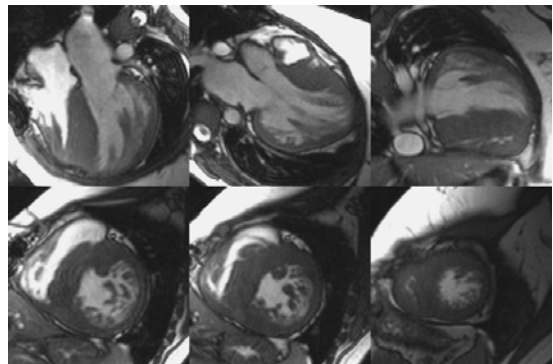
Best diagnosis:

- 1) hypertrophic cardiomyopathy



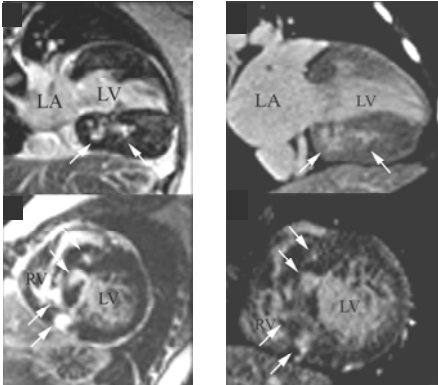
Circulation. 2007;115:e430-e431

MRI, same patient



Circulation. 2007;115:e430-e431

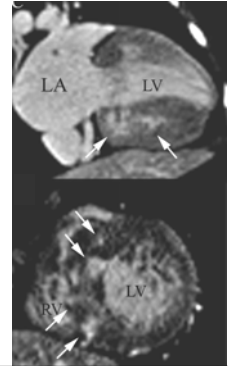
MRI (left), CT (right) – delayed



Circulation. 2007;115:e430-e431

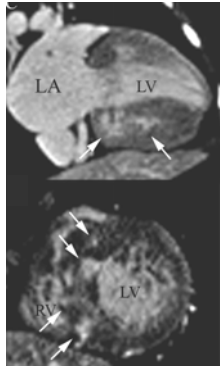
Current understanding of enhancement in hypertrophic cardiomyopathy

- 1) enhancement is associated with congestive failure
- 2) enhancement relates to better prognosis, fewer arrhythmias
- 3) enhancement corresponds to collagen deposition



Current understanding of enhancement in hypertrophic cardiomyopathy

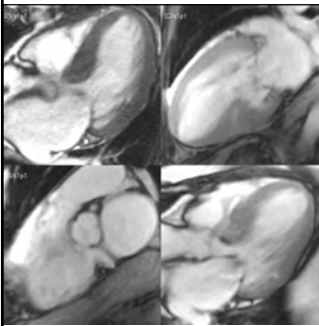
- 1) enhancement is associated with congestive failure
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Hypertrophic Cardiomyopathy

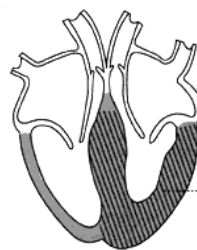
- abnormal muscle fibers, leading to thickened heart walls.
- *Myocardial disarray*: disorganized myocytes with fibrosis
- 1/500, 0.2% in the U.S.
- Chest pain, syncope, sudden death

Hypertrophic Cardiomyopathy (HOCM)

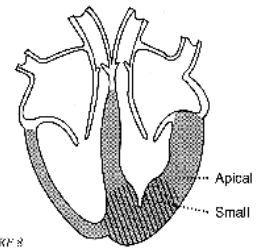


- Most common cause of sudden cardiac death <30 yrs old
- (This case: death in the mother, both male siblings were affected)

Hypertrophic Cardiomyopathy

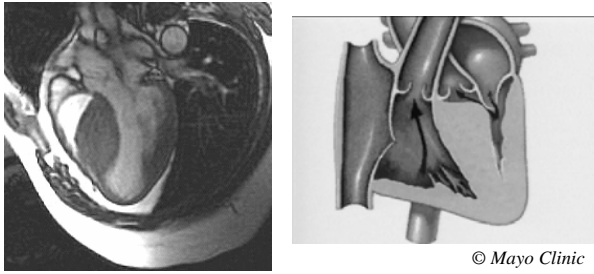


Symmetric



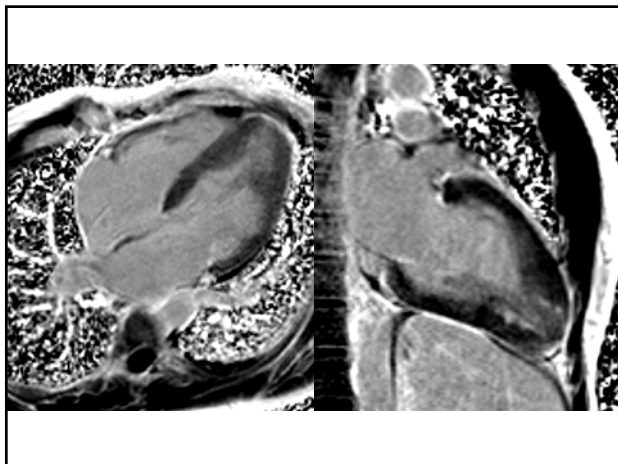
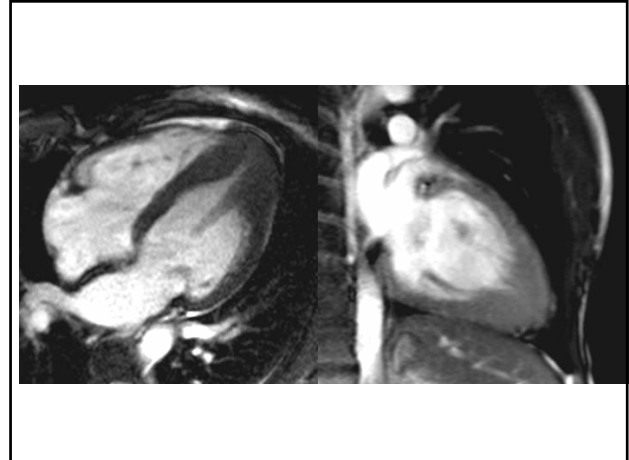
Apical variant

Asymmetric septal hypertrophy

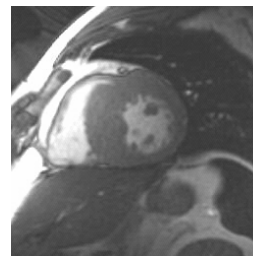


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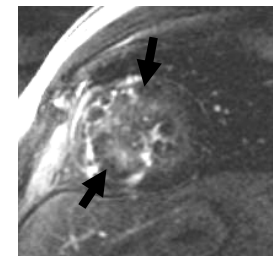
Systolic anterior motion (SAM) of the mitral valve at late systole, resulting in aortic outflow obstruction.



Hypertrophic CM: 80% show patchy intramural delayed enhancement



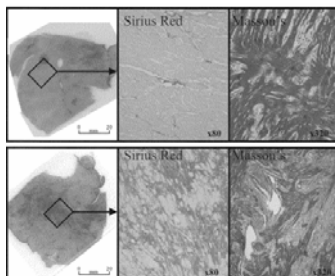
Cine



Delayed contrast

Hypertrophic cardiomyopathy

Delayed gadolinium enhancement correlates with collagen deposition but not myocardial disarray.¹



¹Moon et al, JACC, Volume 43, Issue 12, 16 June 2004, Pages 2260-2264

Late enhancement of the left ventricular wall in hypertrophic cardiomyopathy by ultrafast CT: a comparison with regional myocardial thickening

Br J Radiol. 1991 Nov;64(767):993-1000.

Saito H, Naito H, Takamiya M, Hamada S, Imakita S, Ohta M.

- 8 patients with HCM with ultrafast CT
- Late enhancement was patchy, on delayed phase
- Out of 48 LV segments, 21 had LE.
- Regional wall thickening in segments with LE was less segments without LE

Thank you

Acknowledgements:

Joint coordination of NASCI and RSNA

