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01.14.14

RAD-PATH CONFERENCE: CARDIAC MASSES

Topics from ABR Core study guide

- Modalities
  - Indications and limitations of echo, CT, MRI
  - MRI basics pertinent to our cases
- **Cardiac masses**
  - Non-tumor masses
    - Thrombus
    - Lipomatous hypertrophy of the interatrial septum
  - Primary benign tumors
    - Myxoma
    - Lipoma
    - Rhabdomyoma
    - Fibroma
  - Malignant tumors
    - Angiosarcoma
    - Lymphoma
    - Metastasis

Modalities

Evidence-based guidelines (ACR)

APPROPRIATE USE CRITERIA

ACCF/SCCT/ACR/AHA/ASE/ASNC/NASCI/SCAI/SCMR 2010 Appropriate Use Criteria for Cardiac Computed Tomography

ACCF/ACR/AHA/NASCI/SCMR 2010 Expert Consensus Document on Cardiovascular Magnetic Resonance: A Report of the American College of Cardiology Foundation Task Force on Expert Consensus Documents

Revised 2011 (Resolution 25)*

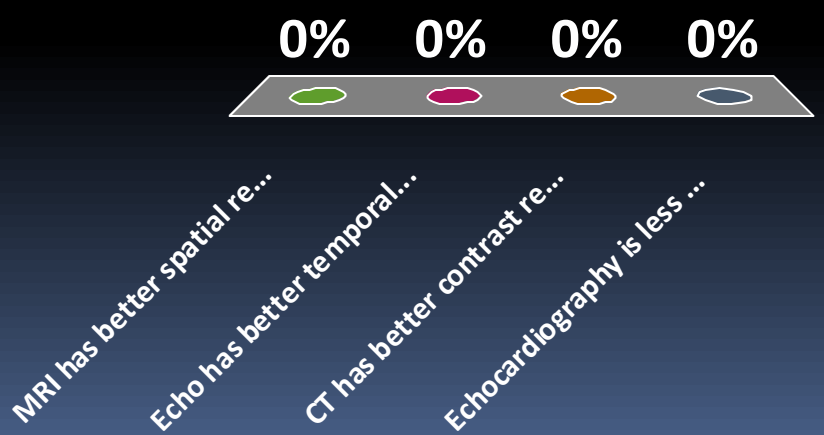
ACR–NASCI–SPR PRACTICE GUIDELINE FOR THE PERFORMANCE AND INTERPRETATION OF CARDIAC MAGNETIC RESONANCE IMAGING (MRI)

Modalities

- Echo **first-line** test
  - **Identification** and localization of a mass
  - Excellent temporal resolution, dynamic assessment
  - Low cost, wide availability, ease of use
- MRI often vital for **further evaluation**
  - Excellent contrast resolution – IDs tissues
  - Often provides definitive **characterization**
- CT second line
  - Patients who cannot undergo cardiac MR
  - When MRI is unavailable

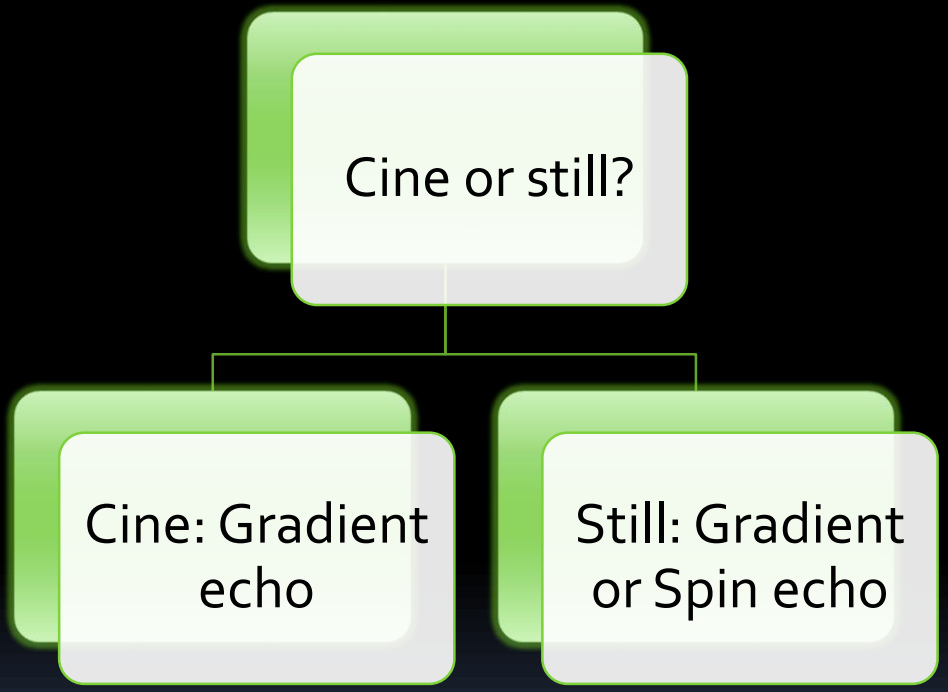
Which of the following statements is true?

A. MRI has better spatial resolution than CT.
B. Echo has better temporal resolution than CT.
C. CT has better contrast resolution than MRI.
D. Echocardiography is less useful than CT, MRI in patients with arrhythmias.

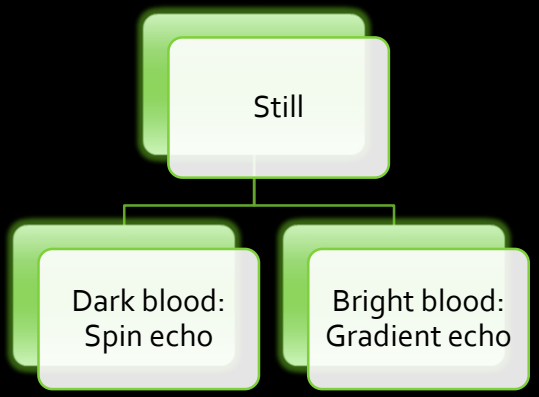


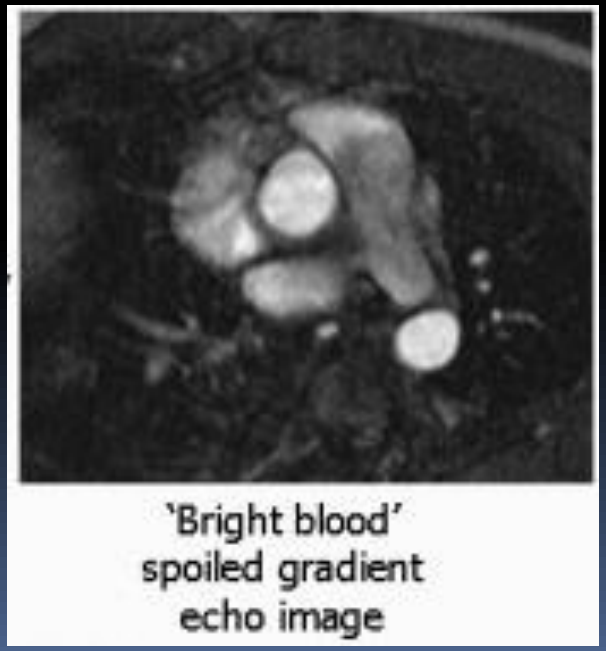
MR basics

CMR: Identifying sequences



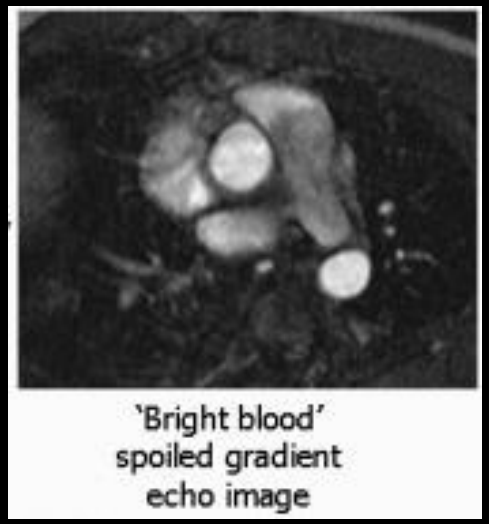
CMR: Identifying sequences





CMR: Identifying sequences

'Black blood'
spin echo image



'Bright blood'
spoiled gradient
echo image

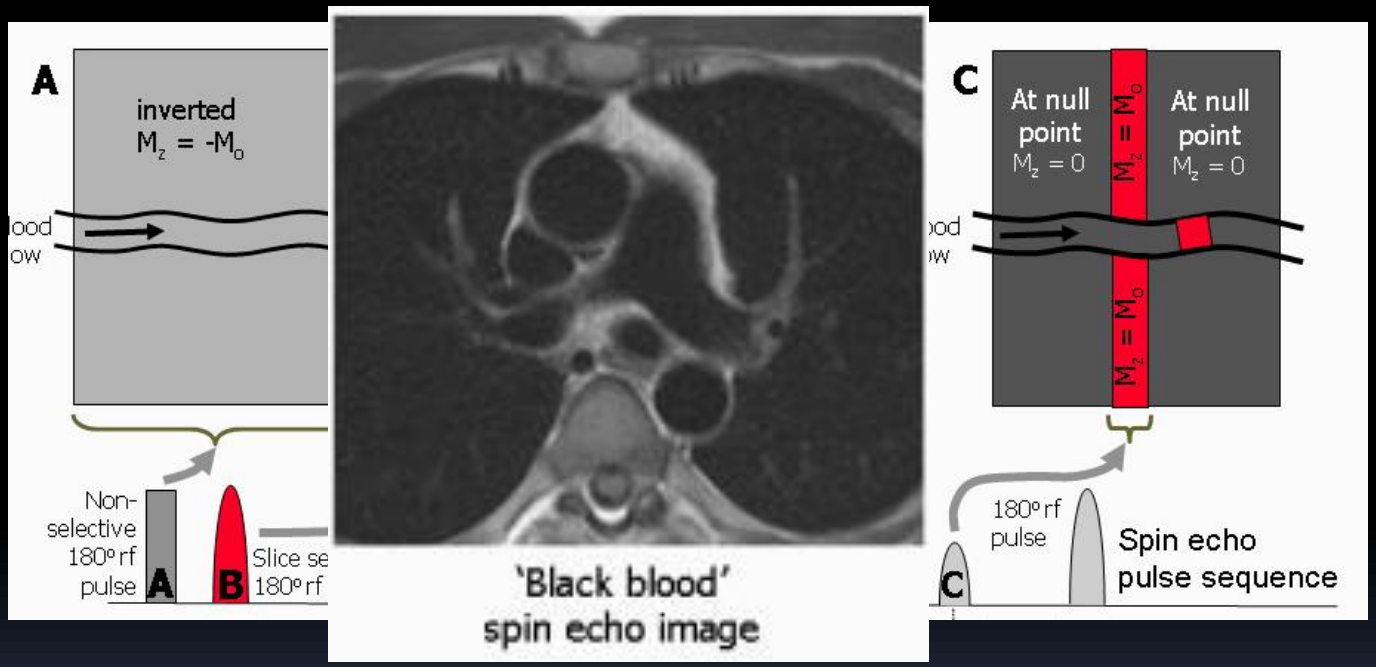
SE/dark blood:

- Uses RF pulses to produce echo
- Longer acquisition time – each image requires breath hold
- High res., good **anatomic detail** (look at sharpness of interfaces)
- Quality (SNR) > Speed
- DIR – double inversion recovery

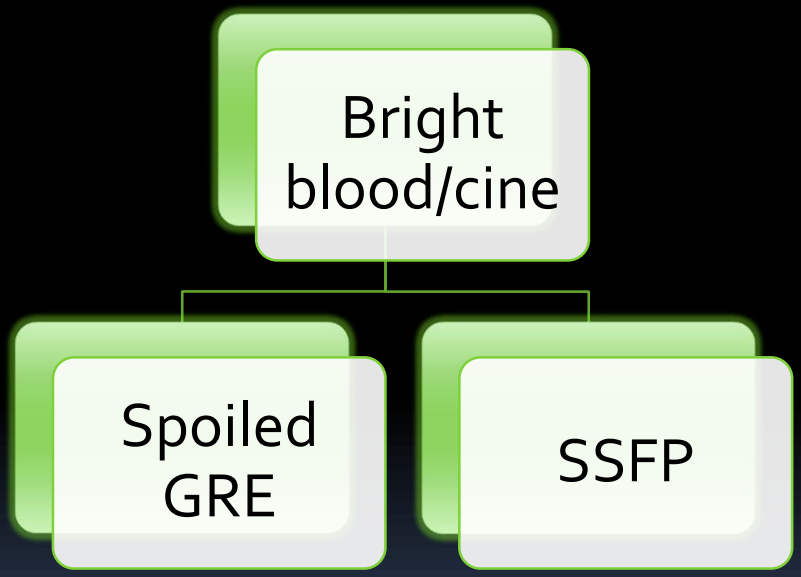
GRE/bright blood:

- Shifting gradients produce echo
- Workhorse – **speed/versatility**
- Short acquisition – cine imaging
- Metal artifact (T_2^*)
- Blood flow, valve disease, perfusion, delayed enhancement, MRA
- Speed > Quality (SNR)

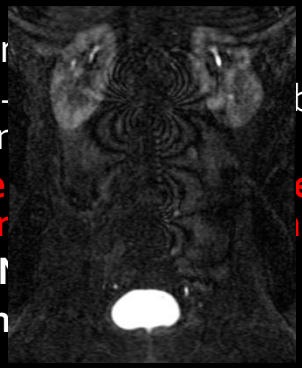
Double inversion recovery



CMR: Identifying sequences

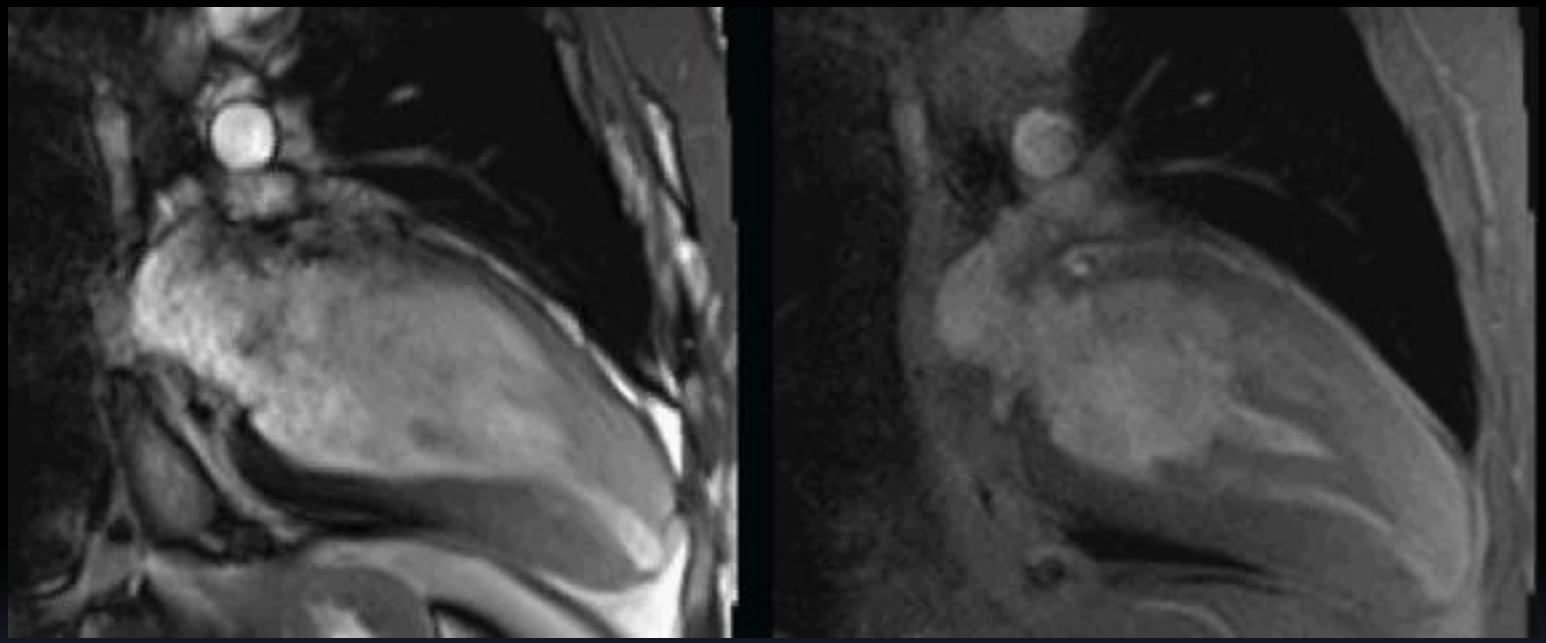


- Cine images: SSFP vs. spoiled GRE (both bright blood)
  - SSFP (Sier
    - T2/T1 - brighter than myocar
    - Excelle een blood/r r interface
    - High SI
    - India in
  - Spoiled GRE
    - Susceptibility artifact
    - Flow dependent contrast – brighter in areas of through-plane than in plane flow.
    - Less definition at endocardial border because of slower flow

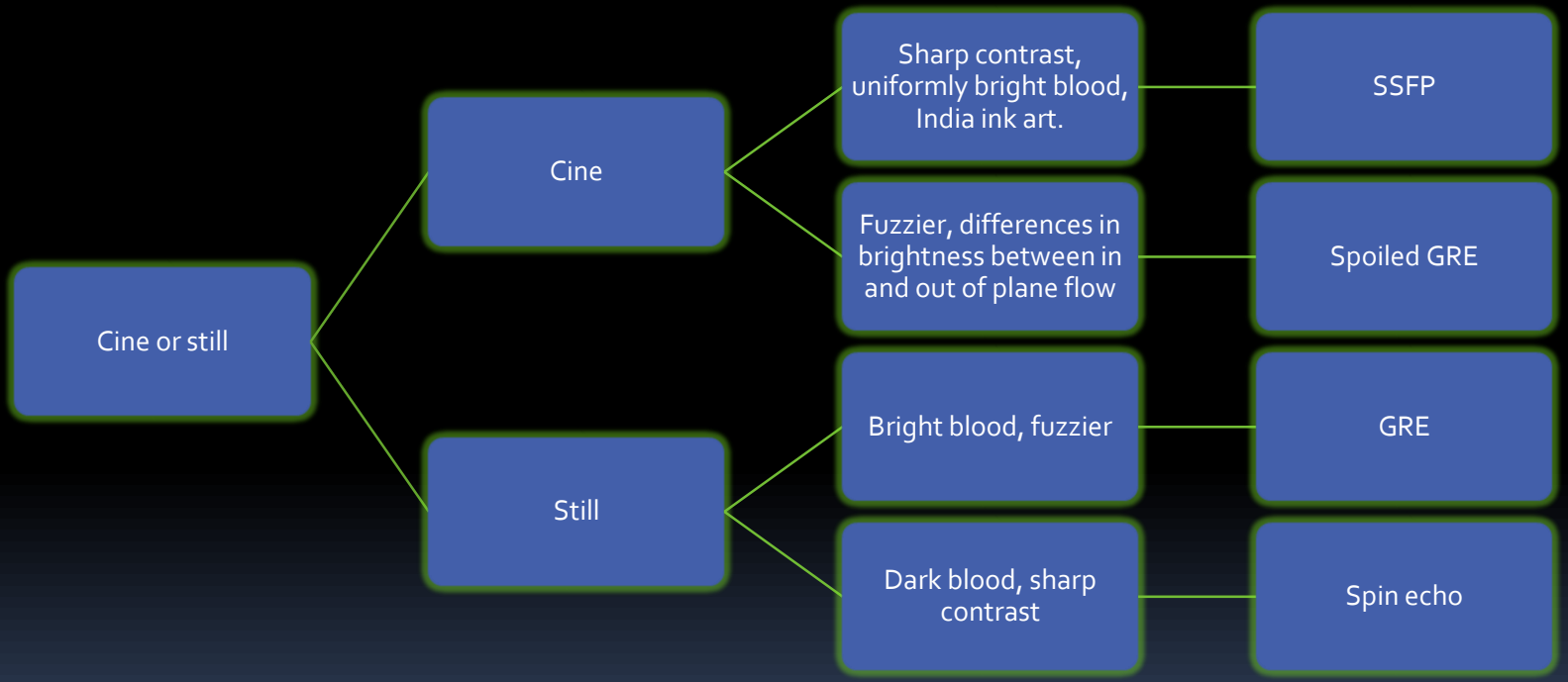


https://www.med-ed.virginia.edu/courses/rad/cardiacmr/Techniques/Cine.html

SSFP vs. spoiled GRE Cine

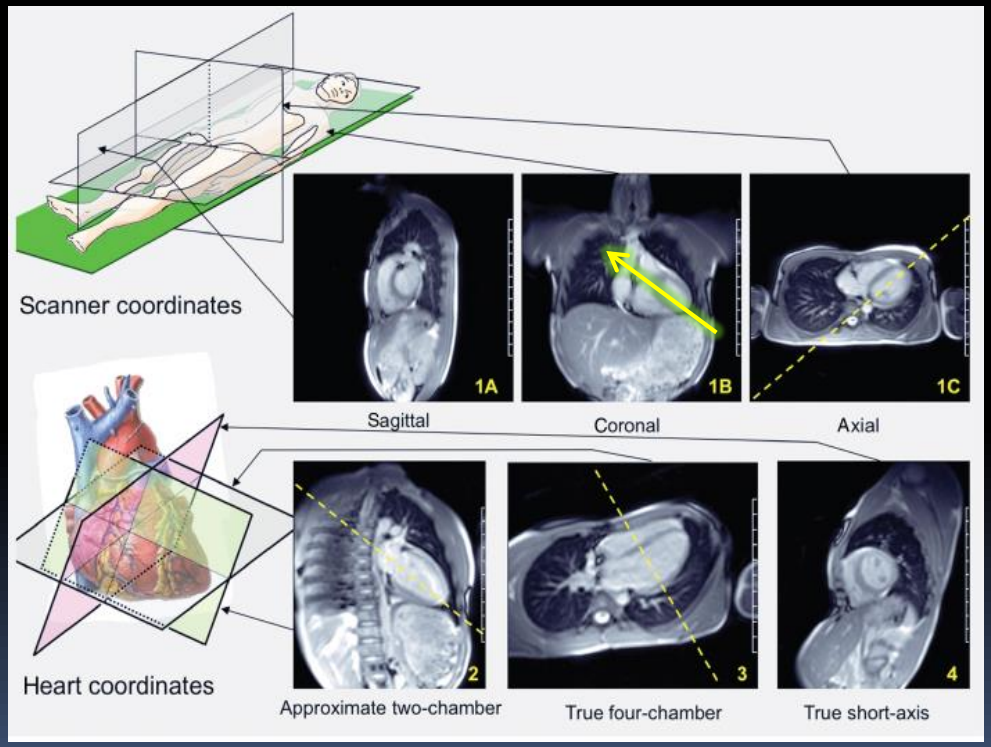


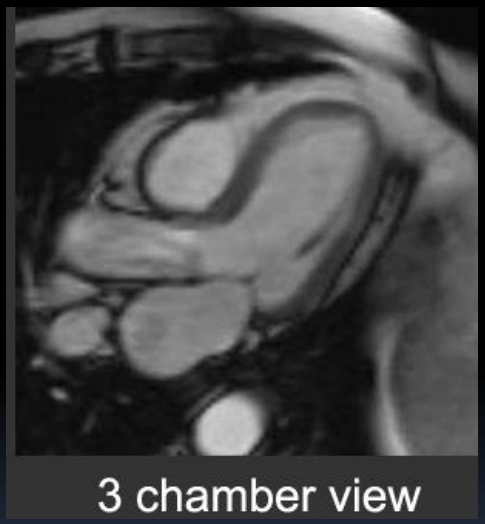
CMR: Identifying sequences



CMR: Identifying views

Vertical long axis/2 chamber: through plane of LA/LV from axial
Horizontal long axis/4 chamber view: through LV/LA from two chamber
Short axis: Through LV/RV mid-ventricle
3 chamber view, inflow/outflow: LVOT, RA, LA





Aka inflow/outflow

Hurst's The Heart > Chapter 23. Magnetic Resonance Imaging of the Heart
https://www.med-ed.virginia.edu/courses/rad/cardiacmr/Techniques/Cine.html

CMR: Identifying views

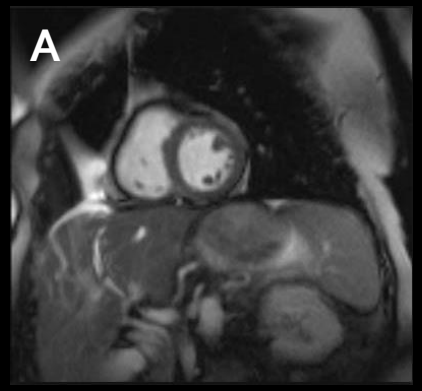
Atrial short axis

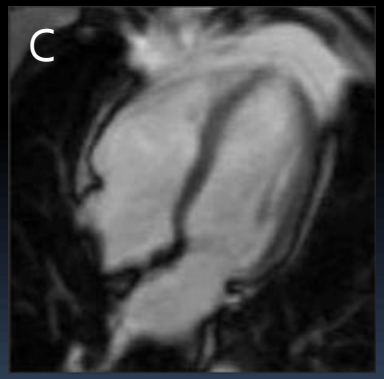
Four ch. long axis

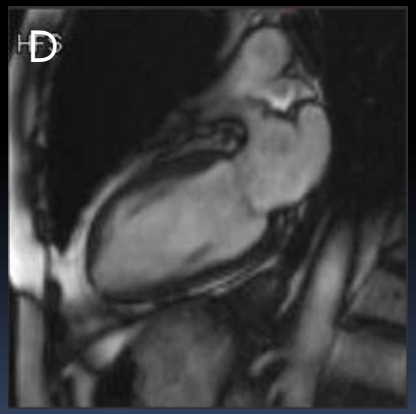
Hurst's The Heart > Chapter 23. Magnetic Resonance Imaging of the Heart

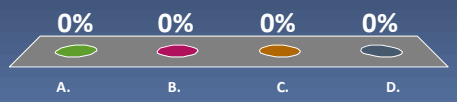
Which CMR view is matched to the correct descriptor?

A. Vertical long axis/2 chamber
B. Inflow/outflow
C. Short axis
D. 4 chamber



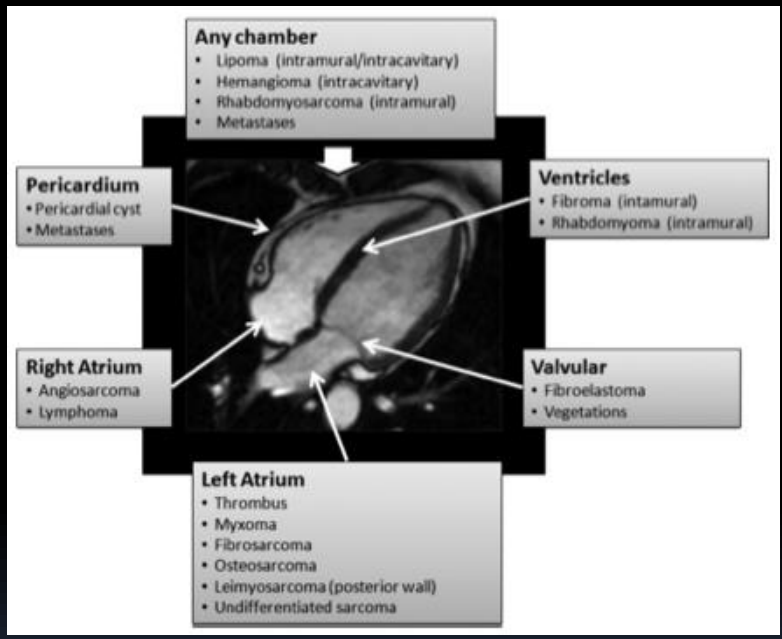






Patient and mass characteristics I

- Where is the abnormality?
  - Anatomic space (e.g., pericardium, valve, myocardium?)
  - Chamber
  - Involved areas within chamber
  - Relationship with other structures
- Broad based or pedunculated?

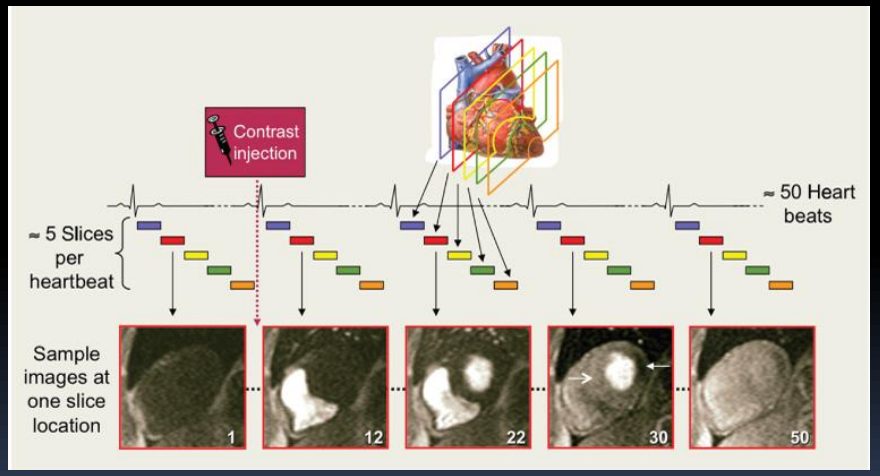


Patient and mass characteristics II

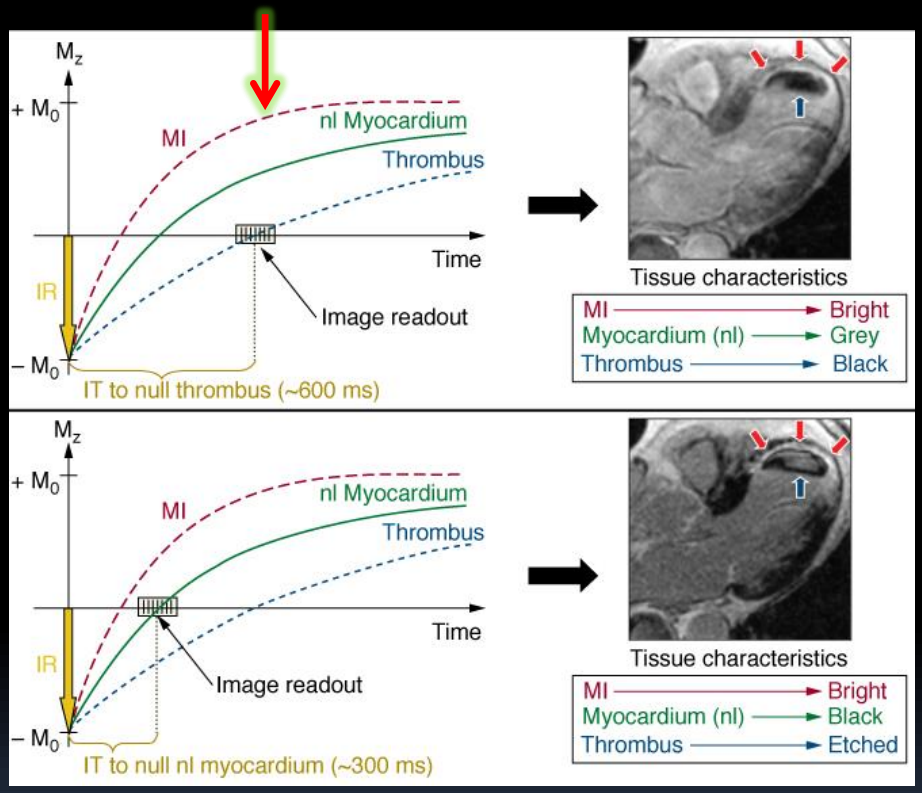
- Does patient have other disease?
  - Embolic phenomena
  - Primary malignancy
- Tissue features
  - Fat
  - Calcification
  - Enhancement (early? late?), vascularity

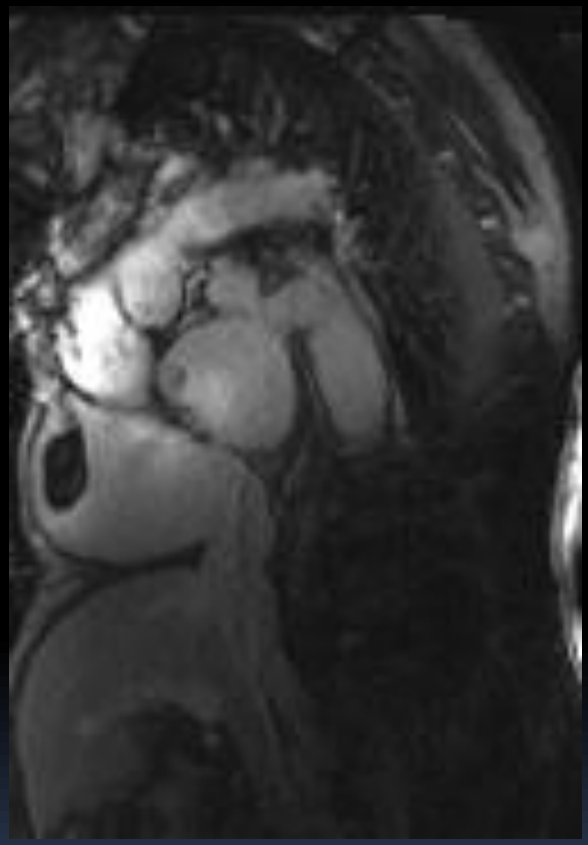
Tissue ID tools cardiac MR

- Blood/thrombus:
  - Long TI
  - Lack of enhancement
- Fat:
  - FS
- Vascularity:
  - First-pass perfusion
  - Delayed enhancement
- Metal and calcium:
  - Susceptibility



Long TI imaging DE-Long TI





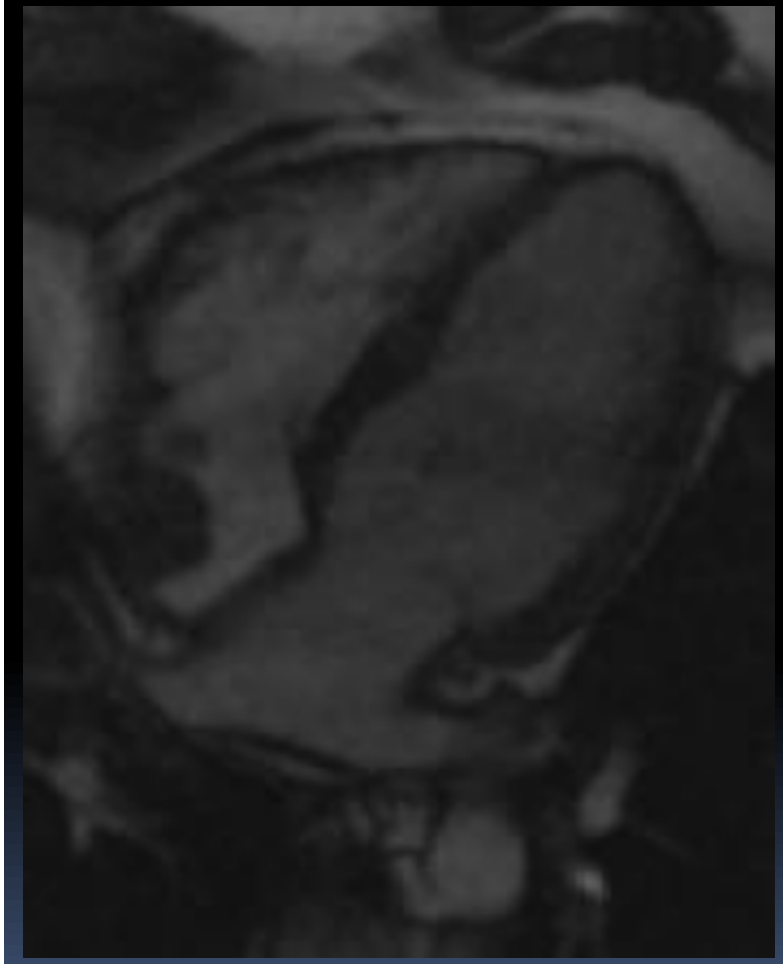
Long TI, 800 ms.

At null point of myocardium, thrombus appears "etched" due different T1 values of different components in periphery and center (e.g., platelets, thrombin, fibrin).

Case 1

- History: 46-year-old male with a history of stage IIA Hodgkin's lymphoma in remission, with incidental cardiac mass on restaging. Clinical question of lymphoma vs. thrombus.

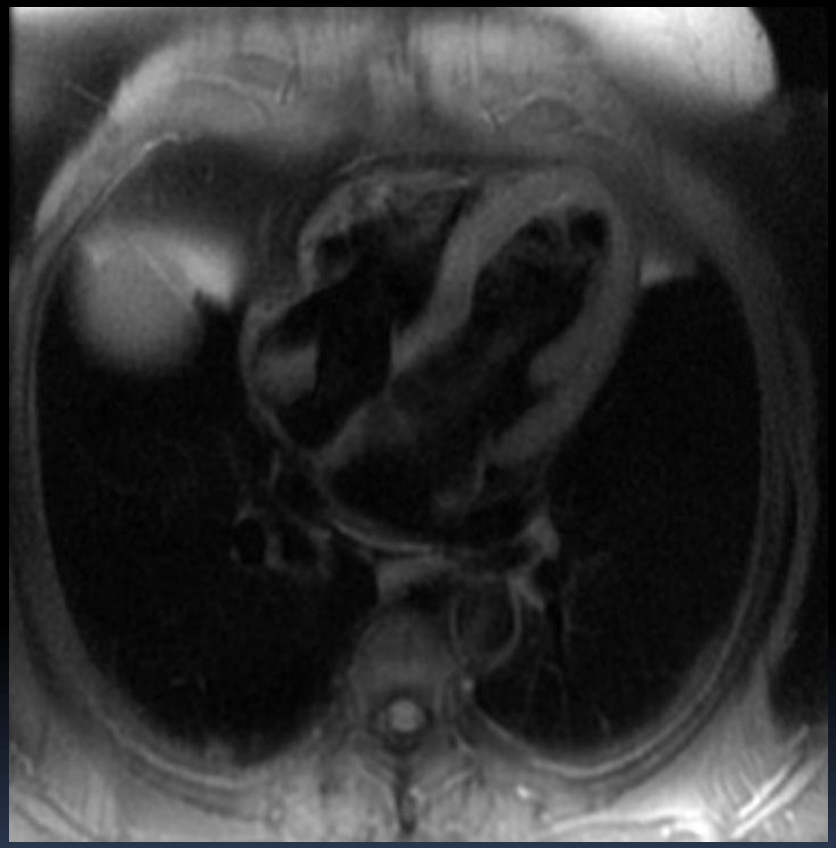
Case 1 – Where is the lesion?



SSFP 4 chamber

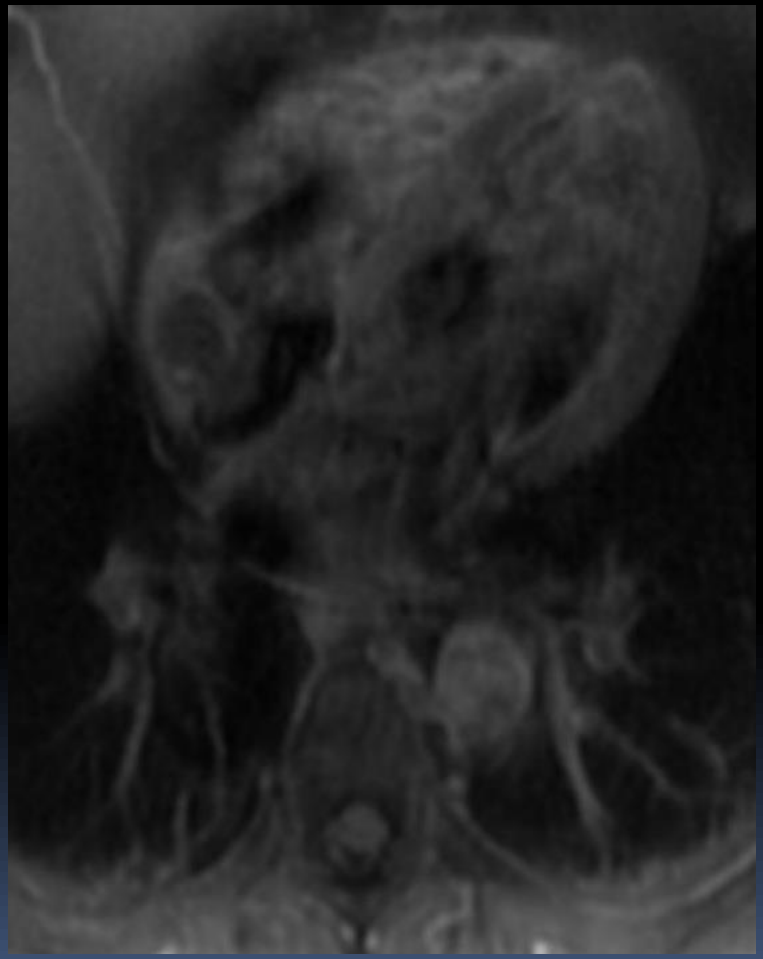
SSFP atrial short axis

Case 1



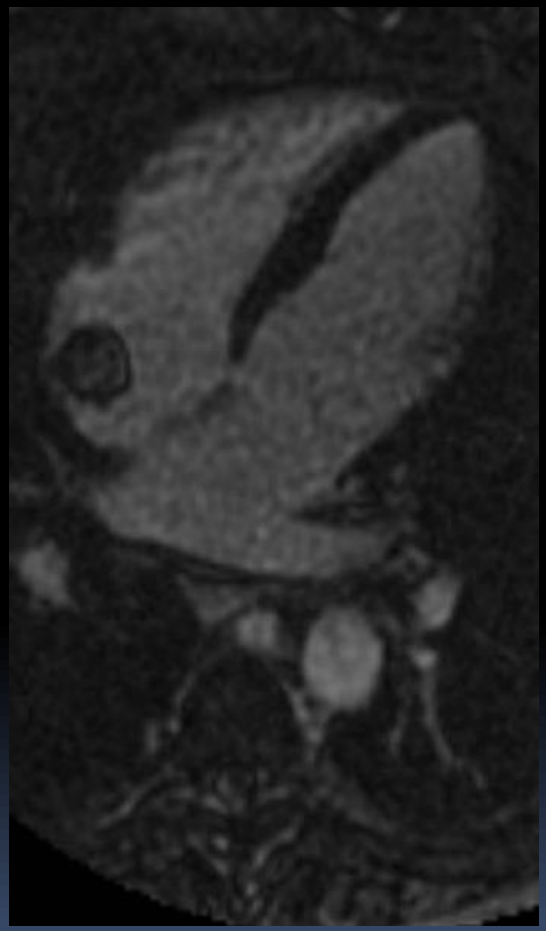
T1 and T1 post **fat saturation**

Case 1

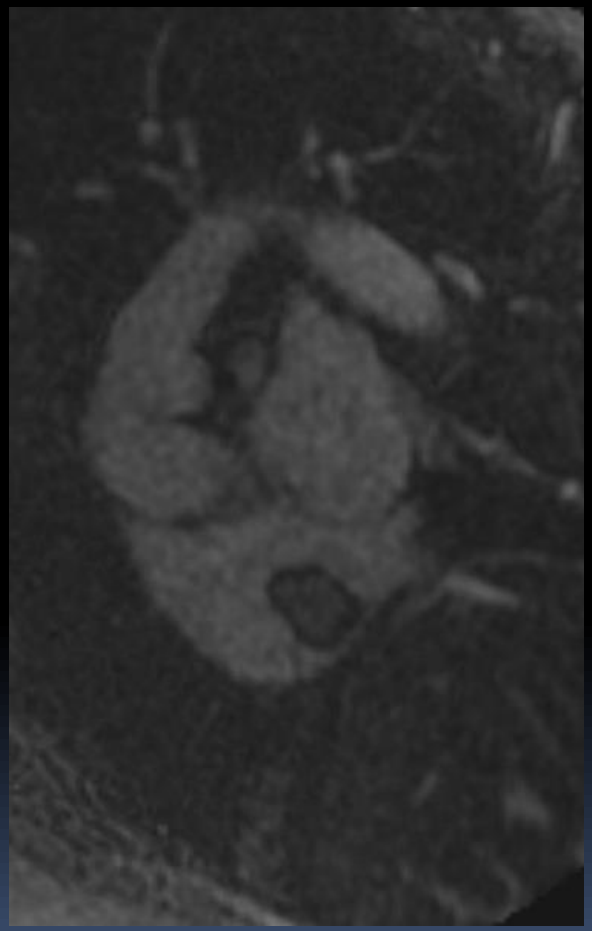


Post-gadolinium

Case 1



4 ch DE IR – nulled myocardium



Mod. SA

Case 1

Long TI, 800 ms. (companion case)

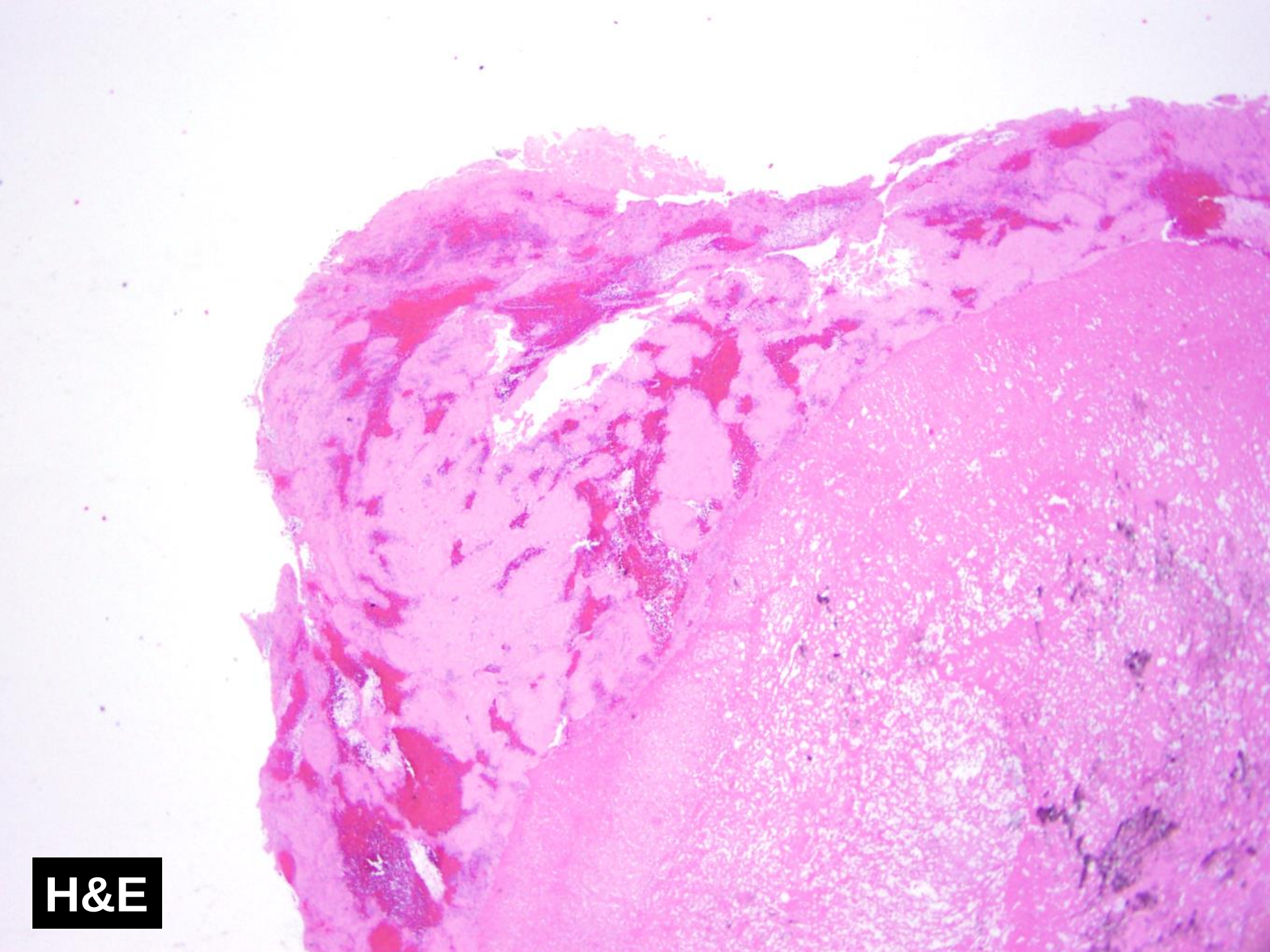
Thrombus (MRN 20495363, BS-06-39602)

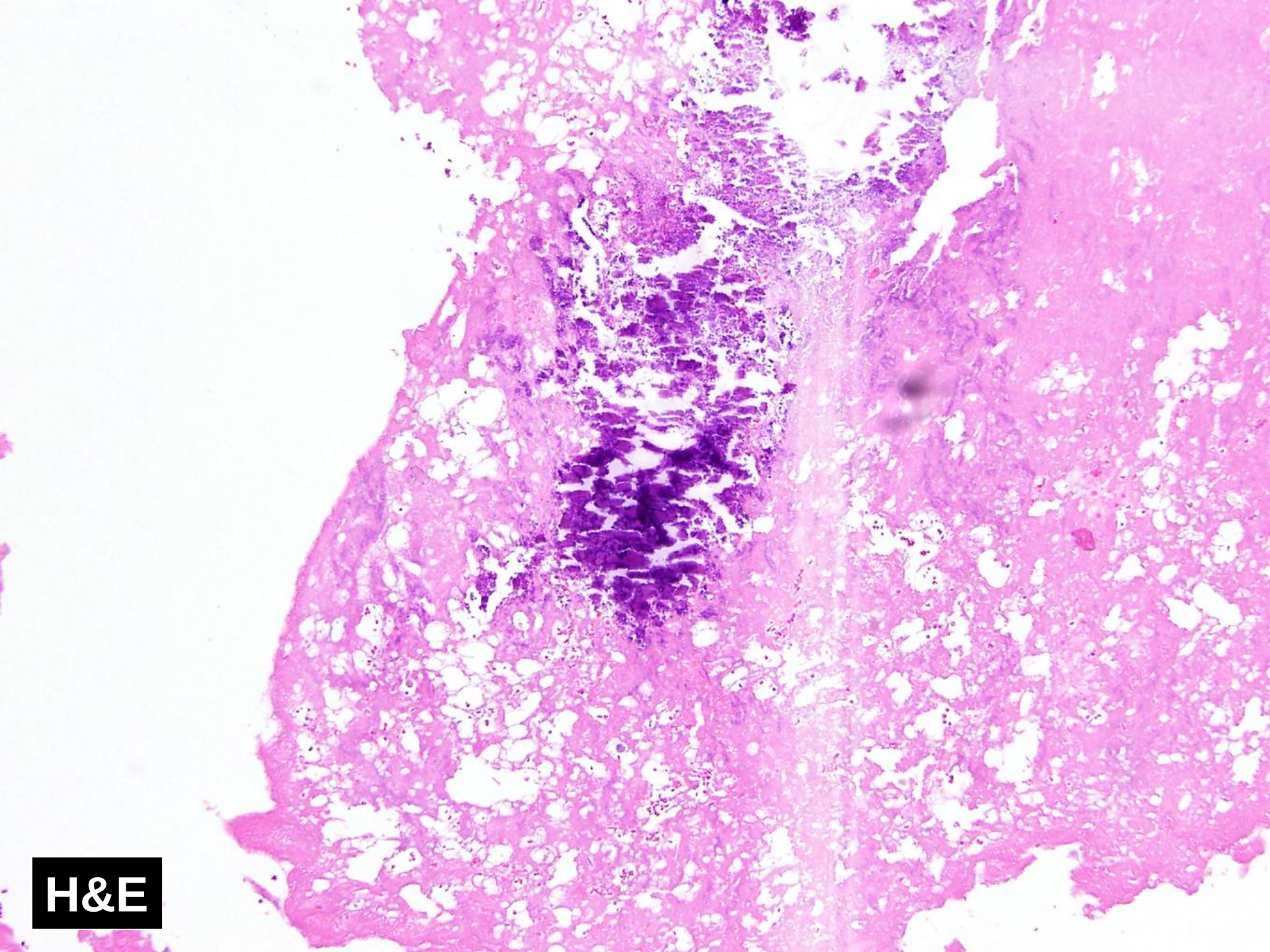
PATHOLOGIC DIAGNOSIS:

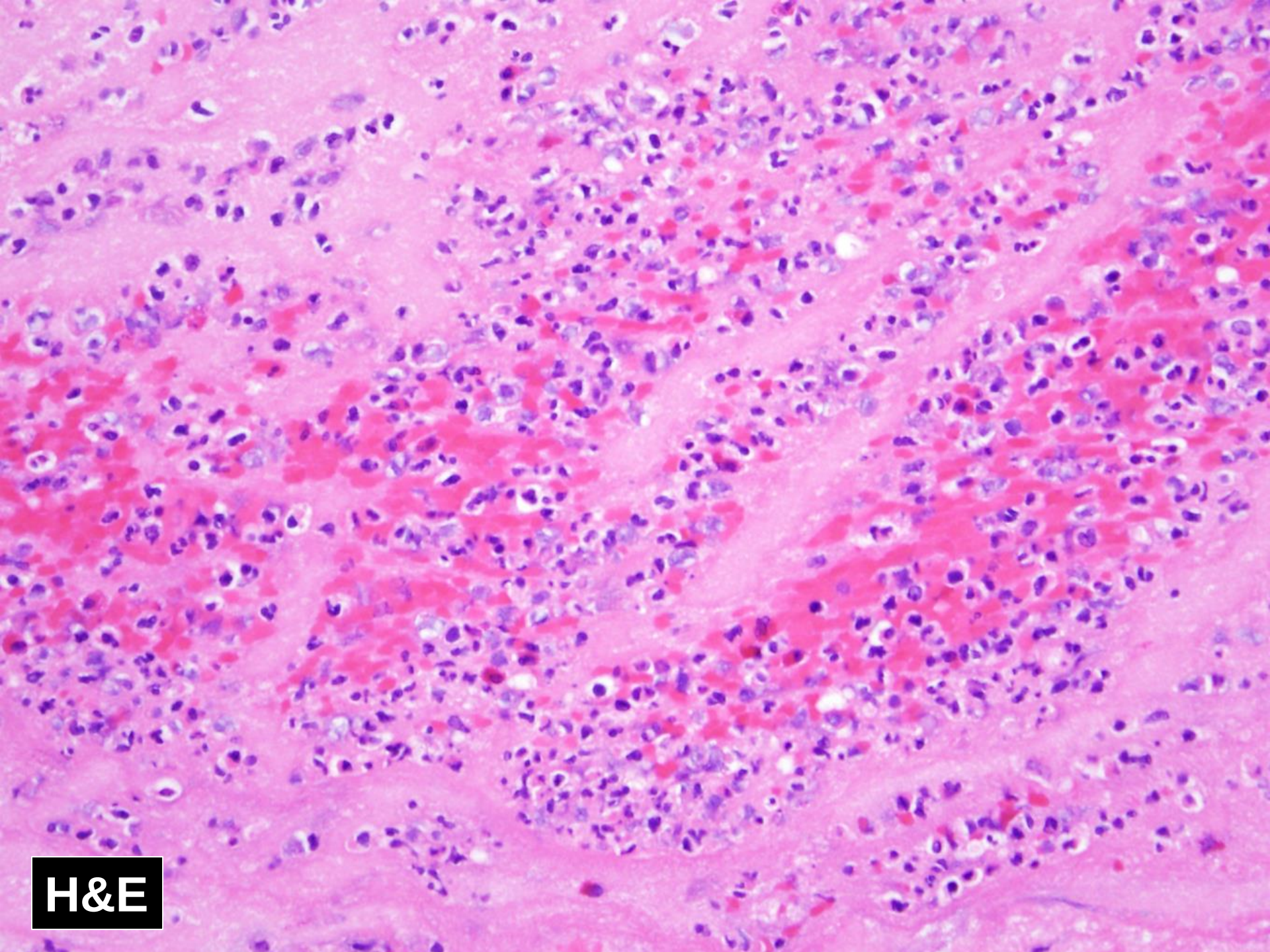
RIGHT ATRIAL MASS:

Bland, unorganized thrombus with focal dystrophic calcification (3.1 cm).

Thrombus (MRN 20495363, BS-06-39602)


H&E


H&E


H&E

Cardiac thrombus: Clinical

- Most common intracardiac "mass".
- LA – Afib, LV—post MI
- Main risk is embolization. Implicated in ~30% of strokes.
- Treatment is anticoagulation.
- If no improvement , question diagnosis.
- Other "pseudo-tumors": normal cardiac structures, pericardial cyst, caseous calcification of mitral valve, LHIAS.

Cardiac Imaging: A Multimodality Approach by Thelen, Erbel

Cardiac thrombus: Imaging

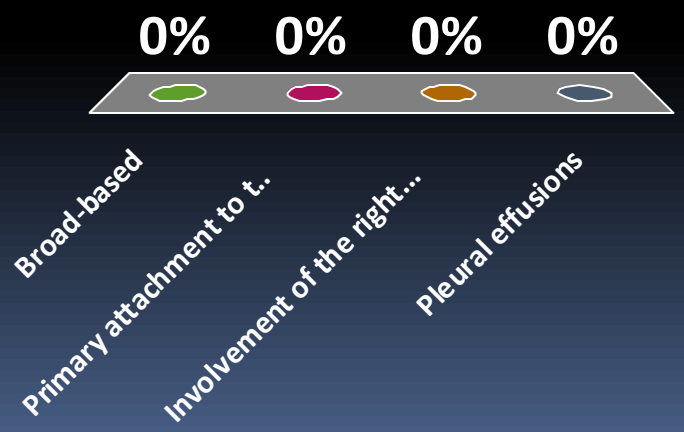
- Usually identified with echo, may need to be further characterized using MRI.
- May be mural, lining infarct OR lobular/ovoid filling defect. May be pedunculated/mobile.
- Layered thrombus may be difficult to see on cine.
- Signal characteristics vary by age.
- **Delayed post-Gd+ IR GRE highly sensitive, specific. Long TI – takes longer to recover T1 than myocardium.**
- **No or centripetal/"tram track" enhancement** (rare, chronic), best seen on early enhanced images (60 s).

Cardiac Imaging: A Multimodality Approach by Thelen, Erbel

“Real” tumors: Benign or Malignant?

Which feature suggests that a tumor is benign?

A. Broad-based
B. Primary attachment to the inter-atrial septum
C. Involvement of the right heart
D. Pleural effusions

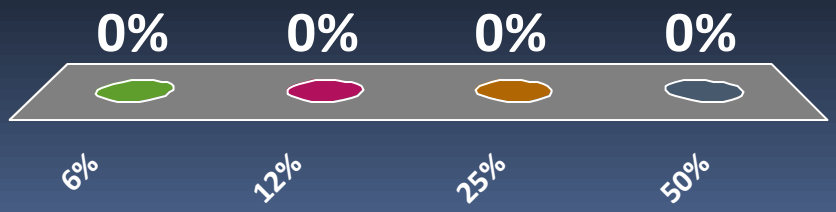


Signs of malignancy

Tumor characteristics	Tissue characteristics
Large (esp. if >5 cm)	Hemorrhage, necrosis
Irregular, ill-defined	Hemorrhagic effusions
Invasion through tissue planes	Enhancement
Involving the right heart, right atrial free wall	High T1, low T2 (melanoma met)
Pericardial/pleural effusions, nodularity	
Multiple	

About what % of cardiac tumors are malignant?

A. 6%
B. 12%
C. 25%
D. 50%

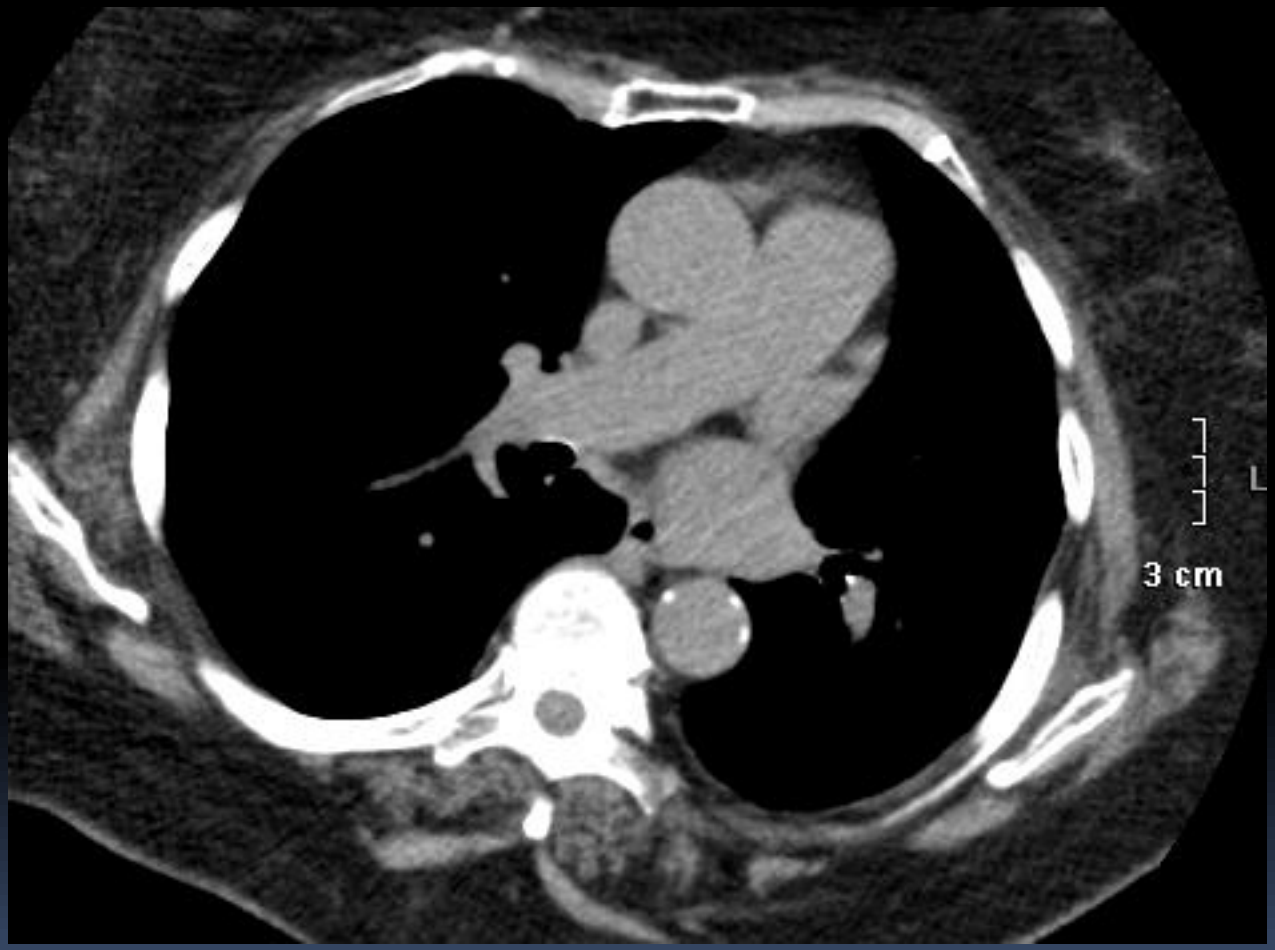


Benign tumors

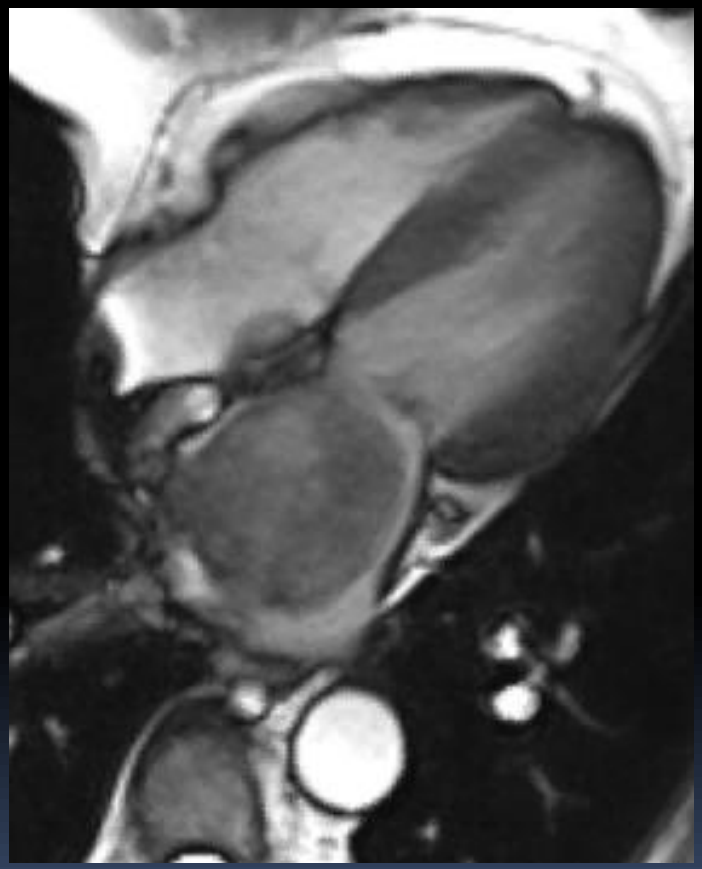
Case 2

- 78-year-old female with persistent cough after recent pneumonia.

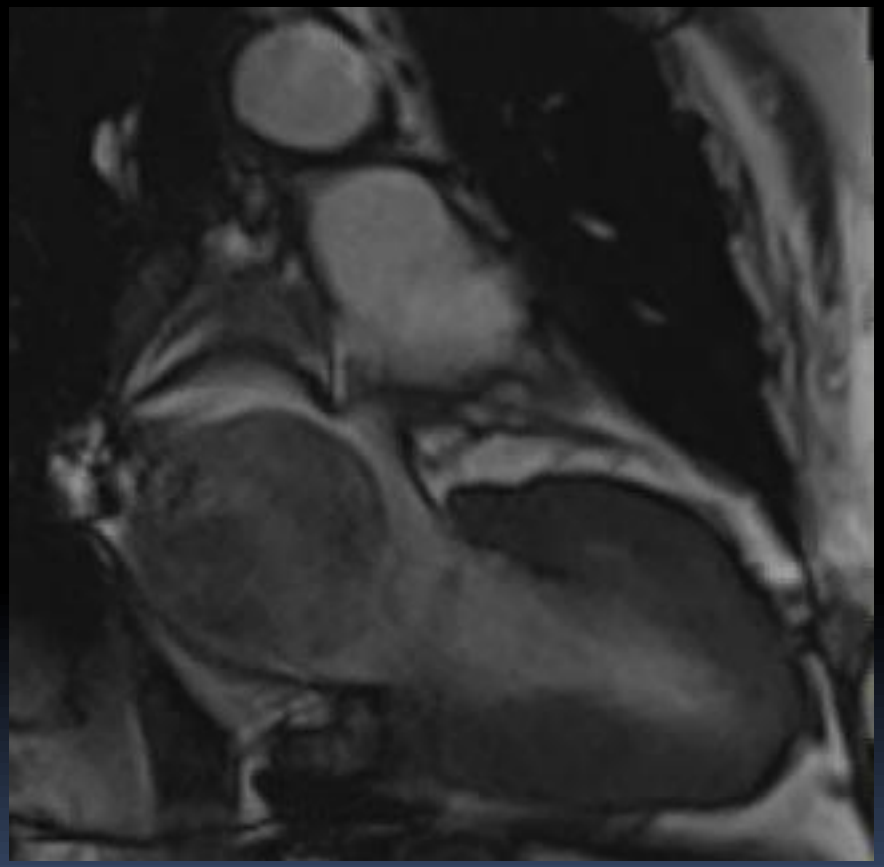
Case 2



Case 2

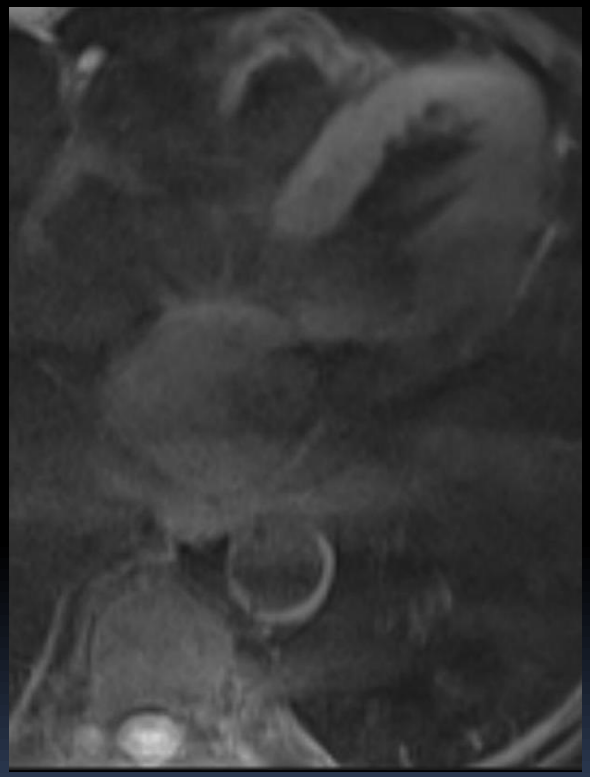


SSFP 4 chamber

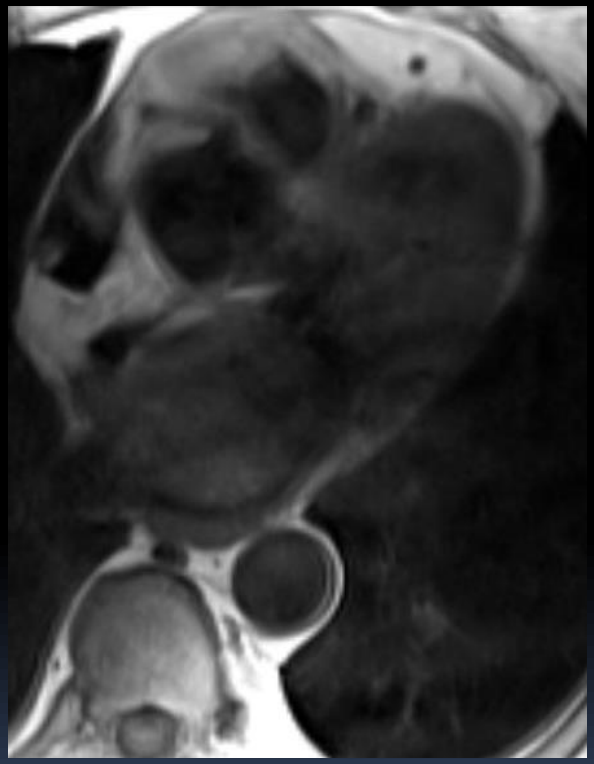


SSFP 2 chamber

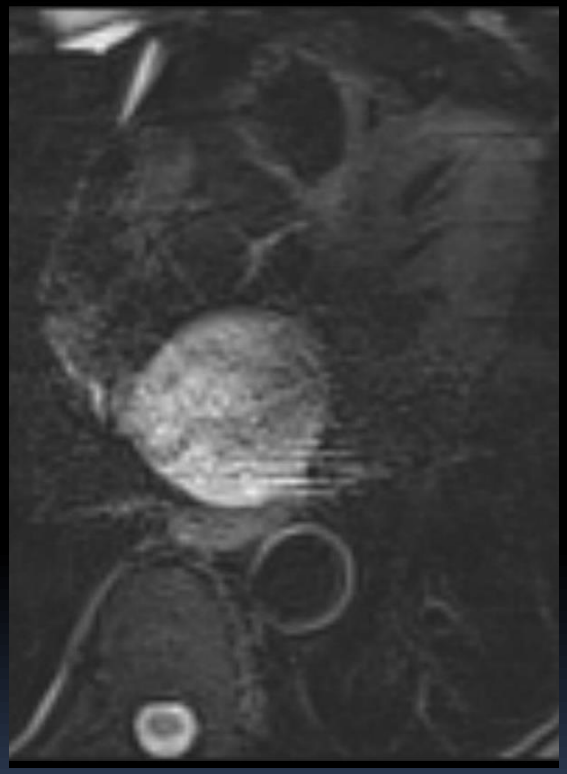
Case 2



T1



T1 FS



T2

Case 2

VLA first pass perfusion

Mod. SA first pass perfusion

Case 2

4 ch MDE

Myxoma (MRN 09265232, BS-13-29880)

PATHOLOGIC DIAGNOSIS:

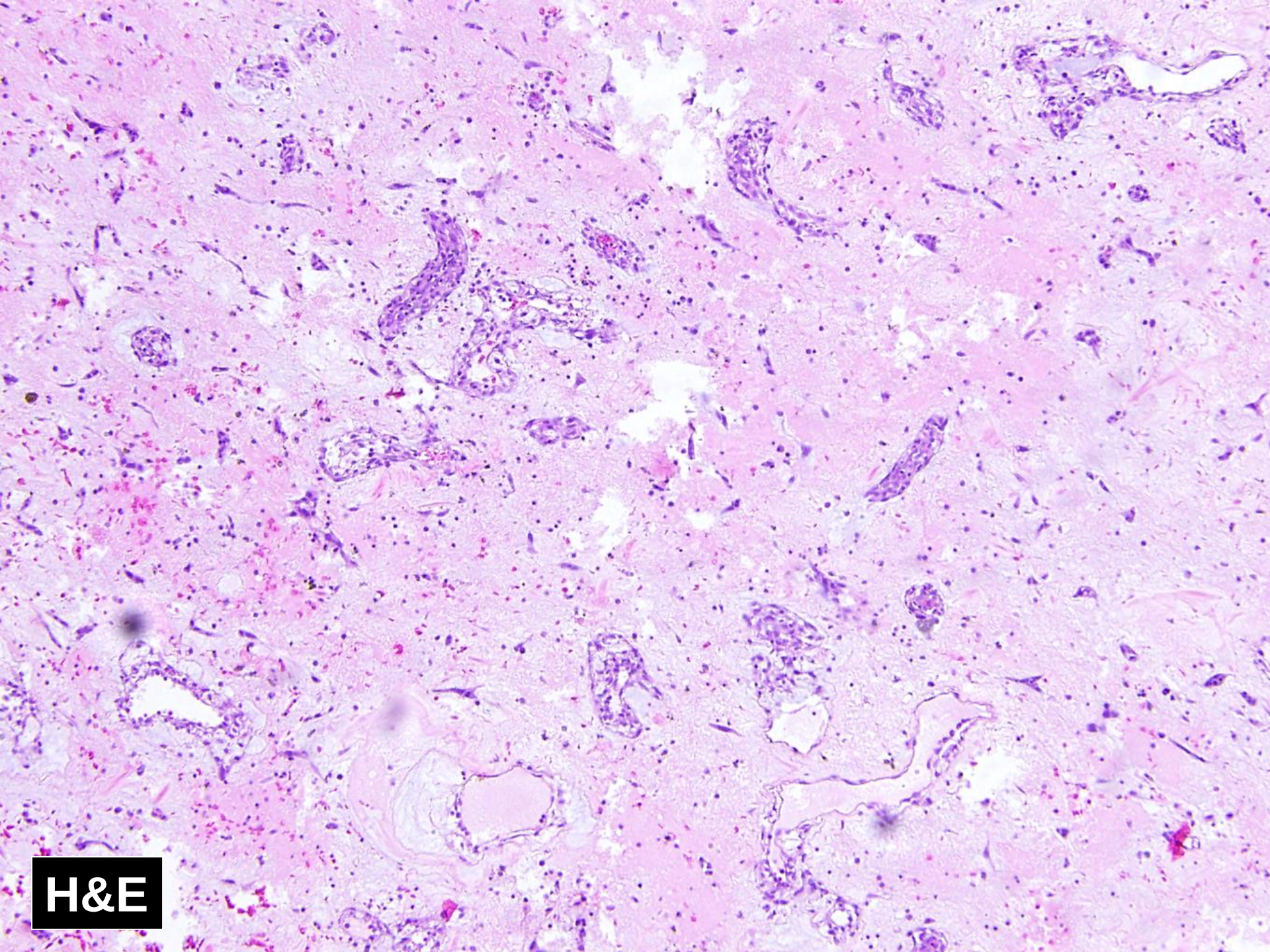
LEFT ATRIAL MYXOMA:

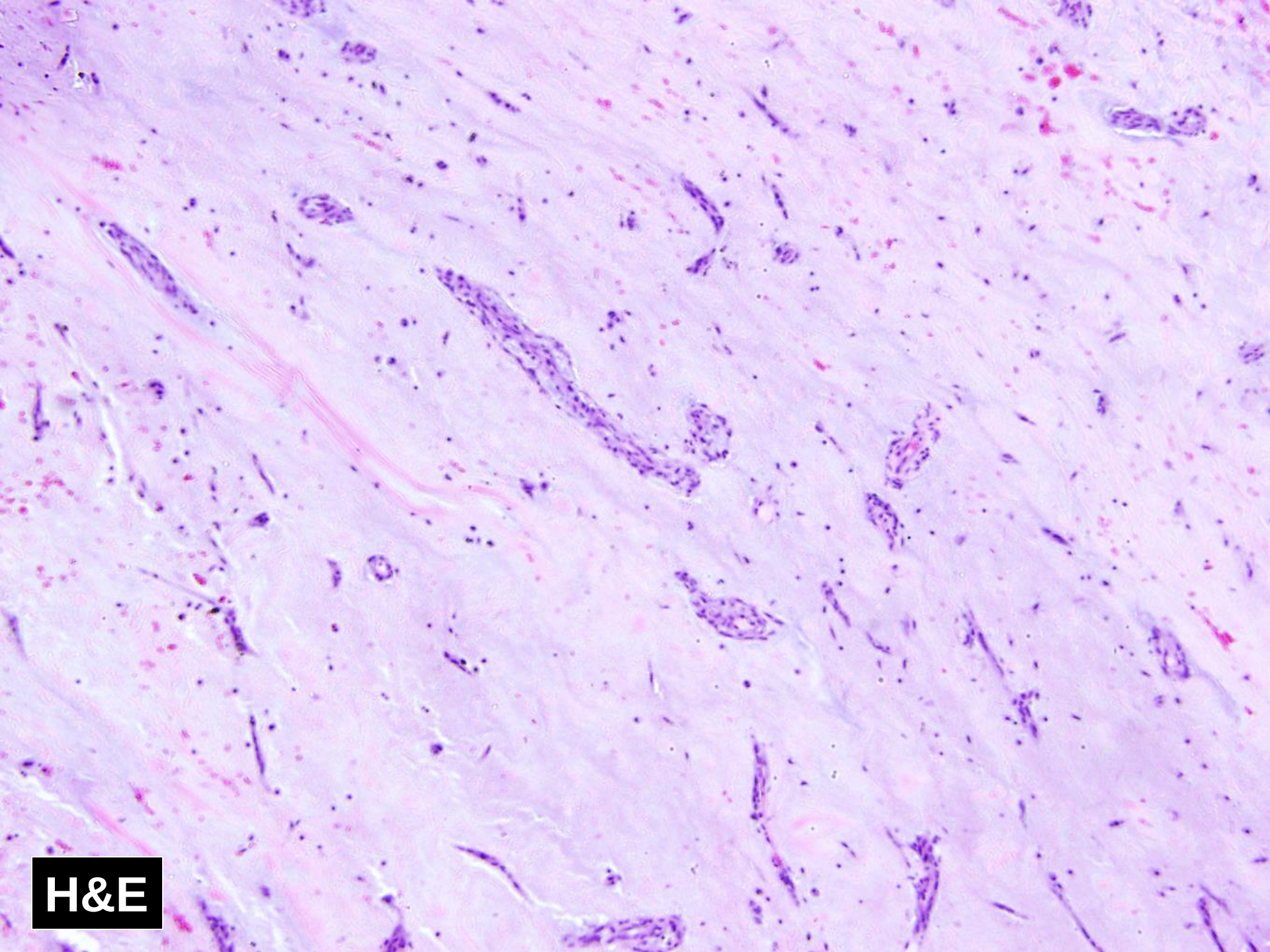
ATRIAL MYXOMA, 5.6 cm.

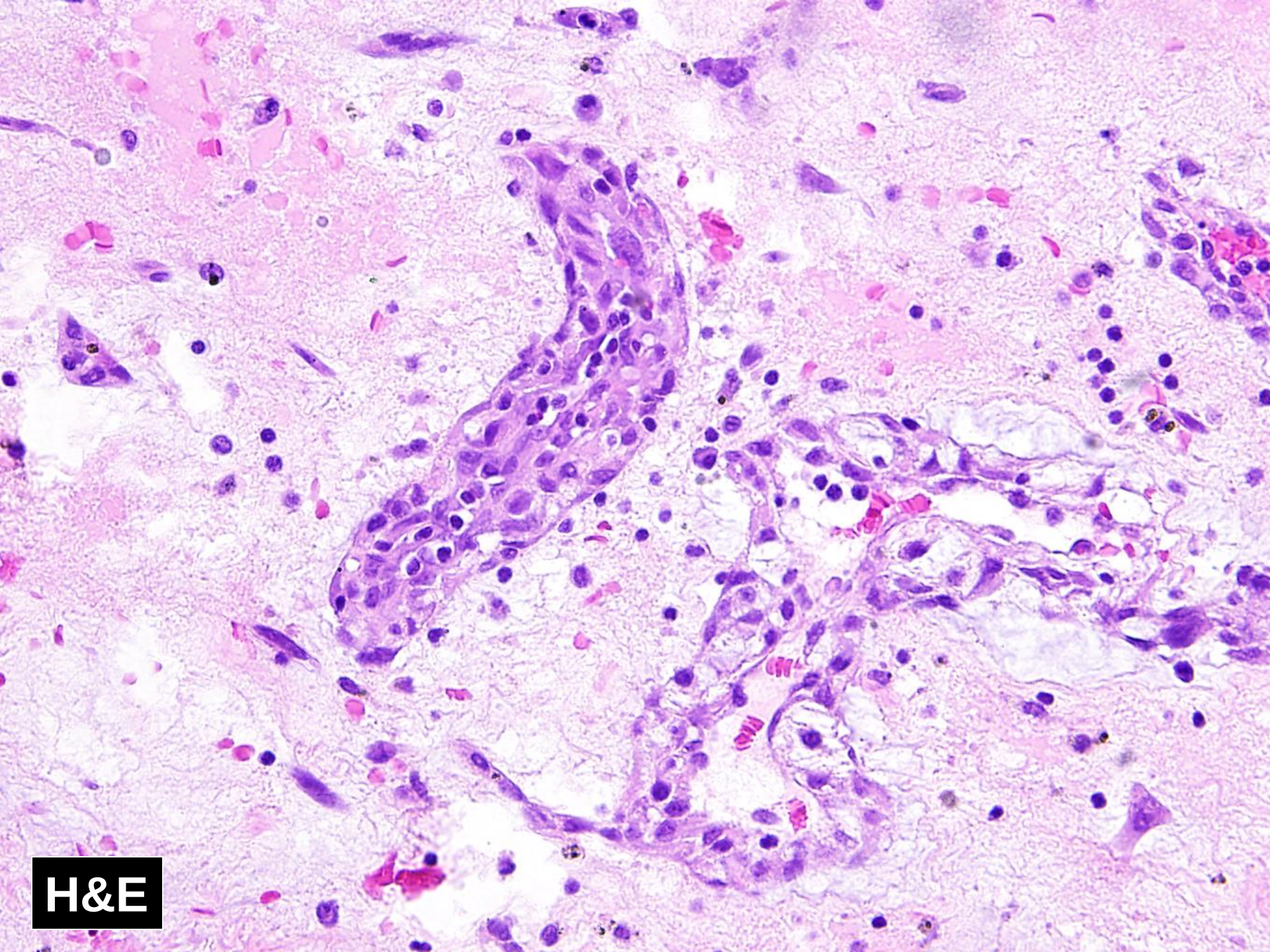
Organizing mural thrombus and chronic inflammation.

Myocardium with moderate interstitial and replacement fibrosis, and myocyte hypertrophy.

Myxoma (MRN 09265232, BS-13-29880)


H&E


H&E

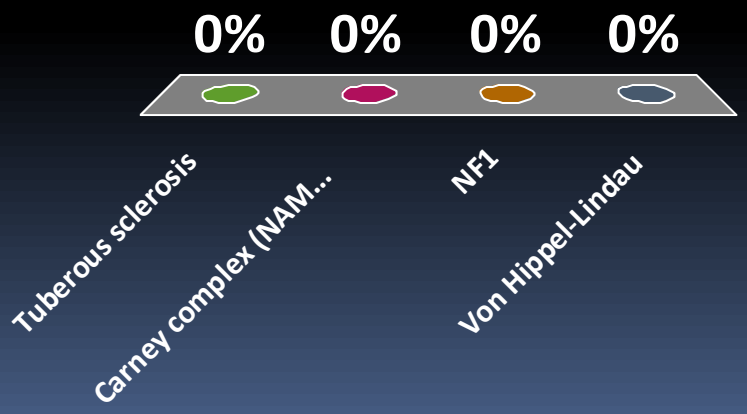

H&E

Myxoma: Clinical

- Most frequent cardiac tumor in adults and most common primary cardiac tumor (25-50%).
- W>M, ages 30-60.
- Constitutional symptoms, atypical chest pain, embolism.
- Surgery usually indicated due to risk of embolization, hemodynamic compromise.

Which syndrome is associated with higher incidence of atrial myxoma?

A. Tuberous sclerosis
B. Carney complex (NAME/LAMB)
C. NF1
D. Von Hippel-Lindau



Carney Complex: aka NAME/LAMB

- 7% of myxomas part of Carney complex
  - Endocrinopathy (Cushing),
  - Myxomas (cardiac, breast, skin)
  - Blue nevi
  - AD inheritance
- In Carney complex, myxomas may recur, distant from initial site.
- Different from Carney triad, which is an MEN with:
  - GIST
  - Pulmonary chondroma
  - Extra-adrenal paraganglioma

True or false: myxomas do not tend to grow over time.

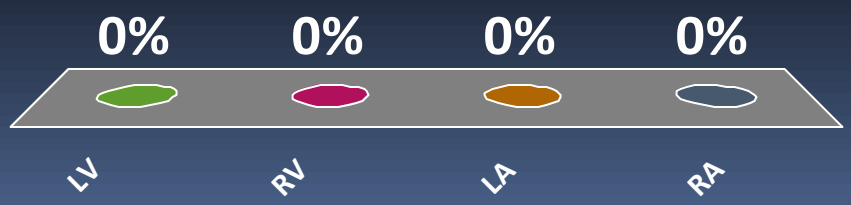
A. True
B. False

Myxoma: Imaging

- Usually pedunculated mobile masses , classically attached to fossa ovalis.
- **Distinguished from thrombus by enhancement (moderate, patchy, heterogeneous),** but may have rim of thrombus.
- **High extracellular water: bright T2.**
- May contain Ca^{2+}, hemorrhage, fibrosis.
- Highly mobile, may prolapse/obstruct.

What is the most common location for cardiac myxomas?

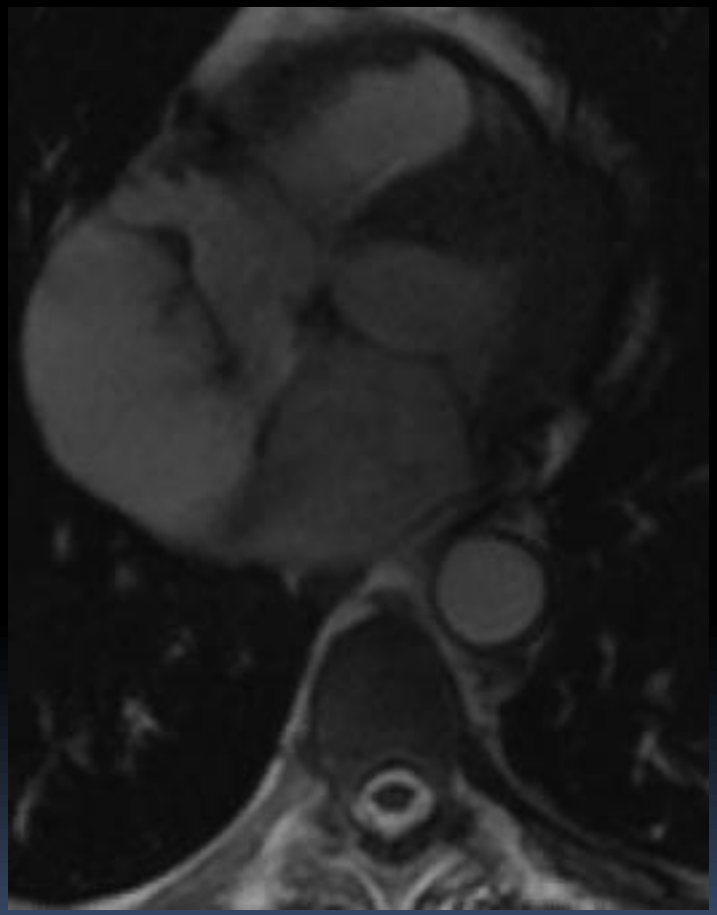
A. LV
B. RV
C. LA
D. RA



Case 3

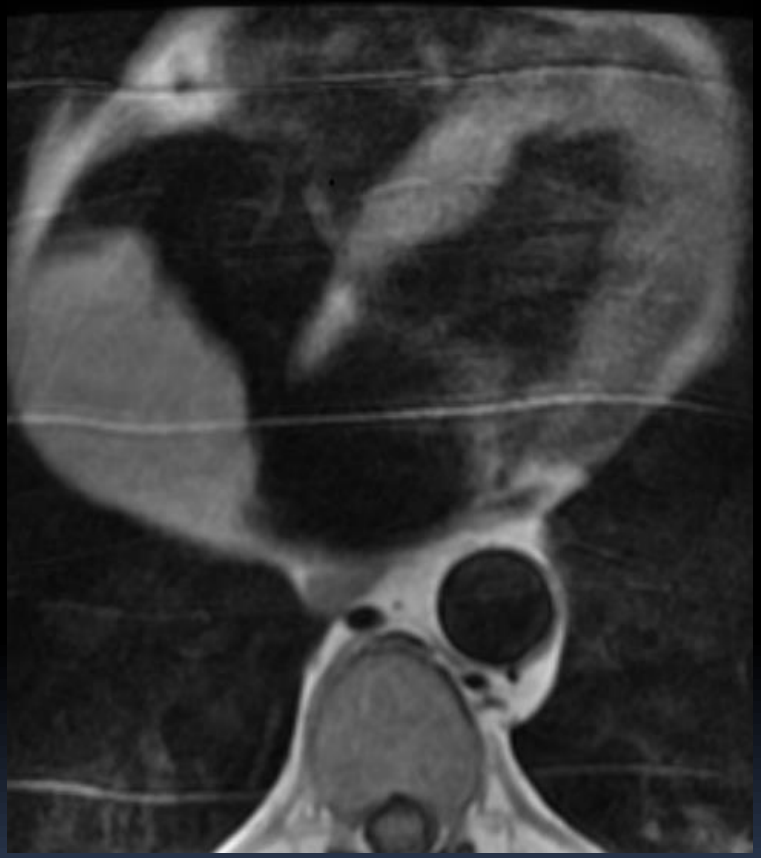
- 61-year-old male who presented to an outside hospital with nausea, vomiting, presyncope, and diaphoresis.

Case 3

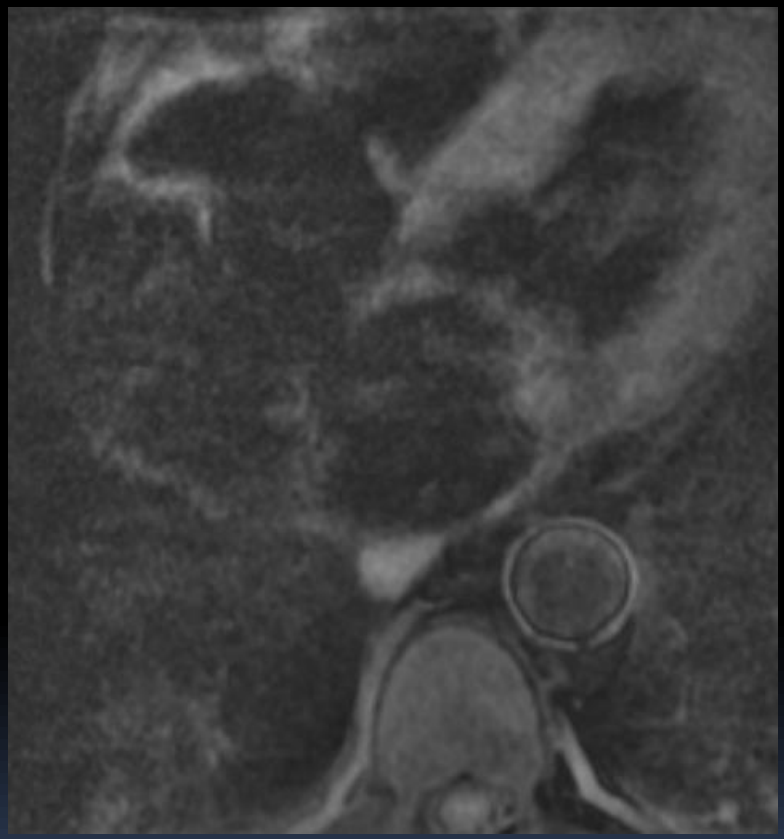


4 ch SSFP

Case 3

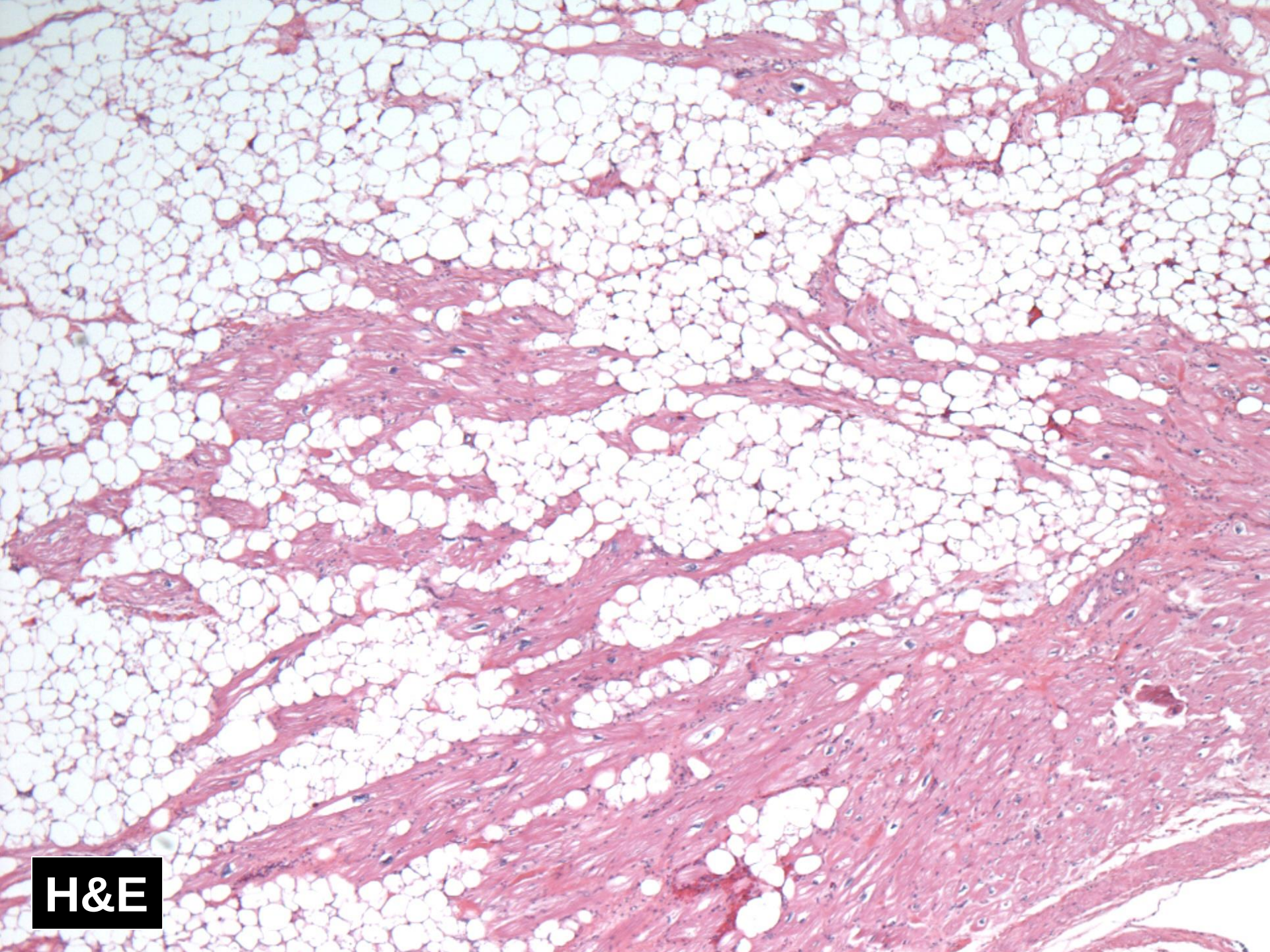


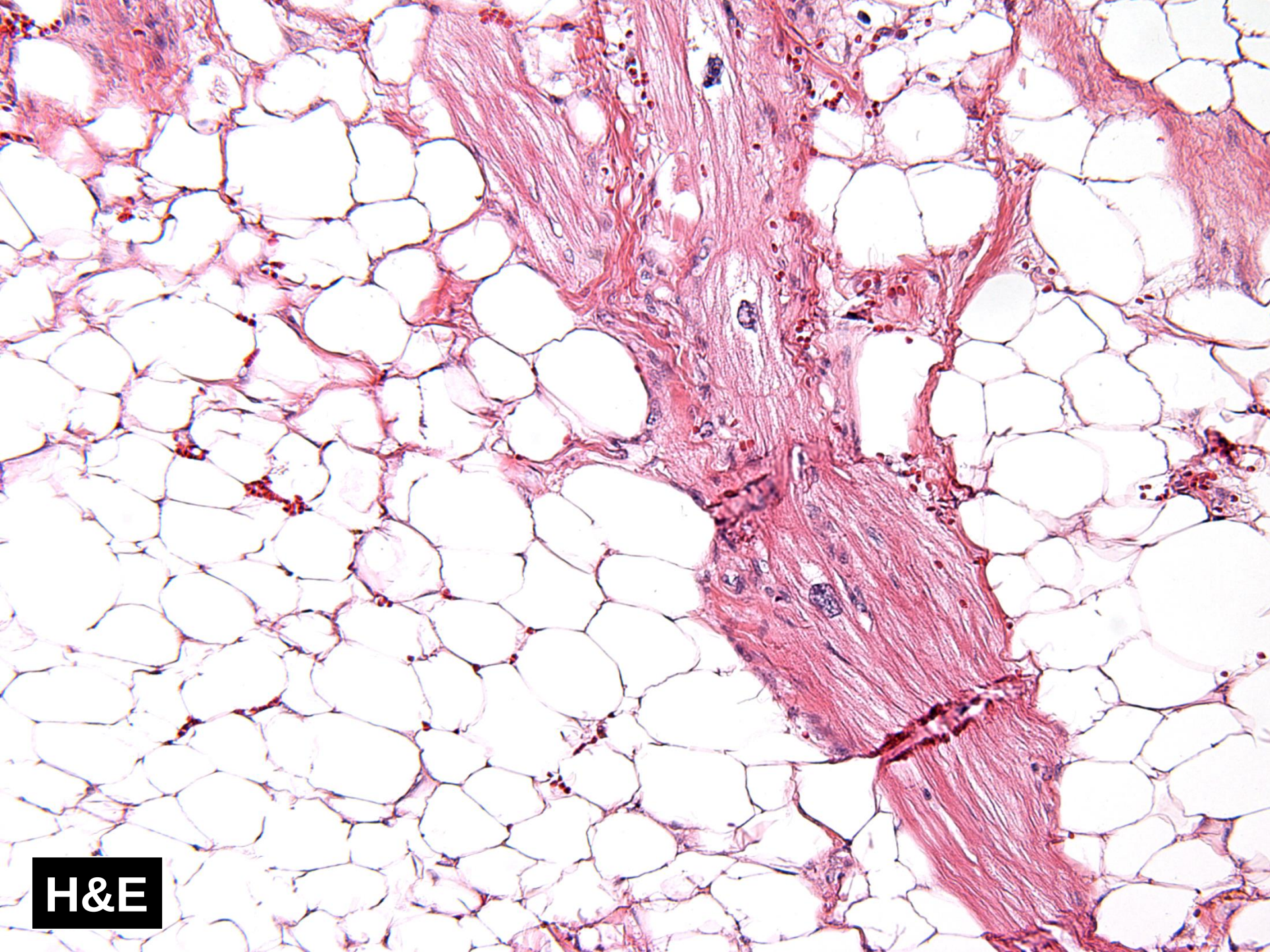
4 ch T1



4 ch T1 FS

Lipoma (MRN 19533025, S0435409R)


H&E

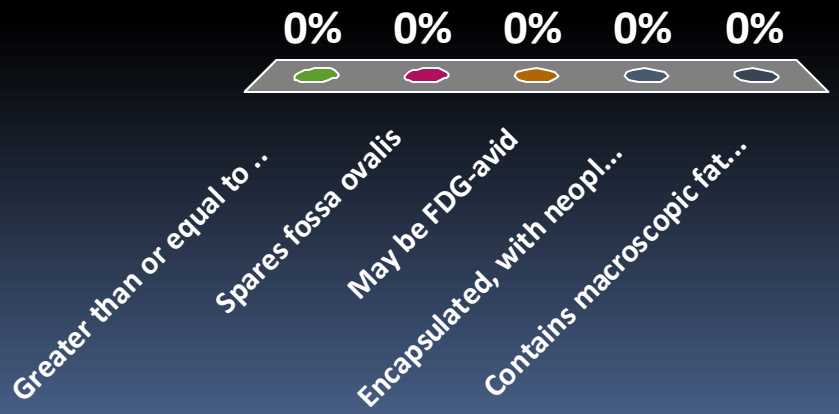

H&E

Lipoma

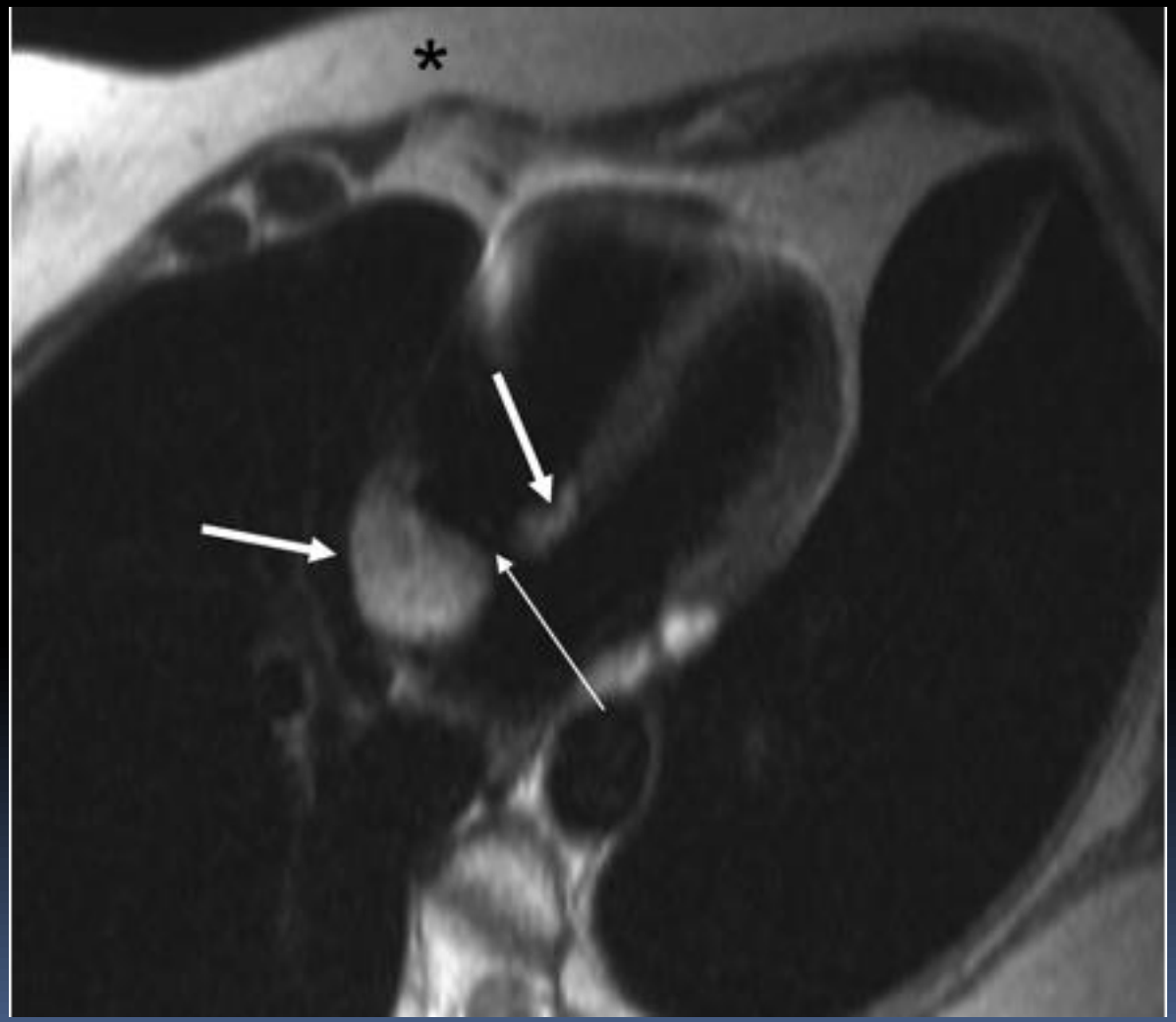
- 3rd most common cardiac tumor after myxoma and fibroelastoma (10%).
- Encapsulated, well-defined, homogeneous; neoplastic fat cells.
- Majority epicardial → pericardial space. Subendocardial lipomas smaller, sessile.
- Avascular, nonenhancing.
- **Similar to fat on T1 and T2, and suppress with FS**

Which is NOT true of LHIAS?

A. Greater than or equal to 20 mm in thickness
B. Spares fossa ovalis
C. May be FDG-avid
D. Encapsulated, with neoplastic fat cells
E. Contains macroscopic fat (suppressed by FS)

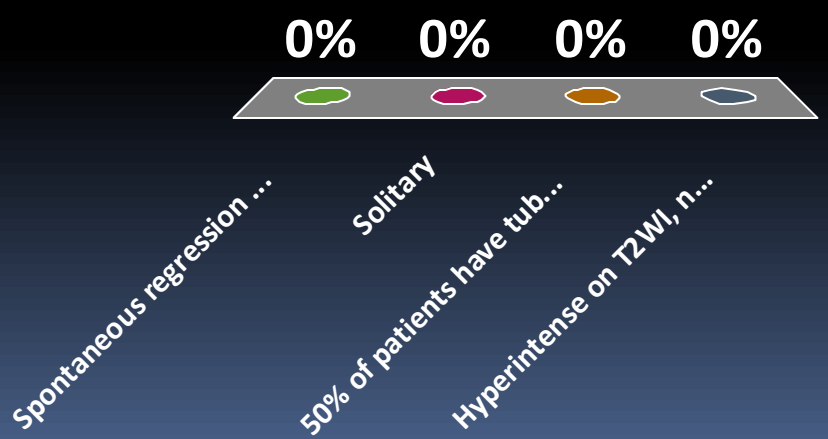


Lipomatous Hypertrophy



Which characteristic is more typical of fibroma than rhabdomyoma?

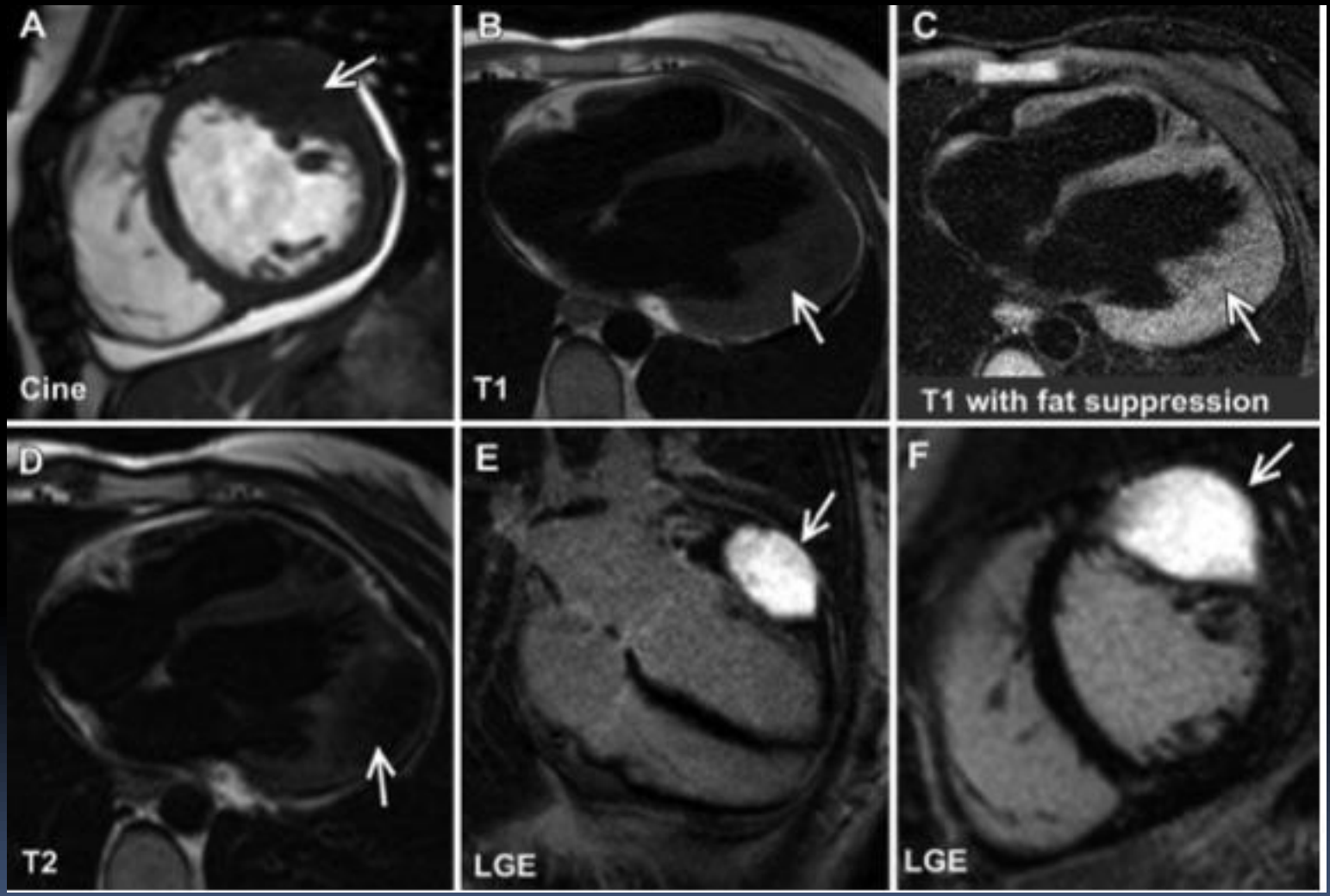
A. Spontaneous regression before age 4
B. Solitary
C. 50% of patients have tuberous sclerosis
D. Hyperintense on T2WI, no enhancement



True or false: Myxoma is the most common primary cardiac tumor in children.

A. True
B. False

Other benign masses



Other benign masses

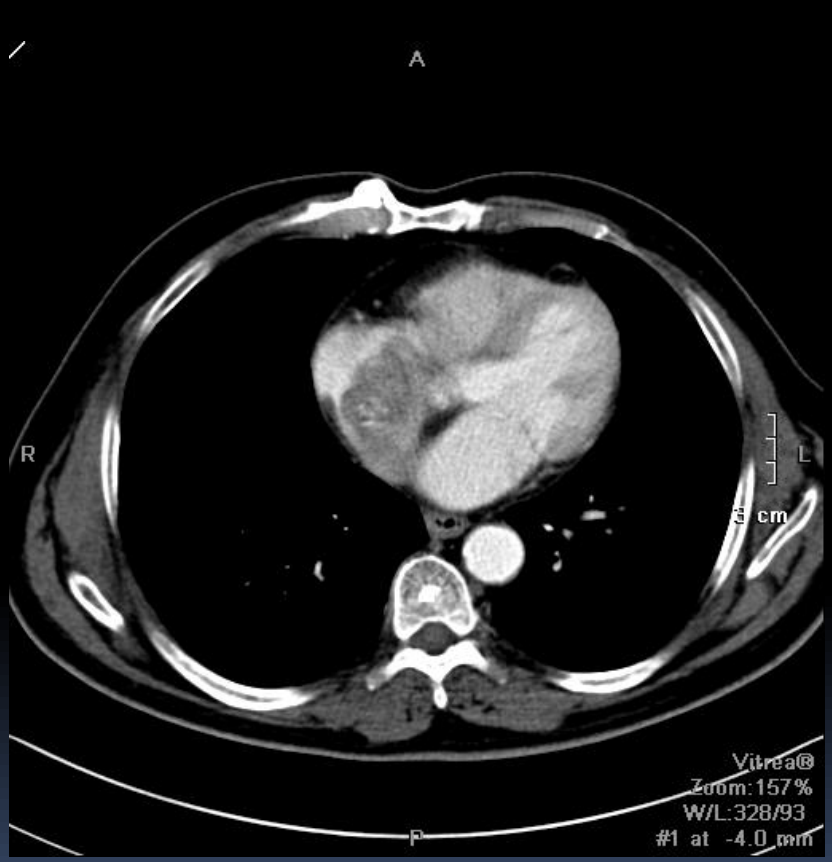
- Fibroelastoma – 10% primary cardiac tumors:
  - Small, **valvular** papilloma on a stalk.
  - Usually asymptomatic, incidental.
  - Echo usually sufficient. MR may be need to distinguish from vegetations, thrombus.

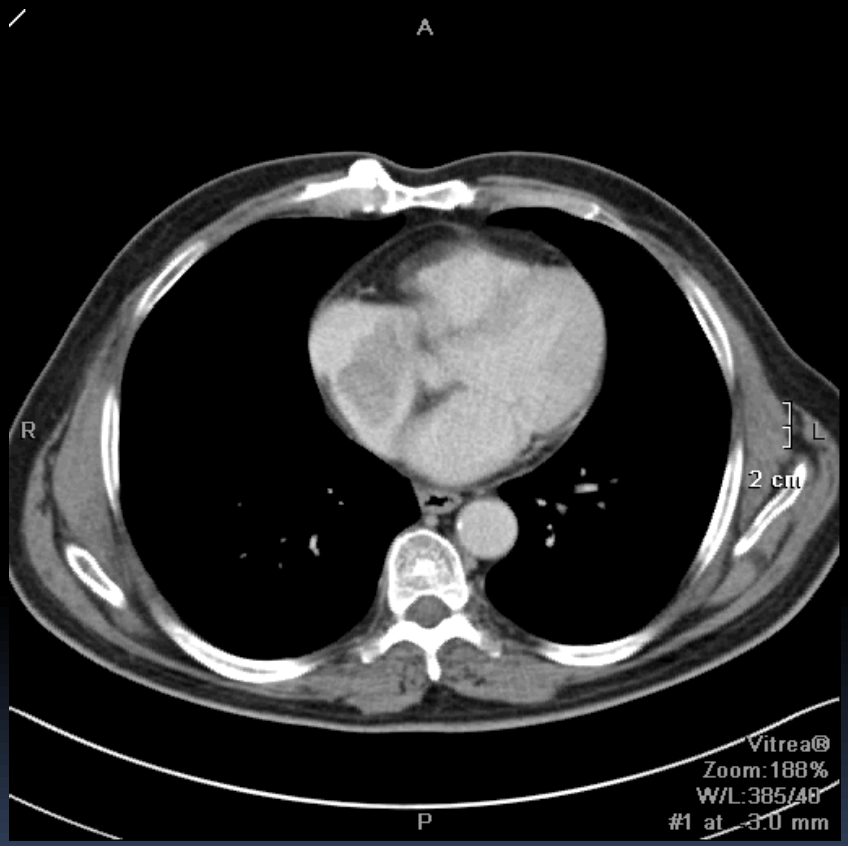
Malignant masses

Case 4

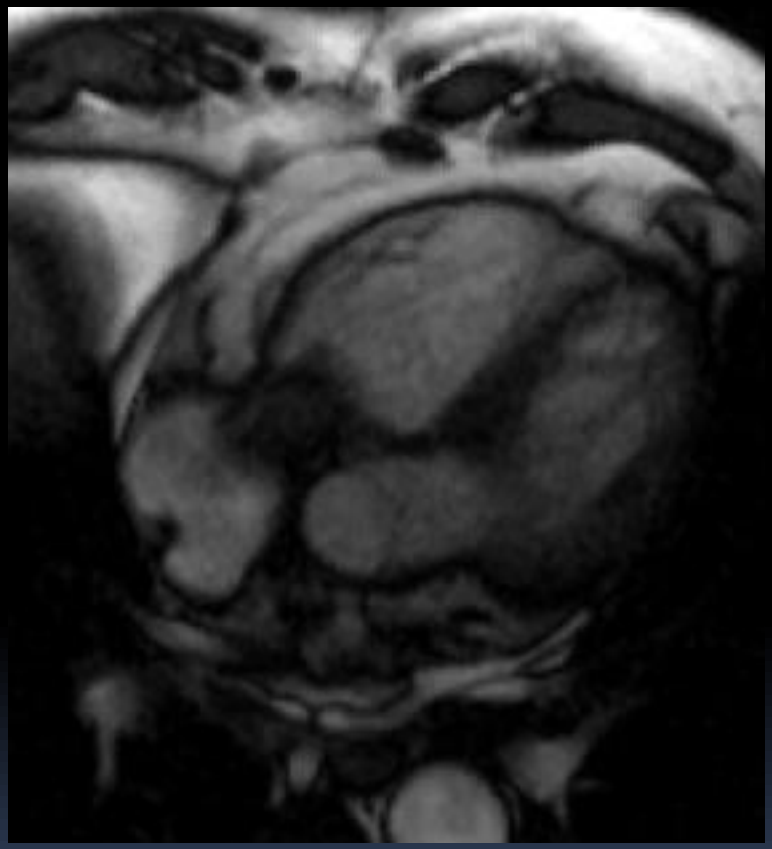
- 71-year-old male with known malignancy presenting for cancer restaging.

Case 4

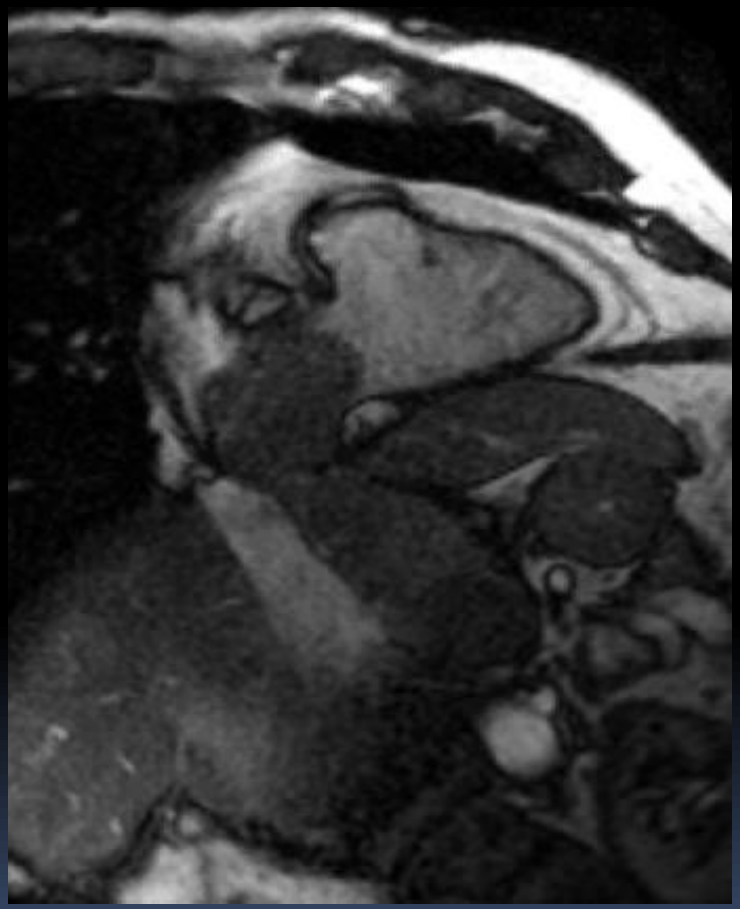

A
R
L
3 cm
Vitrea®
Zoom:157%
W/L:328/93
#1 at -4.0 mm


A
R
L
2 cm
P
Vitrea®
Zoom:188%
W/L:385/40
#1 at -3.0 mm

Case 4 – Where is the lesion?



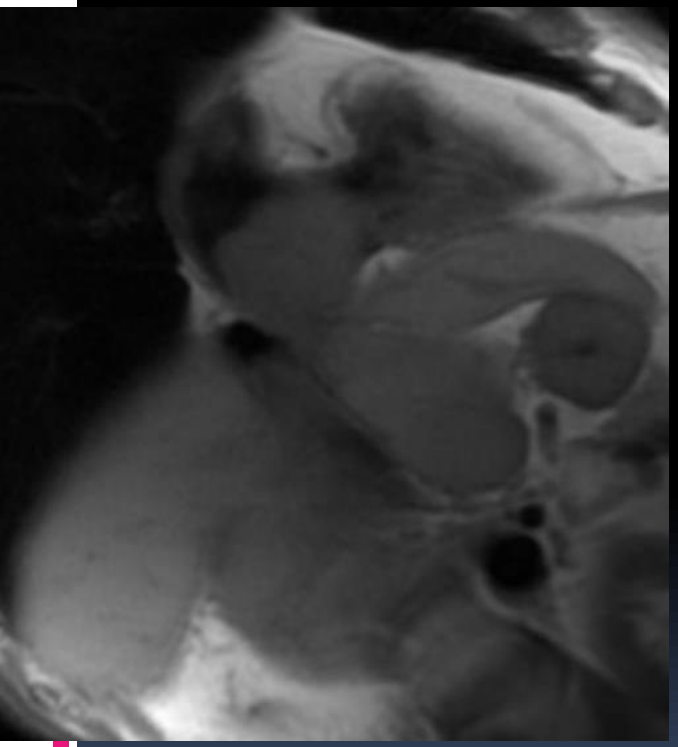
Modified 4 ch SSFP



Modified 2 ch SSFP

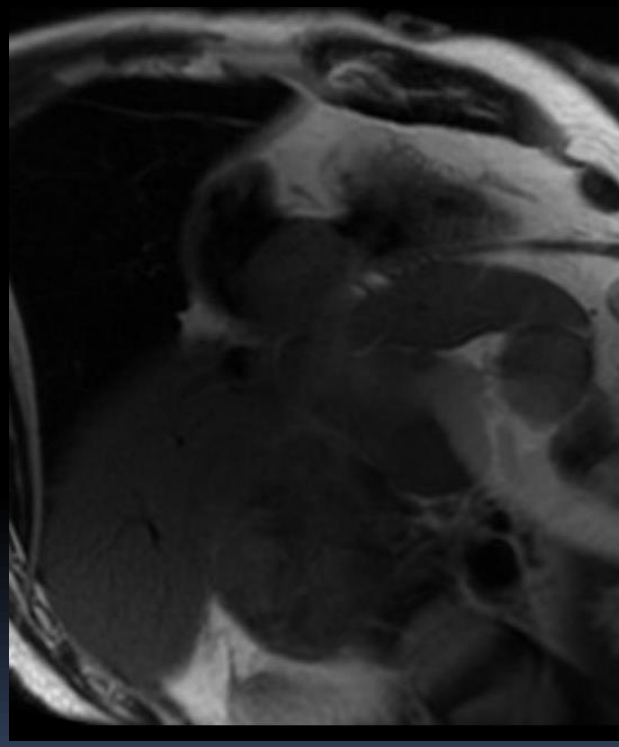
Case 4

Modified 2 chamber/VLA view to characterize the mass



T1

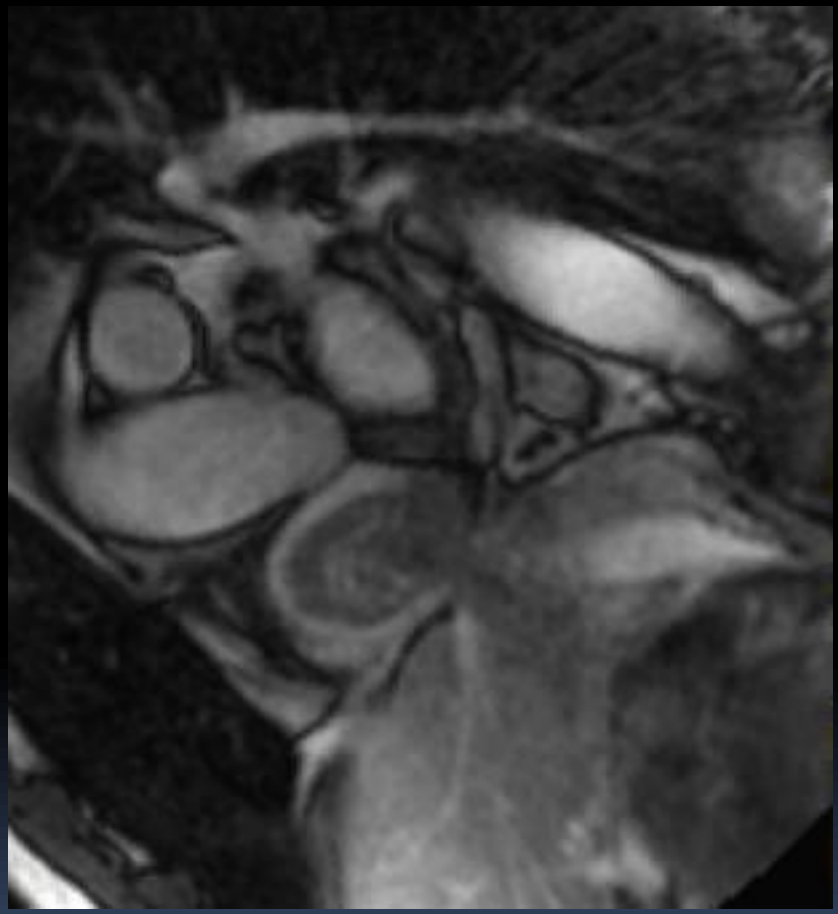
T1 FS



T2

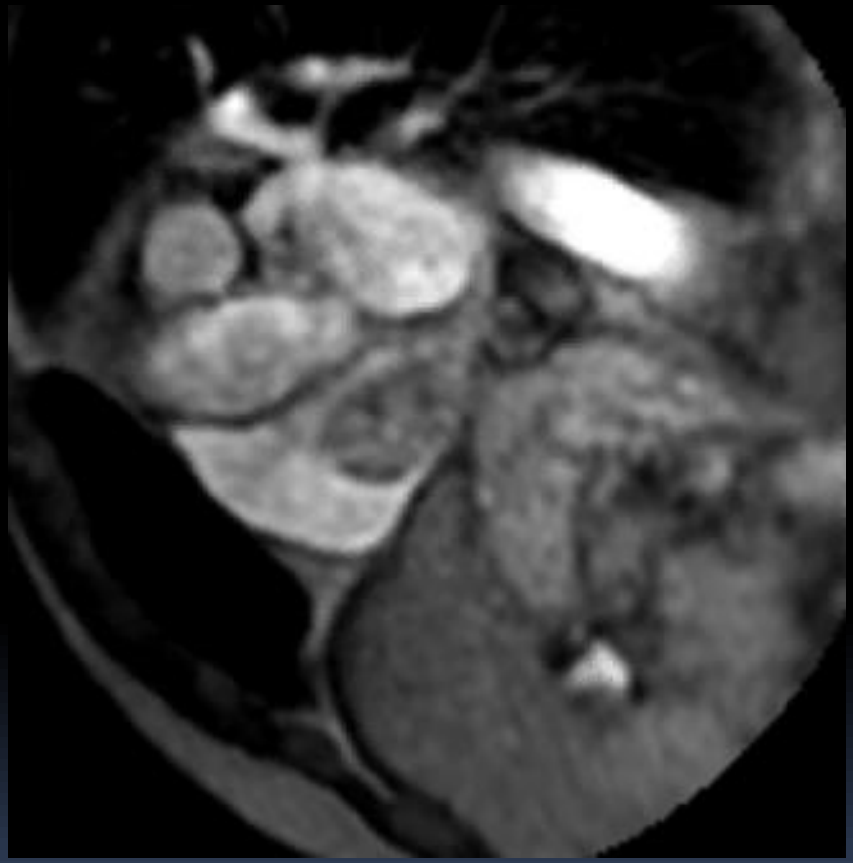
Case 4

Modified short axis SSFP



Modified short axis SSFP

Case 4



Modified short axis first pass perfusion

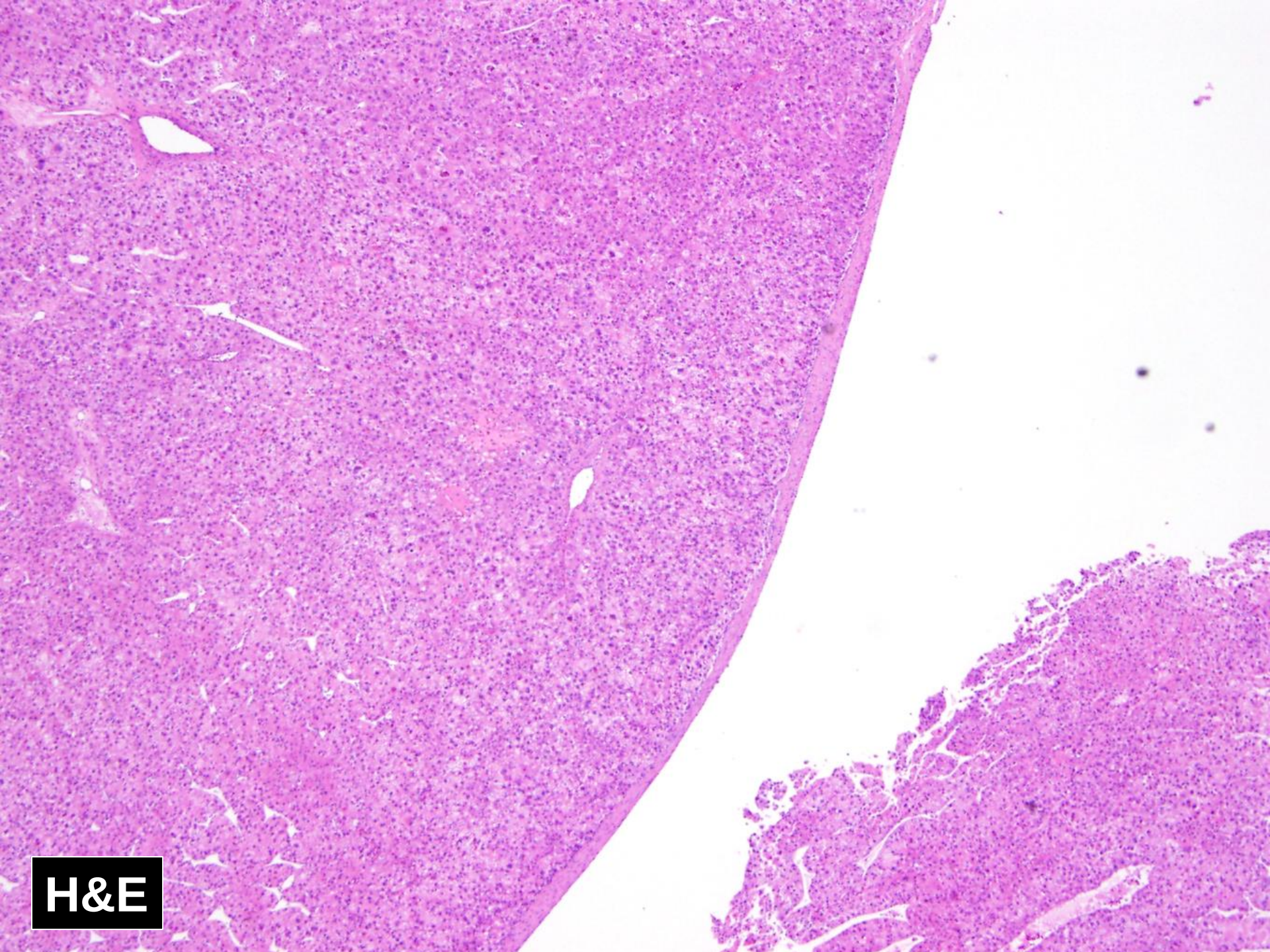
Modified short axis DE

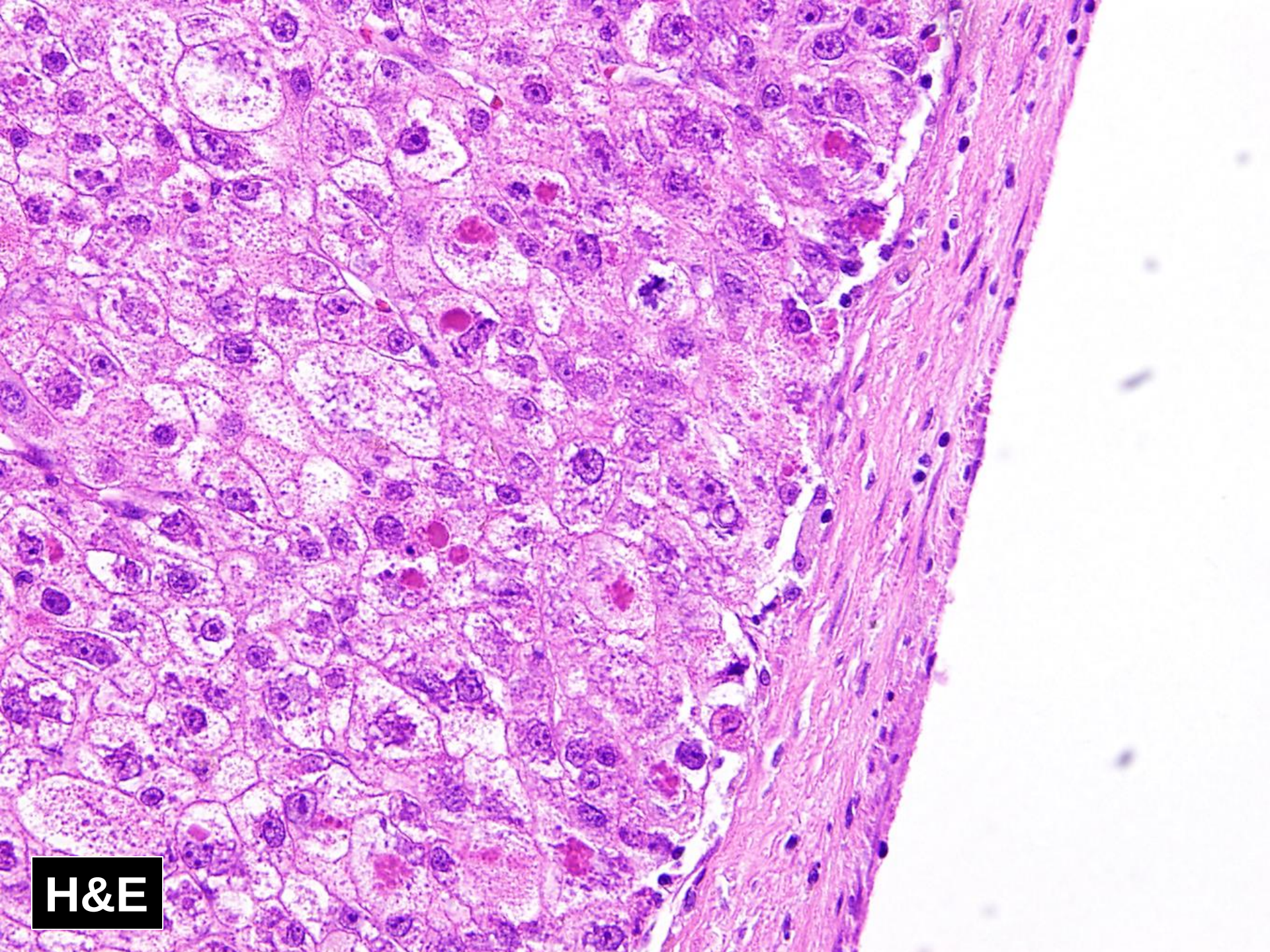
Metastatic HCC (MRN 19878073, BS-07-19421)

PATHOLOGIC DIAGNOSIS:

RIGHT ATRIAL MASS:

METASTATIC CARCINOMA, consistent with metastasis from patient's known hepatocellular carcinoma.


H&E


H&E

Of these, which is the least likely malignancy to metastasize to the heart?

A. Lung ca.
B. Breast ca.
C. Primary extracardiac lymphoma
D. Colon ca.
E. Melanoma

Metastasis

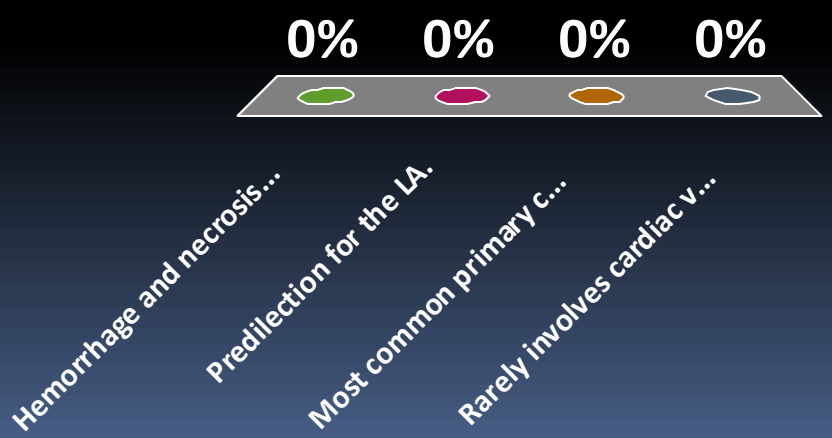
- 20-40x more common than primary cardiac tumors.
- Most without cardiac symptoms.
- Direct invasion, transvenous, lymphatic.
- Most commonly pericardial, with hemorrhagic effusions (high T1).
- Intramural: melanoma/lymphoma.
- Except for melanoma, tend to be dark T1, bright T2.
- Usually enhance heterogeneously.

Primary cardiac malignancies

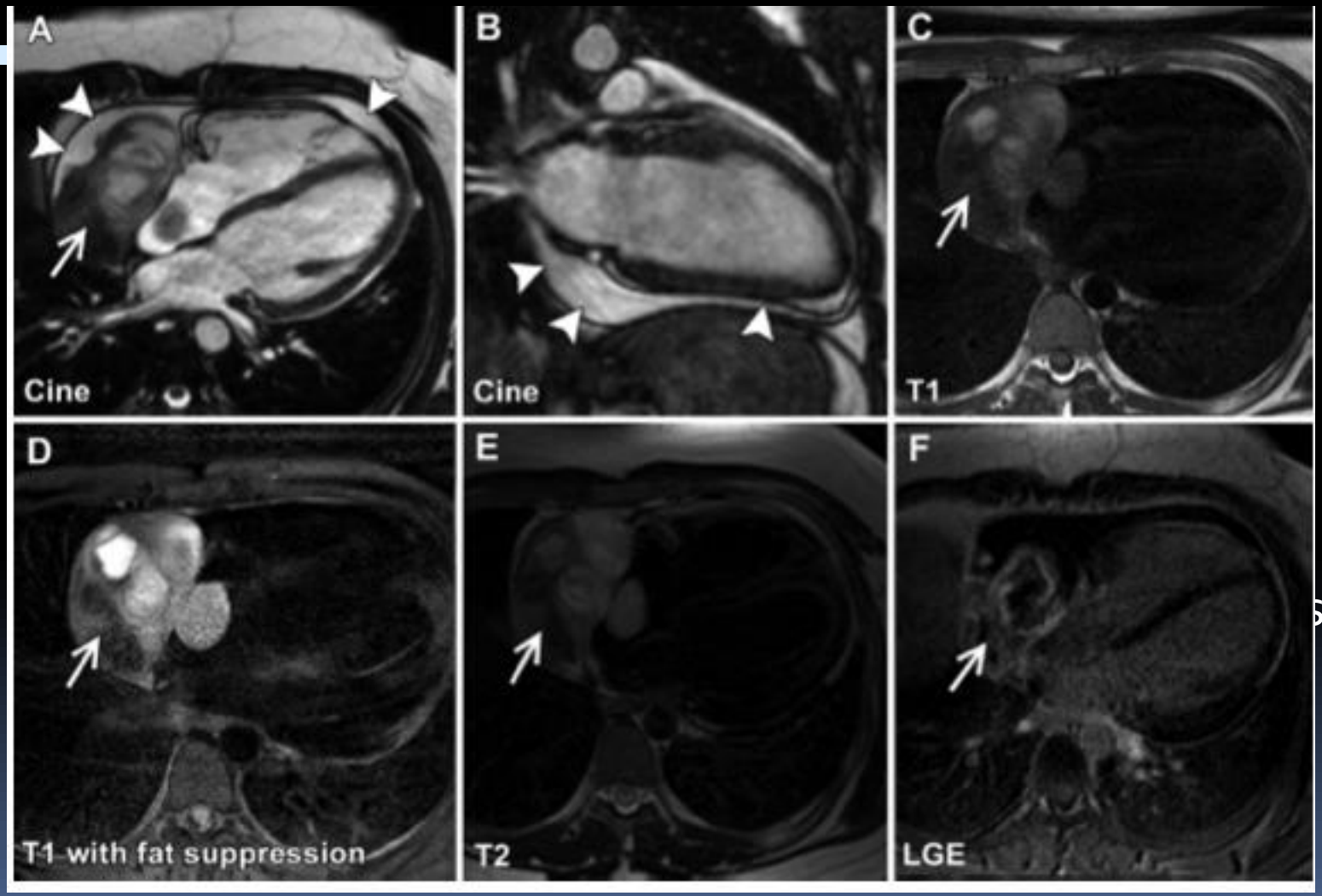
- 25% of cardiac tumors are malignant.
- Just 10% of **primary** cardiac tumors are malignant.
- 95% of malignant primary cardiac tumors are sarcomas.
  - The rest are pericardial mesotheliomas or lymphomas.

Which is not true of cardiac angiosarcoma?

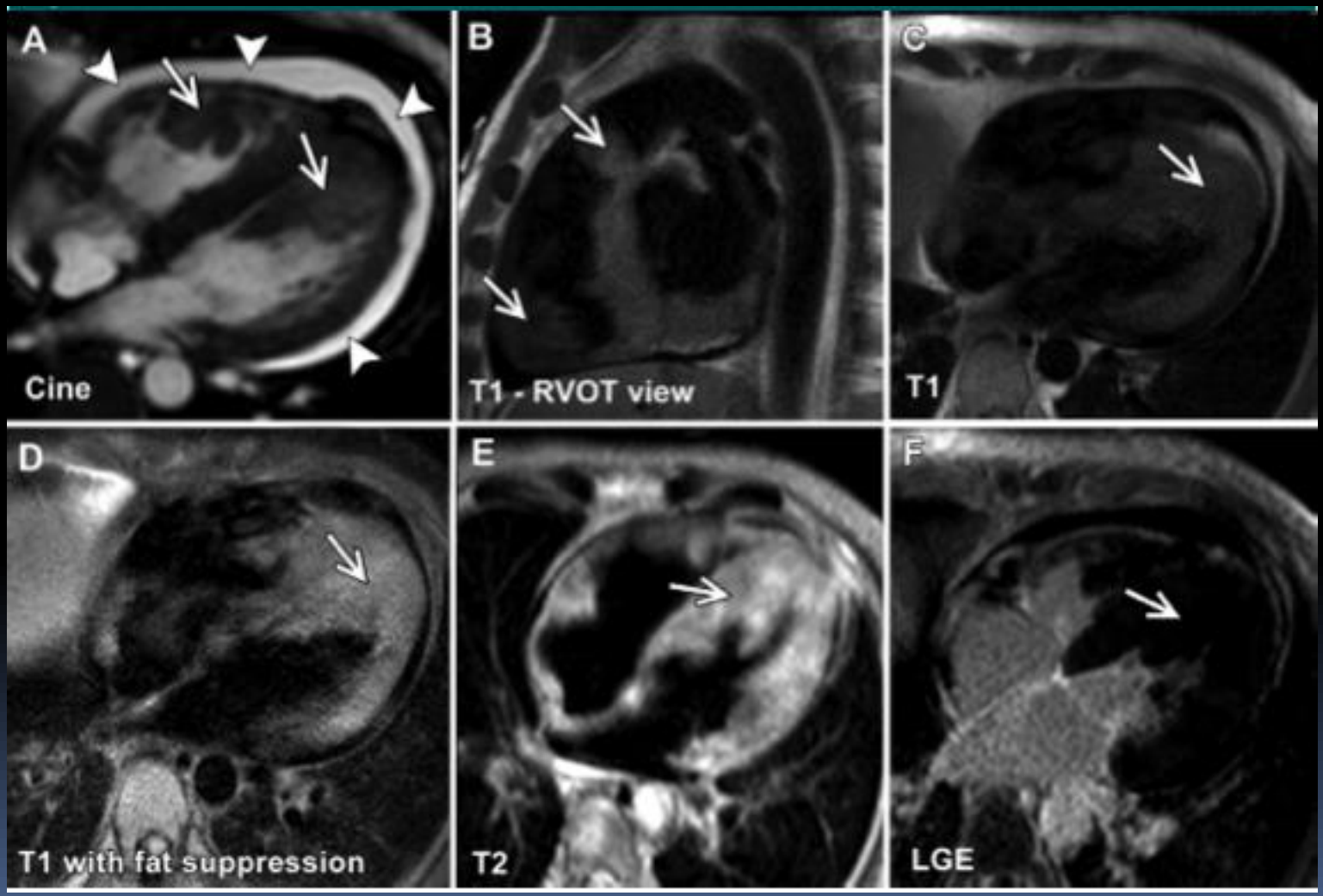
A. Hemorrhage and necrosis are common
B. Predilection for the LA.
C. Most common primary cardiac malignancy in adults.
D. Rarely involves cardiac valves.



Primary cardiac malignancies



Primary cardiac malignancies

- 

Key points

- Echo is usually first imaging test, MRI commonly used for further characterization due to excellent contrast resolution; CT second-line
- Differential diagnosis varies by site of involvement
- 25% of cardiac masses are malignant
- Malignancy associated with right heart and effusions
- Most common cardiac tumor in adults is myxoma (also most common 1°)
- Most common malignancy is metastasis
- Most common 1° cardiac malignancy is angiosarcoma
- Important pseudolesions: thrombus, LHIAS

Thank you: It takes a village to raise an Asha

- Advisor: Angela Giardino
- Prashant Nagpal (!)
- Beth Ripley
- Rachna Madan
- Matt Oliff
- Mike Steigner
- Ruth Dunne
- Ayaz Aghayev

References and resources

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