

Cardiac masses/tumors

**EACVI Preparatory Course to
Certification in CMR**

- 29 Sept. -1st Oct. 2022 -

**European Heart House, Sophia
Antipolis, France**

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European Association of
Cardiovascular Imaging

 European Society of Cardiology

DOI

- I have nothing to disclose

Cardiac masses/tumors

Learning objectives:

Systematic approach

Benign and malignant tumours, metastasis, thrombus

Cardiac masses/tumors

Size and localization (+ age, gender)

Morphologic analysis

Signal intensity characteristics

**Dynamic and equilibrium enhancement
(functional evaluation)**

Cardiac masses/tumors

Echocardiography

Cardiac MRI

Cardiac CT

(Hybrid imaging: PET-CT, PET-MR)

Cardiac masses/tumors: CMR protocol

Mandatory

Bb FSE T1 w

Bb FSE T2 w + FS (or STIR)

Cine

Post Gad T1

(early IR-GRE, bbFSE and late IR-GRE)

Optional

First pass

Phase velocity mapping

Tagging

Cardiac masses/tumors: the three general rules



- 1. Thrombus is the most frequent intra-cavitary «tumor»**
- 2. Secondary neoplasms are more frequent than primary**
- 3. Benign tumors are much more frequent than malignant (3:1)**



Cardiac masses/tumors: relative incidences of primary tumors

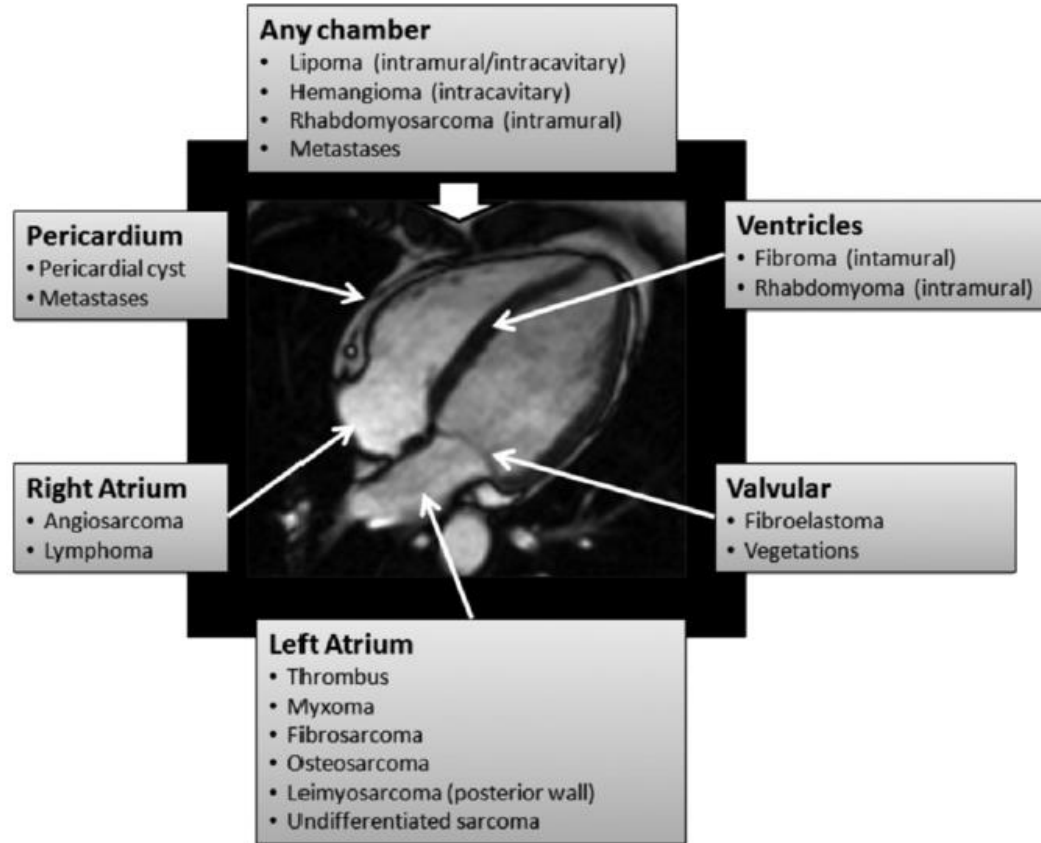
benign

Myxoma	30%
Lipoma	10%
Fibroelastoma	10%
Rhabdomyoma	8%
Fibroma	4%
Teratoma	3%
Other	5%
TOTAL	70-75%

malignant

Angiosarcoma	9%
Rhabdomyosarcoma	6%
Mesothelioma	4%
Fibrosarcoma	3%
Lymphoma	2%
Other sarcomas	3%
Teratoma	<1%
Other	<1%
TOTAL	25-30%

Cardiac masses/tumors: localization



Cardiac masses/tumors: “malignant morphology”

Large size (mostly > 5 cm)

Irregular ill-defined borders

Direct invasion

Right heart localization

**Pericardial and/or pleural involvement
(effusions, nodules)**

Multiple lesions

Cardiac masses/tumors: “malignant» tissue characteristics

Signal heterogeneity in T1 and T2 images (hemorrhage and necrosis)

Hemorrhagic pericardial effusion (high T1 SI)

Contrast enhancement (mostly heterogeneous)

High T1 and low T2 SI: metastatic melanoma

Cardiac masses/tumors: “malignant” tissue characteristics



MR Imaging Tissue Characteristics of Common Cardiac Masses

Cardiac Mass	T1-weighted Imaging*	T2-weighted Imaging*	After Contrast Enhancement (LGE Imaging)
Pseudotumor			
Thrombus	Low (high if recent)	Low (high if recent)	No uptake [†]
Pericardial cyst	Low	High	No uptake
Benign			
Myxoma	Isointense	High	Heterogeneous
<u>Lipoma</u>	<u>High[‡]</u>	<u>High[‡]</u>	<u>No uptake</u>
Fibroma	Isointense	Low	Hyperenhancement [§]
Rhabdomyoma	Isointense	Isointense/high	No/minimal uptake
Malignant			
Angiosarcoma	Heterogenous	Heterogeneous	Heterogeneous
Rhabdomyosarcoma	Isointense	Hyperintense	Homogeneous
Undifferentiated sarcoma	Isointense	Hyperintense	Heterogeneous/variable
Lymphoma	Isointense	Isointense	No/minimal uptake
Metastasis	Low	High	Heterogeneous



Cardiac masses/tumors: most relevant differential diagnosis



Cardiac thrombus

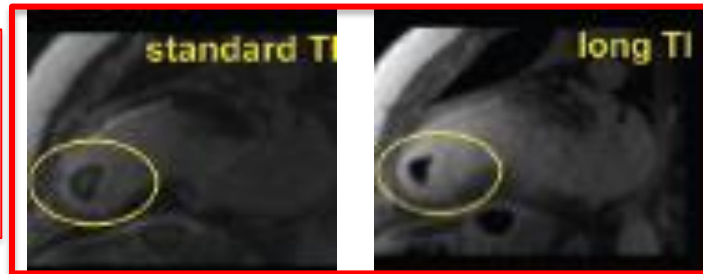
Cardiac MR Imaging Signal Intensity Characteristics for Thrombus

Age of Thrombus	T1-weighted Signal Intensity	T2-weighted Signal Intensity	EGE Imaging	LGE Imaging
Acute	High	High	No uptake	No uptake
Subacute	High	Low	No uptake	No uptake
Chronic	Low	Low	No uptake	No uptake*

* Organized chronic thrombus may show peripheral enhancement on LGE images owing to fibrous content.

LGE TIP: use both conventional (200-300 ms according to LL) and long (> 600 ms) TI:

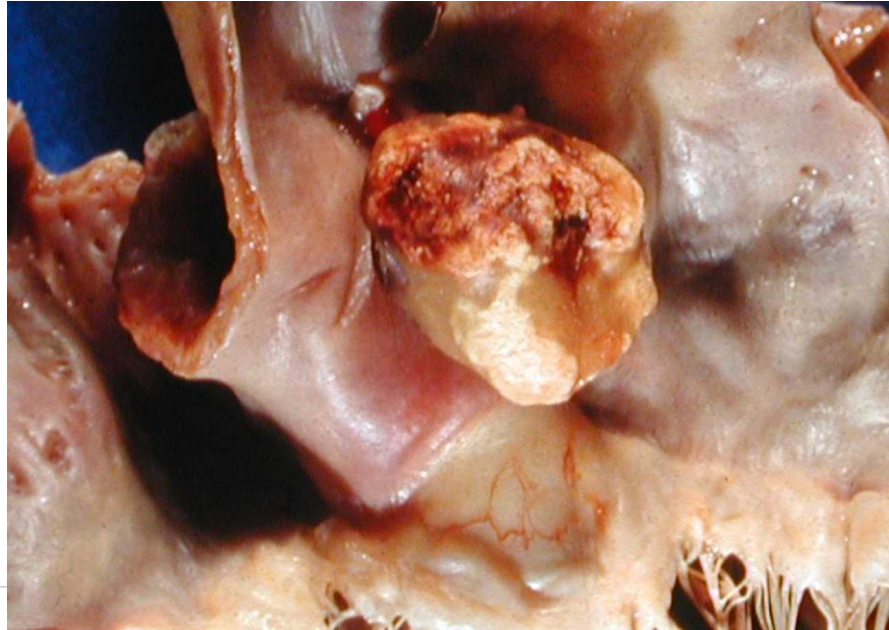
thrombus is always black!



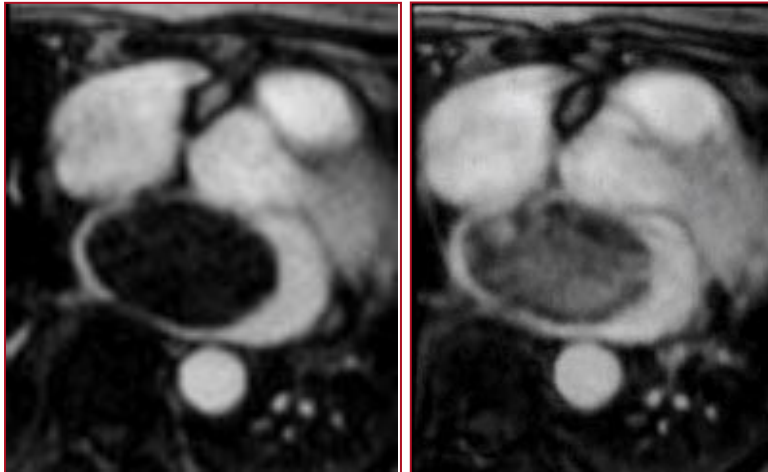
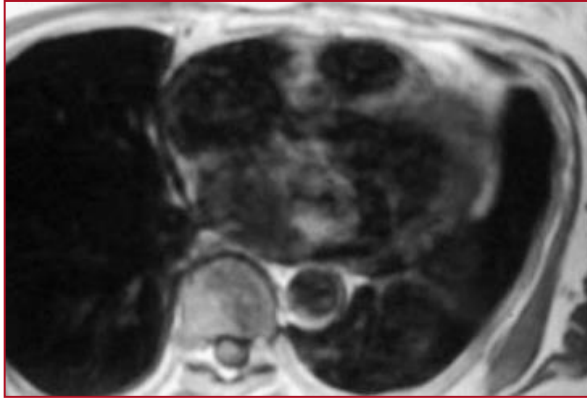
Cardiac masses/tumors: myxoma

- endocardial origin
- no infiltration
- endocavitary growth
- round/oval shape
- smooth, lobular, irregular surface

- Site: - 75% LA (fossa ovalis)
 - 20% RA
 - 5%:ventricles
- Pedunculates 50%



Cardiac masses/tumors: myxoma

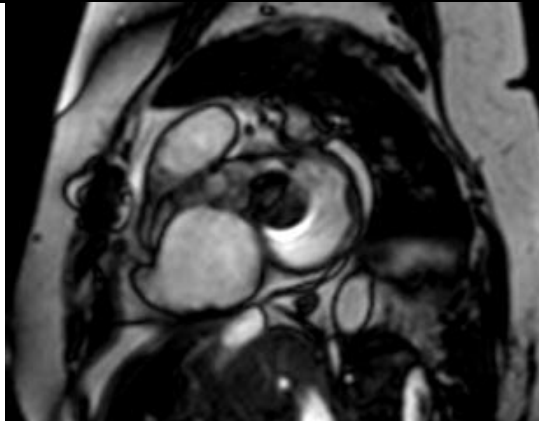


- **SI myxomatous part:**
↓ in T1; ↑ in T2; ↓↓ in “Cine”
- **Heterogeneous SI:**
 - fibrosis
 - thrombus stratification
 - calcifications
 - hemorrhage
- **Inhomogeneous enhancement**

DD: thrombus

- No enhancement
- Atrial: appendage, or large atria (wall)
- Ventricular: close to dysfunctional segments or in aneurysm

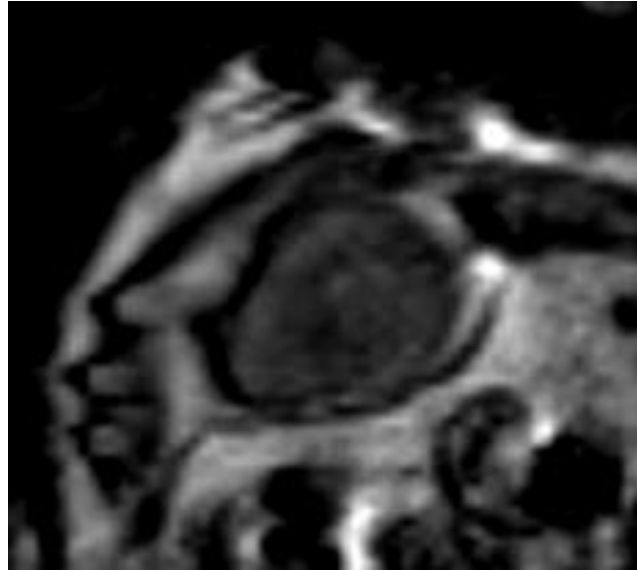
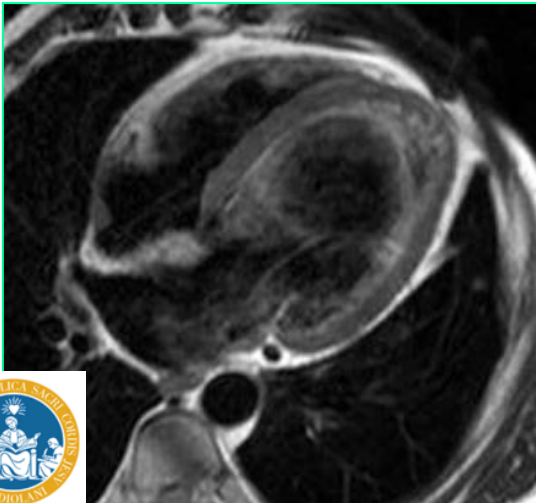
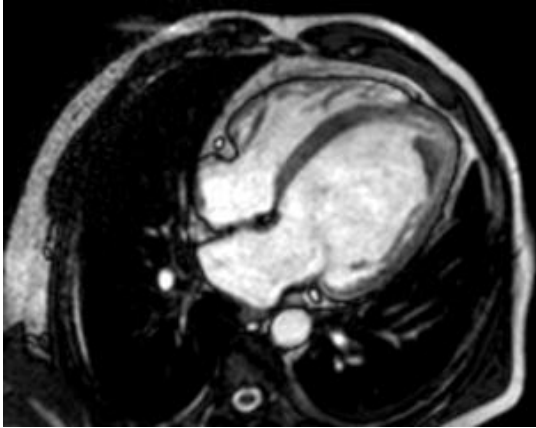
Cardiac masses/tumors: LA thrombi



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Cardiac masses/tumors: LV thrombi



Cardiac masses/tumors: myxoma



No symptoms

incidental finding

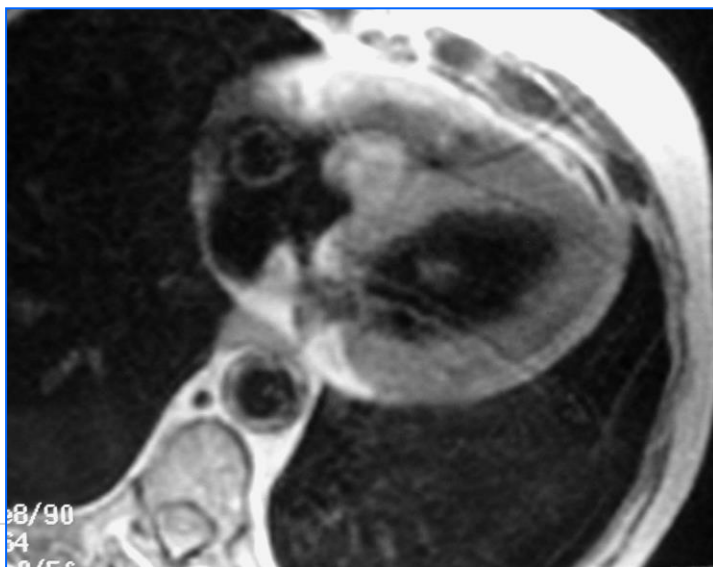
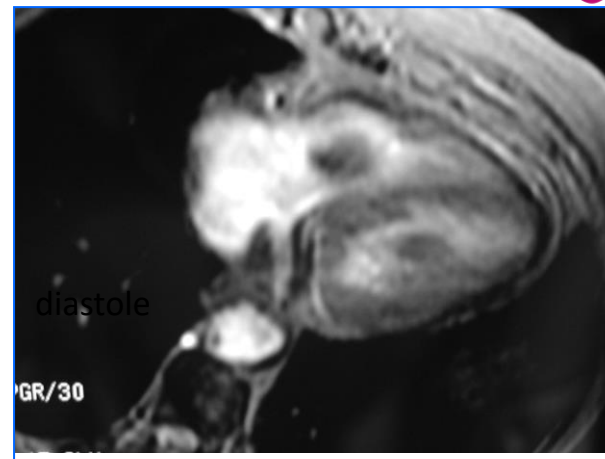
Symptoms

obstruction

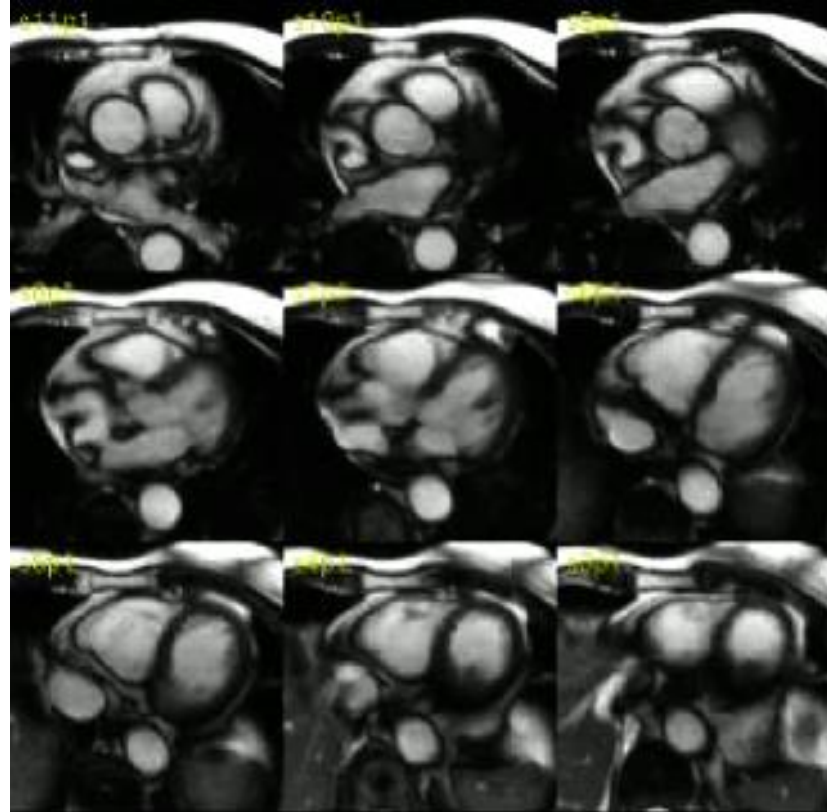
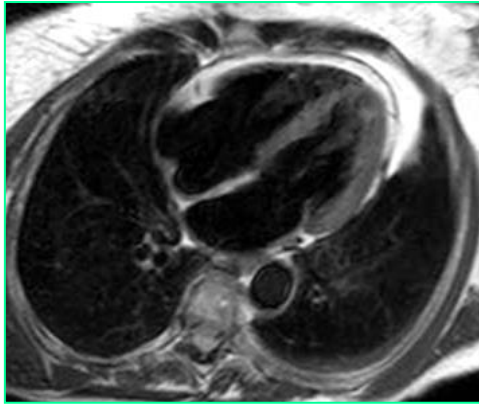
Embolic events

General symptoms: fever,

fatigue, weight loss

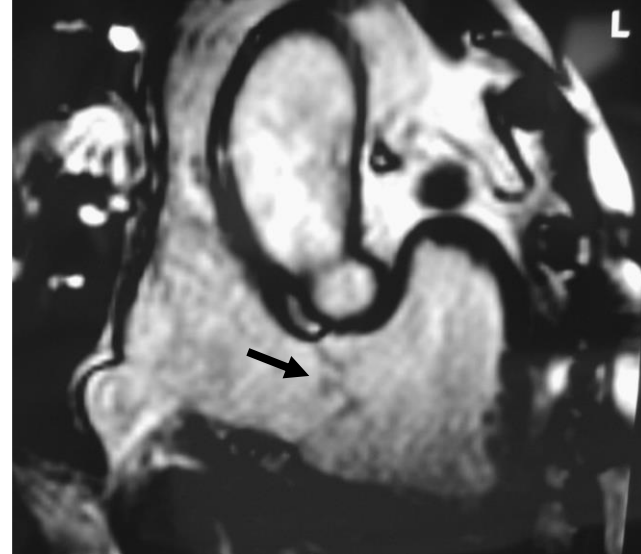


Cardiac masses/tumors: pseudotumors (crista terminalis)



Cardiac masses/tumors: papillary fibroelastoma

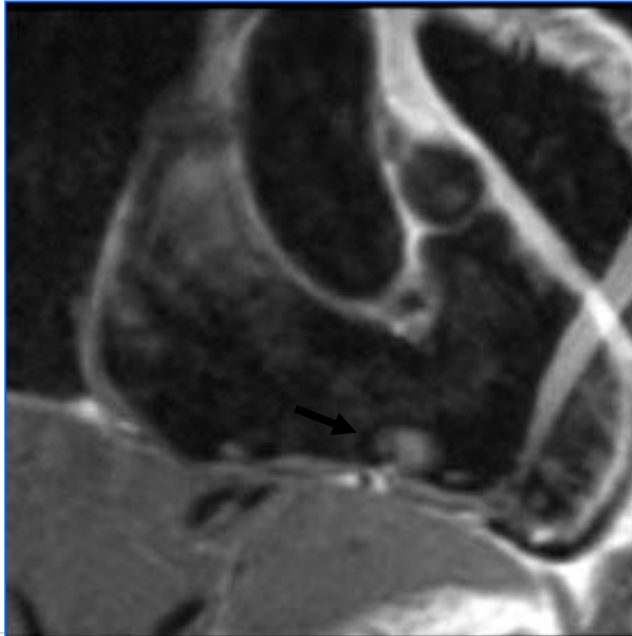
- 10% of cardiac tumors, 2° benign tumor
- Small size (<1 cm)
- Small vegetations originating from myocardium
- 90% originate from valvular surface
- Usually **asymptomatic** (autopsy) - **embolic events**



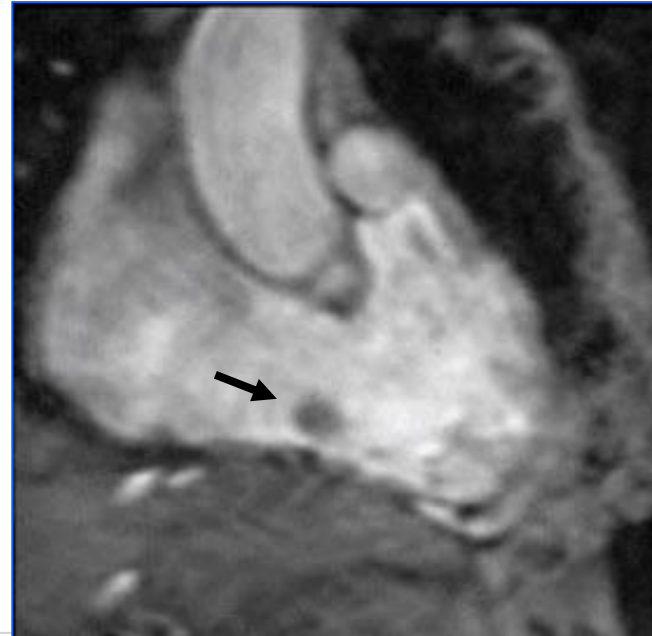
Cardiac masses/tumors: papillary fibroblastoma

Echo: moving small valvular lesions, homogeneous

Difficult to recognize in bbFSE

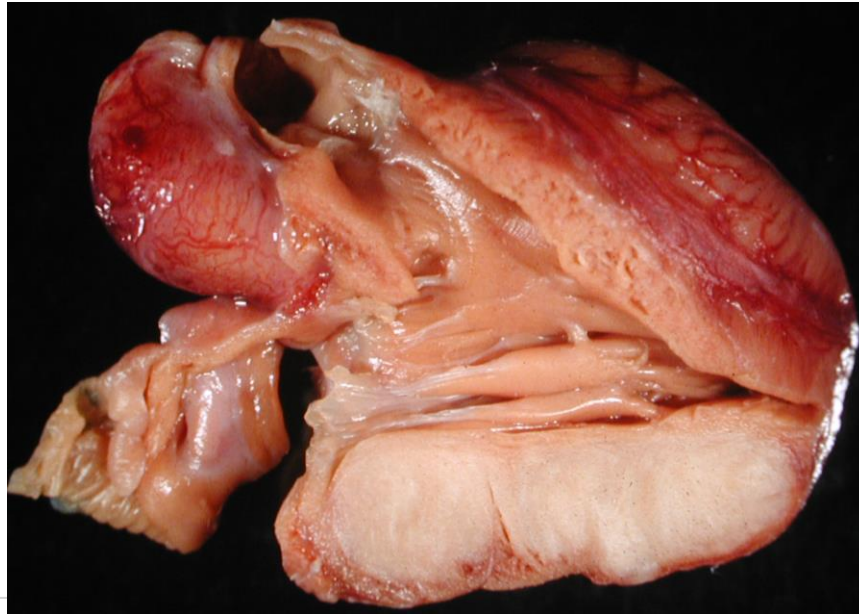


Easier recognition with cine



Cardiac masses/tumors: fibroma

- congenital, 1/3 in 1 yo children, 15% in young and adults
- In 14% of pts. with Gorlin syndrome
- 1/3 asymptomatic
- Symptoms: heart failure; arrhythmias; sudden death

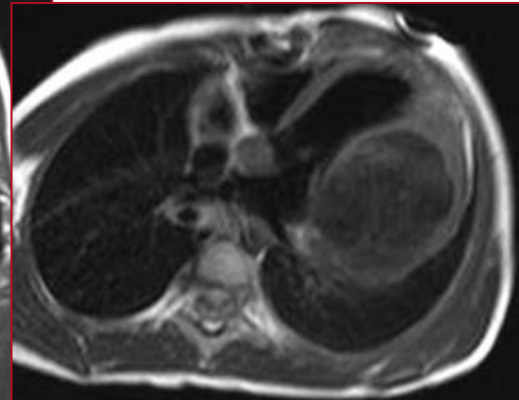
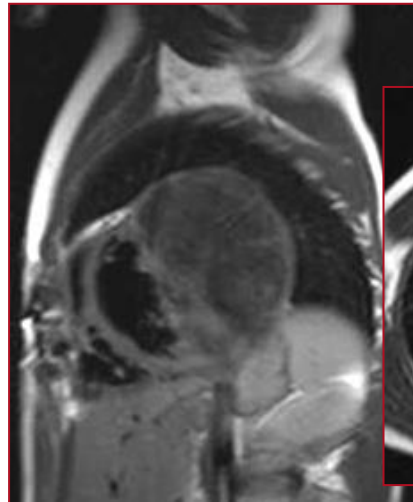
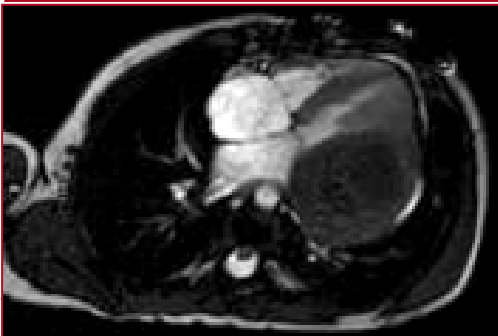
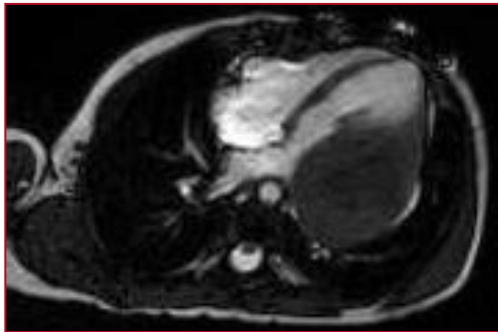


Cardiac masses/tumors: fibroma

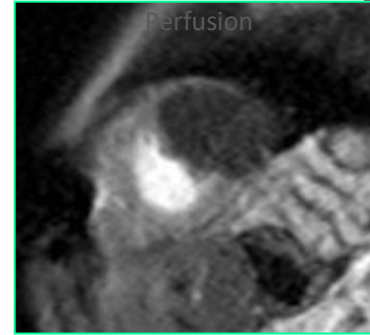
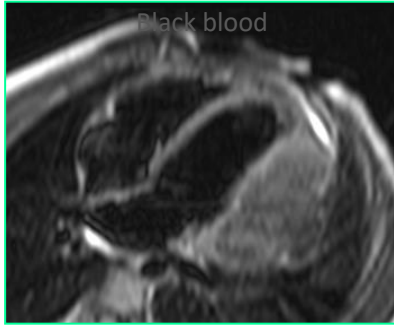
- Intramural growth; round shape, middle-to-large (2-10 cm)
- Frequent site: ventricles (LV free wall and IVS)
- Homogeneous SI (↓ in T2w): no cystic components, hemorrhage, necrosis
- Calcifications
- D.D. with rhabdomyoma in children

Rhabdomyoma

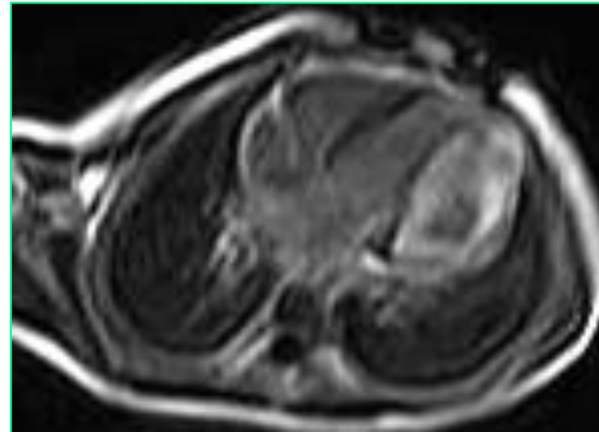
- multifocal
- ↑ in T2
- No calcifications



Cardiac masses/tumors: fibroma

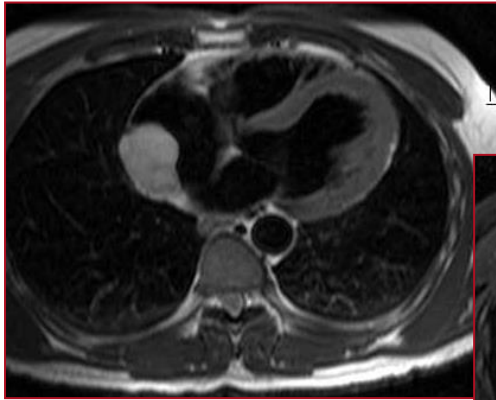


LATE ENHANCEMENT

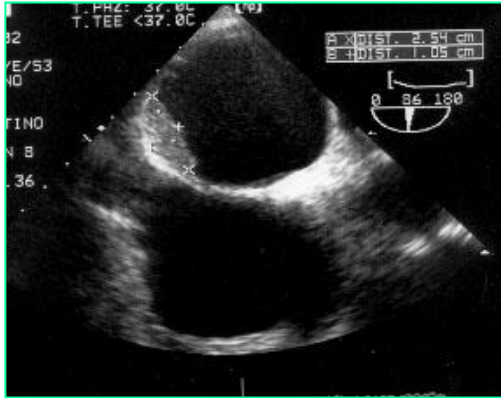


Cardiac masses/tumors: angioma

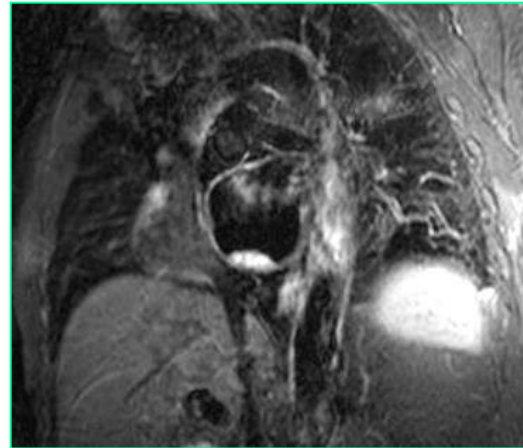
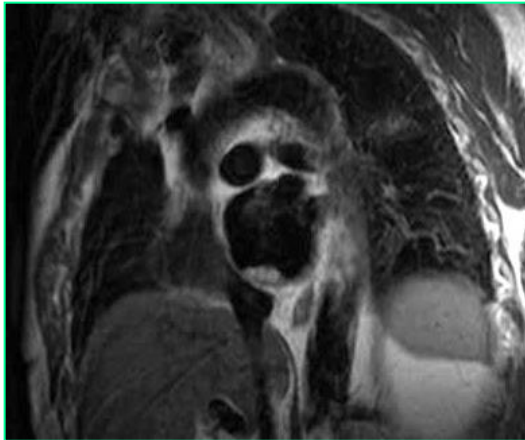
- 5-10% of benign tumors.
- Classification: **cavernous; capillary; artero-venous**
- Endocardial (capillary, faint margins). Intramural (all three categories)
- SI: intermediate in T1w, **hyperintense in T2w**
- **Enhancement: homogeneous or inhomogeneous, early or late depending on type**
- D.D. angiosarcoma



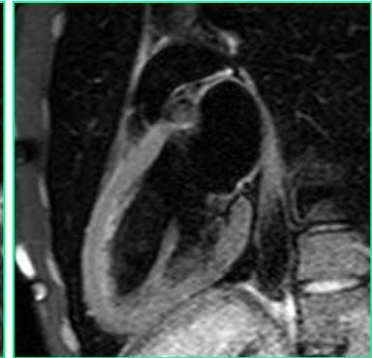
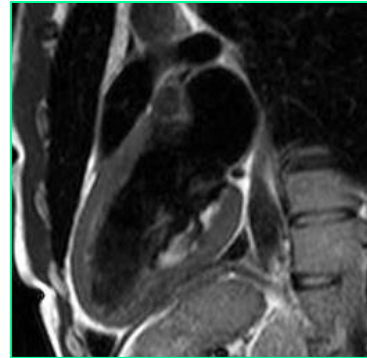
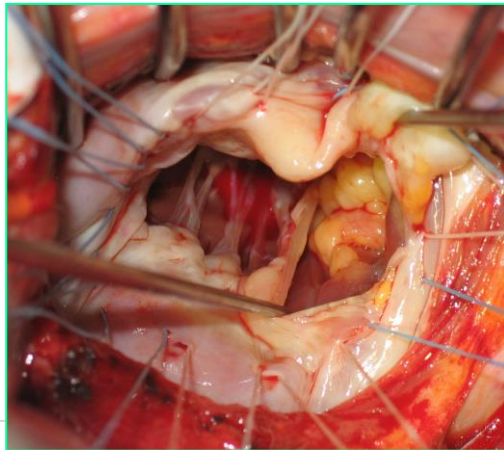
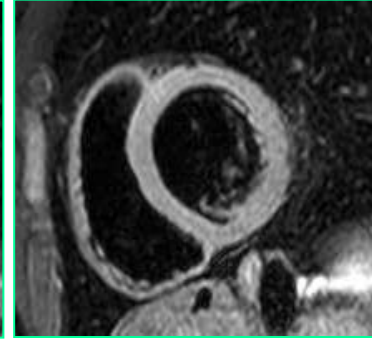
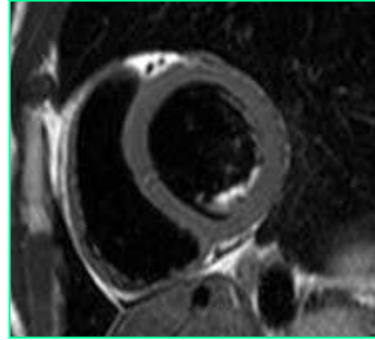
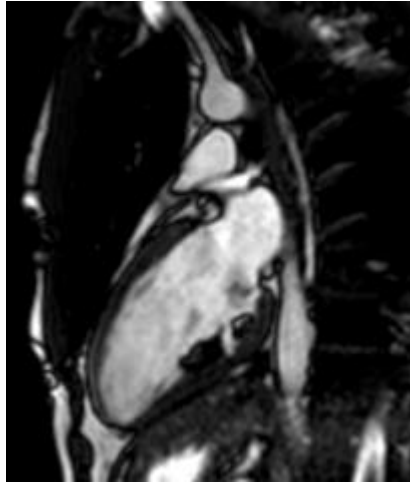
Cardiac masses/tumors: paraganglioma



- Site: atrial wall, arises from APUD cells
- Catecholaminergic (resembles pheochromocytoma)
- MIBG myocardial scintigraphy
- High SI in T2
- D.D.: myxoma and angioma



Cardiac masses/tumors: lipoid amarthoma



Cardiac masses/tumors: sarcomas



Prevalence: 2nd cardiac primary tumor; 1st malignant

Histopathology:

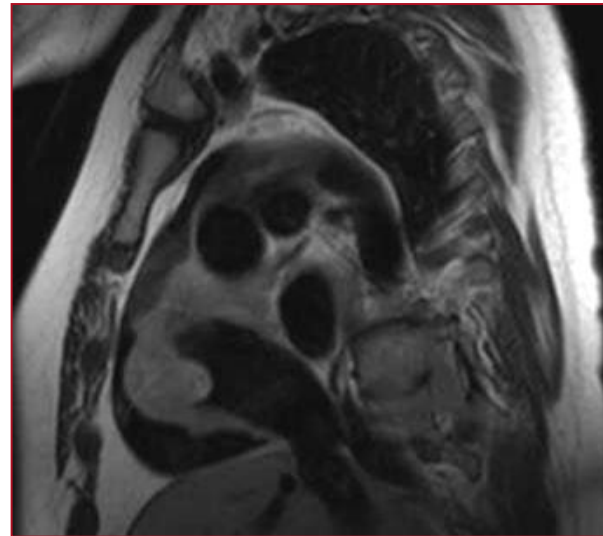
- 37% Angiosarcoma
- 24% — Saraplastic sarcoma
- 4-7% Rhabdomyosarcoma
- 11% — Malignant fibrous hystiocitoma
- 8-9% Leiomyosarcoma
- 3-9% Osteosarcoma

Site:

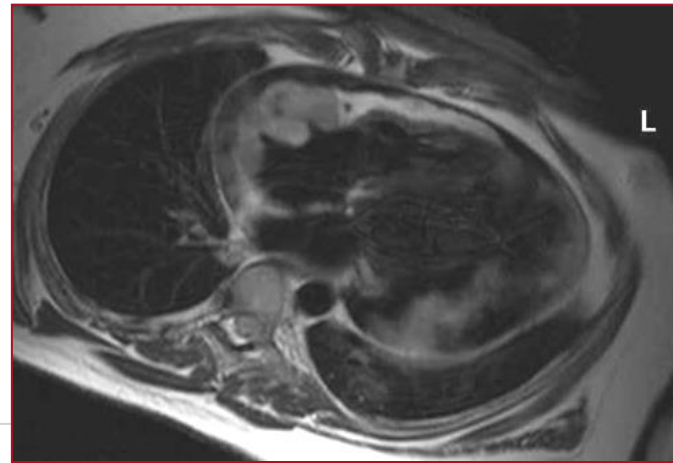
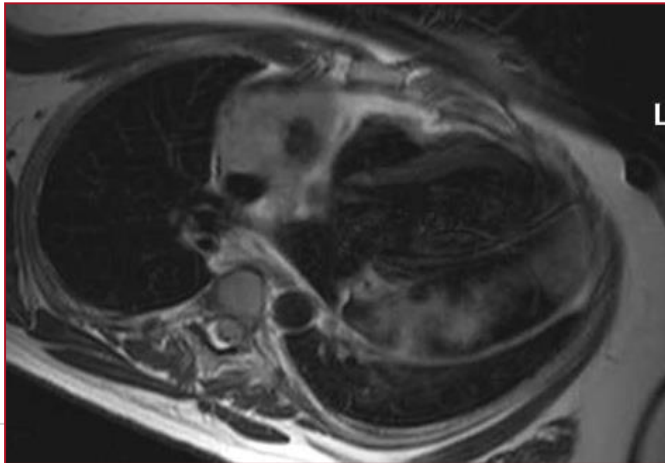
- Angiosarcoma → right atrium
- Rhabdomyosarcoma → RA > LA > RV > LV
- other sarcoma → LA (DD: mixoma)

Cardiac masses/tumors: angiosarcoma

- RA
- Large infiltrating mass
- Large base
- Pericardial involvement
- Hemorrhagic pericardial effusion
- Heterogeneous SI in T1, \uparrow SI in T2
- heterogeneous enhancement post Gd

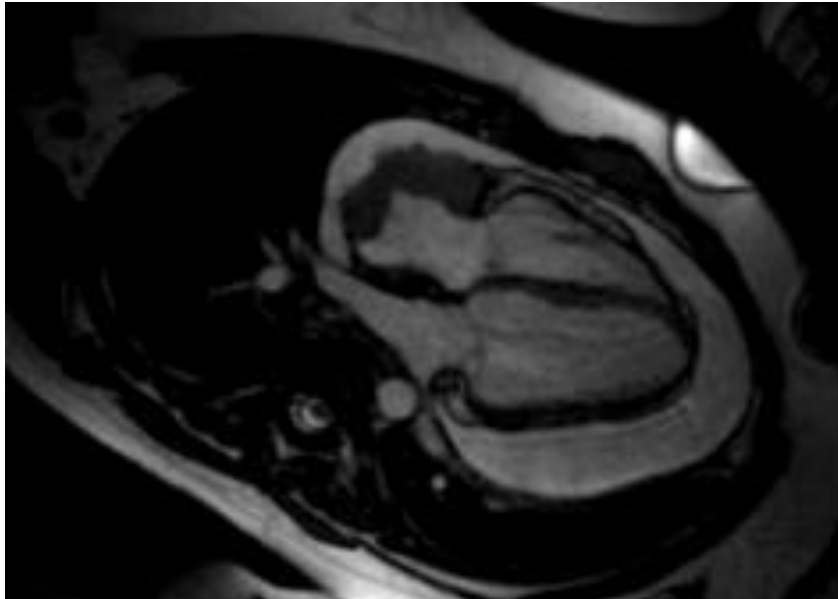


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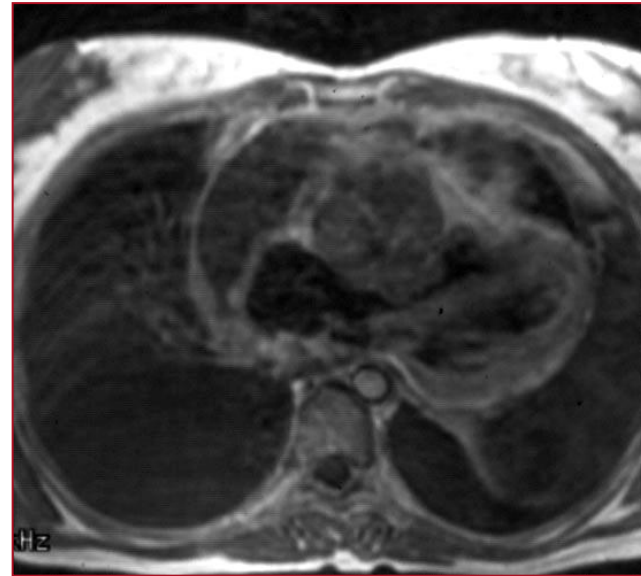
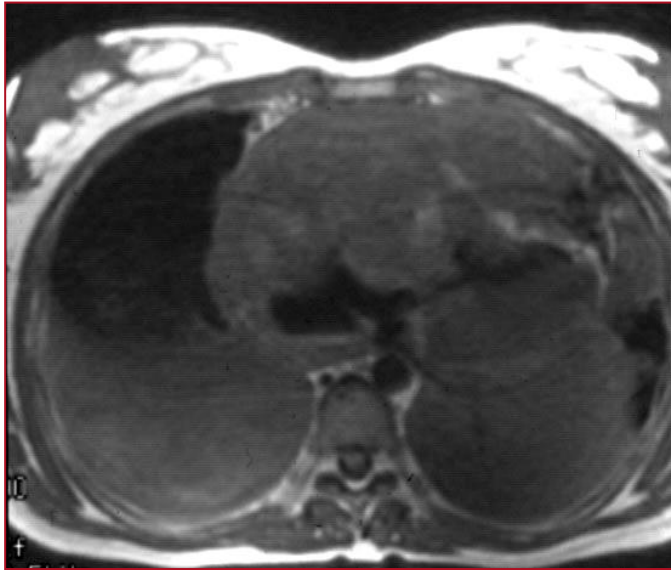
Cardiac masses/tumors: angiosarcoma

- Growth: in atrial cavity and toward pericardium
- Clinical presentation:
right cavity impaired filling/ tamponade

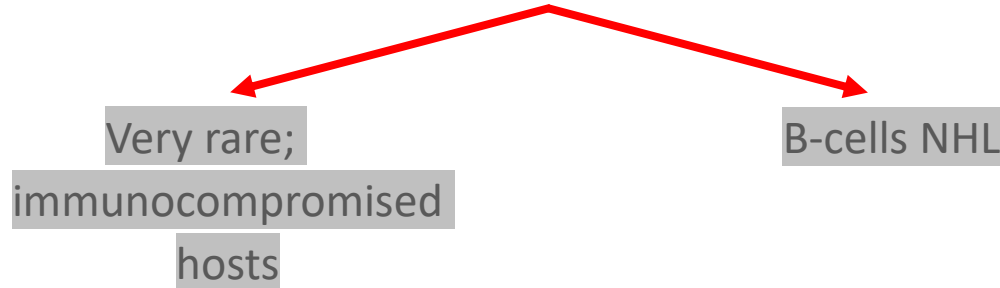


Cardiac masses/tumors: rhabdomyosarcoma

- 4-7 % of cardiac sarcomas, the most frequent in childhood
- In any cardiac chamber; frequent valve involvement
- Pericardial involvement: multiple nodules/masses



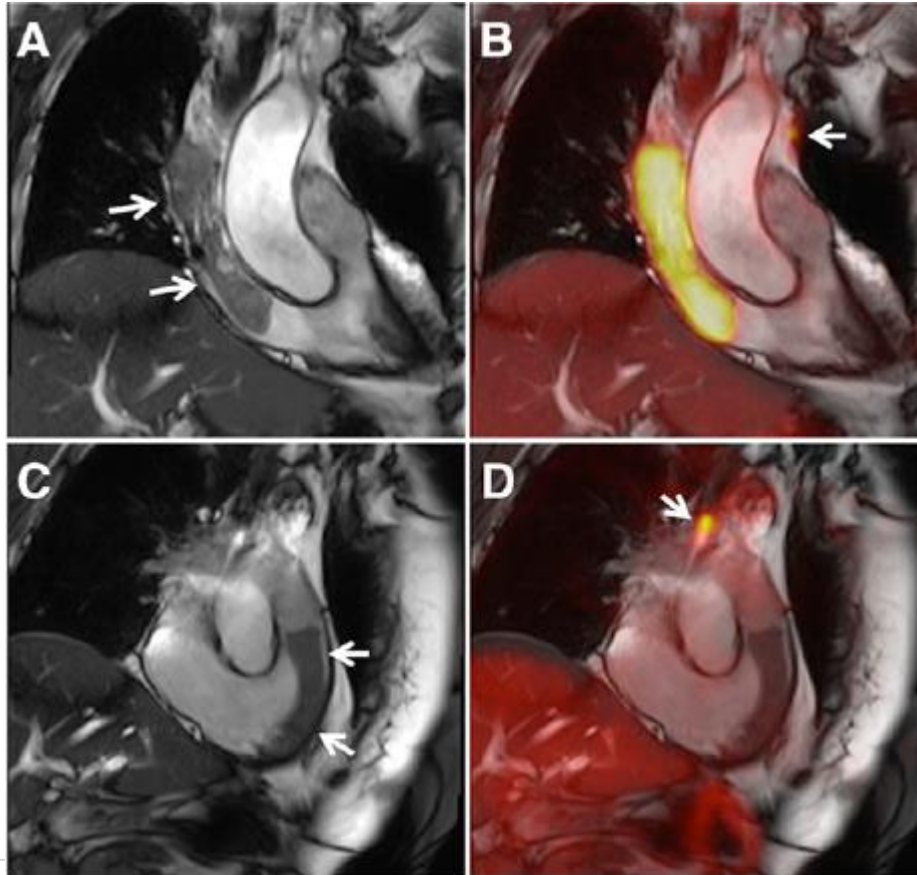
Cardiac primary lymphoma: exclusive cardiac/pericardial localization (no extra-cardiac site at diagnosis)



- 75%: more than one chamber
- Multiple inhomogeneous and ill-defined solid masses
- SI: iso-hypointense on T1, iso-hyperintense on T2
- Inhomogeneous Enhancement

**MRI useful in response
assessment during
treatment**

Cardiac masses/tumors: hybrid imaging (PET-MRI)



J Nucl Med 2015; 56:255–260

Cardiac masses/tumors: hybrid imaging (PET-MR)

Feature	Sensitivity (%)	Specificity (%)	Positive predictive value (%)	Negative predictive value (%)
SUV _{max}				
Cutoff ≥ 5.2 , optimal	100	92	88	100
Cutoff ≥ 3.5 (10)	100	85	78	100
Tumor volume (cutoff ≥ 23.1 mL, optimal)	100	85	78	100
Pericardial effusion	71	85	71	85
Cine SSFP morphology	86	92	86	92
T1w hyperintensity	29	54	25	58
T2w hyperintensity	100	54	54	100
Contrast enhancement	100	46	50	100
MR imaging overall	100	92	88	100
MR imaging overall & SUV _{max} (cutoff ≥ 5.2 , optimal)	100	100	100	100

J Nucl Med 2015; 56:255–260

- **MRI can be used to evaluate signal properties and morphologic characteristics of a cardiac mass and help define the nature of the lesion.**
- **MRI is an ideal tool for preoperative evaluation and follow-up in patients with cardiac tumors.**
- **The most frequent cardiac mass is thrombus**
- **Most primary cardiac tumors are benign, myxomas are the most frequent.**
- **Mets are the most common cardiac malignancy.**
- **Sarcomas are the most frequent malignant primary cardiac tumors.**