ASSESSMENT OF RIGHT-SIDED CARDIAC MASSES BY CARDIAC MRI: Case-Based Review And Imaging Tips

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2017
Nothing to disclose
LEARNING OBJECTIVES

▸ To review the spectrum of right-sided cardiac masses

▸ To explain the utility of CMR and suggest a protocol for imaging

▸ To provide a histologically confirmed case-based review of CMR findings
OUTLINE

1. Right-sided cardiac masses: short overview
2. Imaging protocol
3. Right-sided mimickers of cardiac masses
4. Right-sided non-neoplastic cardiac masses
5. Right-sided benign cardiac tumours
6. Right-sided malignant cardiac tumours
RIGHT-SIDED CARDIAC MASSES

▷ Right coronary artery is dominant in 80% cases\(^1\)

▷ Cardiac lymphatic drainage tends to follow coronary artery distribution: *right drainage system drains the majority of the heart’s lymph*\(^2\)

▷ Pericardial space has additional pathways (*phrenic neurovascular, paraoesophageal, tracheobronchial, etc*)
Lymph drainage in the heart

- The right and left drainage systems are formed separately and tend to follow the main coronary vessels.
- The right drainage system drains the majority of the cardiac lymph.
- Right bundle branch and the AV node are closely related to the subendocardial plexus and right lymphatic pathways.
- Valves and papillary muscles have extensive lymphatic systems.
- Pericardial space has additional pathways (phrenic neurovascular, paroesophageal, tracheobronchial, etc).

From *Cardiac Lymphomas: Spectrum of Cardiovascular Magnetic Resonance Features with Histological Correlation* Arzanauskaite M, Mohiaddin RH // RSNA 2016
RIGHT-SIDED CARDIAC MASSES

▶ Mass =/= tumour

▶ Cardiac tumours are rare (0.002-0.03%)\textsuperscript{3,4}

▶ Mimickers are much more frequent

▶ Metastases are 20-40 times more common than primary neoplasms\textsuperscript{5,6}
MIMICKERS

1. Anatomical variants
   - Crista terminalis
   - Eustachian valve
   - Chiari network
   - LA appendage ridge
   - False tendon in the LV
   - Ventricular trabeculations
   - Dilated coronary sinus

2. Thrombi
   - Acute
   - Chronic

3. Other non-neoplastic masses
   - Vegetations
   - Hydatid cyst
   - Tuberculoma
   - Aspergilloma
   - Calcified amorphous tumour
   - Dystrophic calcification of the mitral annulus
   - Endomyocardial fibrosis/Loeffler
   - Cardiac varices

4. Other
   - Post-op changes
   - Imaging artefacts
PSEUDOTUMOURS

Non-neoplastic

- Mesothelial/monocytic incidental cardiac excrescences (MICE)
- Pericardial cyst
- Heterotopic thyroid tissue
- Bronchogenic cyst
34 years (1970-2004), 210 cases of primary tumours
MRI FOR CARDIAC MASSES

- High temporal resolution
- High spatial resolution
- Tissue characterization ➤ malignancy prediction
- Paracardiac structures
- Precise location for biopsy planning

- ECG gating
- Breath holding
- Pacemakers, ICD
ASSESSMENT OF RIGHT-SIDED CARDIAC MASSES BY CARDIAC MRI: CASE-BASED REVIEW AND IMAGING TIPS

SUGGESTED IMAGING PROTOCOL

60 min

Haste and TrueFisp (anatomical sequences) → Axial, coronal, sagittal

Cine SSFP → Axial, orthogonal

TSE T1w, TSE T2w, STIR → Selective planes

VIBE before gadolinium (optional for extracardiac findings)

Gadolinium study

First pass perfusion (optional)

Early gadolinium phase

Late gadolinium phase

Optional

Velocity mapping over the mass or adjacent chambers/vessels*

Ventricular function module**

* to assess local compression
** of importance before and during chemotherapy

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MIMICKERS

Anatomical variants:

- Chiari network
- Crista terminalis
- Dilated coronary sinus
- Eustachian valve

THROMBES

- Central catheters
- Atrial fibrillation
- DVT
- Valvular prostheses

Young patient. Multiple episodes of PE, history of long-term placement of central venous catheter. T1-W (A), T2-W (B), T2 STIR (C), early and late gadolinium phases (D-E) cine SSFP show a large thrombus (arrow) in the right atrium extending from the junction of superior vena cava. Note the heterogeneous appearance of the enhancement pattern of the thrombus due to partial recanalisation of its lower part.
BENIGN TUMOURS

▸ Myxoma

Myxomas usually arise from the left atrium.

Regardless the location myxomas show typical morphology, signal intensity and contrast enhancement characteristics on CMR.

**Right atrial myxoma.**

Round-shaped, well-defined mass is seen attached to the interatrial septum on still images of cine SSFP sequence (1-3). The mass is isointense to the myocardium on T1W images (4-6) and mildly hyperintense on T2W images with fat suppression (7-9). The mass shows heterogeneous enhancement after contrast administration (late phase; 10-12).
Incidental finding. Four chamber (top panel) and RV in/out view (bottom panel). Right atrial lipoma (arrow) shows adipose tissue signal intensity in cine, T1 and T2 with fat suppression sequences. There was no enhancement on gadolinium study. Atrial lipomas are associated with lipomatous hypertrophy of the interatrial septum (arrowhead).
7 year old with a prenatally reported cardiac mass. Short axis view. Cystic sessile heterogeneous mass in the cavity of the right ventricle (arrows).
A 7-year-old with a prenatally reported cardiac mass.

Top panel: Coronal view confirms a fluid-filled mass (arrow) with a small component of adipose tissue (arrowhead).

Bottom panel: First pass perfusion in sagittal (A), coronal (B) and axial (C) views shows no vascularity.

Teratoma
MALIGNANT TUMOURS

- The majority of right heart malignancies in the heart are secondary.
- They can affect the right heart either via pericardium, systemic venous, arterial or lymphatic circulation.
- Primary cardiac tumours include multiple types of sarcomas, lymphoma and mesothelioma.

Updated WHO classification (2015)\(^8\)
- update on sarcomas (*malignant fibrous histiocytoma ➤ undifferentiated pleomorphic sarcoma*)
- molecular characterisation
MALIGNANT TUMOURS

Metastatic colorectal carcinoma

Irregular heterogeneous pericardial mass seen at the level of RV free wall in mid short axis view (arrows). Note the low signal intensity in early gadolinium phase, indicating central necrosis.

Below, Cine SSFP (four chamber view): free RV myocardial movement, indicating the tumour has not invaded the myocardial wall.
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- Metastatic uterine leiomyosarcoma

Large intracavitary mass in the right ventricle is heterogeneous, hyperintense to the myocardium on T2-STIR (A) image.

Marked enhancement on first pass perfusion sequence (B, video), indicating high vascularity.

Early (C) and late (D) phases after gadolinium administration show an area of necrosis (arrow).
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Renal cell carcinoma

Renal cell carcinoma invading the right atrium through the inferior vena cava. Abdominal CT (A-D, axial plane, soft tissue window) shows the primary tumour (*) directly invading the right atrium. MRI (E, still image of cine SSFP in sagittal view) is useful to assess vessel obstruction and invasion of the venous walls as well as to differentiate thrombus from the primary tumour.⁹
Irregular, heterogeneous mass is seen on axial and sagittal views of cine SSFP sequence (1,6). The mass is isointense to the myocardium on T1W images (2,7) and shows both solid and liquid component on T2W images with fat suppression (3-8). The mass shows heterogeneous enhancement after contrast administration (4-5, 9-10).
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Primary cardiac lymphoma

55 years old male was admitted for NSTEMI. Coronary angiogram showed non-obstructed coronary arteries. Dilated right ventricle with a suspicion of a mass was seen on echocardiogram.

**Figure 1.** Four chamber view showing multiple diffuse masses infiltrating right and left heart walls, both atrioventricular grooves and basal ventricular septum. The lesions are isointense to the myocardium on cine SSFP (1), hyperintense on the T2-weighted sequences with fat suppression (2). The first pass perfusion (3) and early gadolinium phase (4) show no evidence of high vascularity. The late gadolinium sequence (5) shows rather homogenous contrast uptake with small hypointense areas that may reflect presence of necrosis.

From *Cardiac Lymphomas: Spectrum of Cardiovascular Magnetic Resonance Features with Histological Correlation* Arzanauskaite M, Mohiaddin RH // RSNA 2016
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