CMR in Assessment of Cardiac Masses

Primary Benign Tumors

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CARDIAC MAGNETIC RESONANCE (CMR) PLAYS AN IMPORTANT ROLE IN THE ASSESSMENT OF CARDIAC TUMORS, because it combines high contrast and spatial resolution with a panoramic view of the heart and surrounding structures and an unmatched ability to characterize tissues. So, CMR assessment with dedicated protocols (Fig. 1) is frequently recommended to patients with cardiac masses, to confirm the lesion, orient the diagnosis toward the benign or malignant nature, and guide the subsequent patient management.

A selection of images collected in the last 5 years from the archives of our institution is presented to underline the distinguishing aspects of the most frequent primary cardiac tumors and pseudo-masses at CMR; in particular, the CMR images of primary benign cardiac tumors are included and discussed in this paper (Figs. 2 to 6), while the images of primary cardiac malignancies and pseudo-masses will be presented in an upcoming issue of iJACC. Each figure is provided with a 3-line header that sums up peculiar CMR findings.

Main aspects to be considered for helping in the comprehension of mass composition and biological aggressiveness include:

- Topography
- Morphology
- Signal intensity
- Pattern of enhancement at the dynamic contrast-enhanced study

CMR allows a multiparametric approach for the characterization of cardiac masses:

- Cine steady state free precession (SSFP) sequences offer a first morpho-functional evaluation with a balanced T1/T2 effect. SSFP sequences have high spatial and temporal resolution and are particularly useful to evaluate the mobility of a lesion and its impact on cardiac contractility or valves function.
- The variable acquisition of multiplanar “black blood” T1-weighted, T2-weighted, and/or proton density-weighted sequences, which can also be preceded by saturation pulses to suppress fat signal, allows a more accurate understanding of the size and the extension of the lesion as well as of mass composition.
- The perfusion study offers both qualitative and quantitative information about tumor vascularization (1).
- Late gadolinium enhancement of the lesion, detected acquiring inversion recovery sequences several minutes after gadolinium injection, might help in distinguishing small or large fibrotic components, which are frequent in benign conditions such as fibromas, fibroelastomas, and rarely myxomas (2).
CMR protocols for the assessment of cardiac masses

Valvular masses
- Multislice cine SSFP sequences on planes perpendicular and parallel to the involved valve
- Phase-contrast cine sequences on the involved valve can be associated for assessment of potential hemodynamic effect of the mass

Atrial masses
- Stack of multislice cine SSFP sequences on axial or four chamber view and short axis cardiac plane
- Black-blood IR-TSE sequences with and without fat suppression on the same planes
- Contrast-enhanced study with perfusion assessment and late-enhanced sequences, choosing the best plane from previous sequence

Ventricular masses
- Cine SSFP sequences on short-axis and on horizontal and vertical long-axis views
- Black-blood double IR-TSE and black-blood STIR sequences usually performed on short-axis view (on long-axis plane in case of apical masses)
- Perfusion and late enhancement studies on the best planes to evaluate the enhancement of the lesion and the relationship between tumor and normal surrounding tissues

**FIGURE 1** CMR Protocol for the Assessment of Cardiac Masses According to Lesion Location

Cardiac magnetic resonance (CMR) protocols vary, depending on the mass location that itself can orient the diagnosis. Fast cine sequences are useful to evaluate valve lesions, although these are well-assessed by echocardiography. In case of atrial or ventricular masses, a complete protocol usually includes functional cine sequences, morphological black-blood sequences, and a contrast-enhanced study. Imaging planes should be always tailored to the specific mass; however, the most-used views for each single cardiac chamber are presented in the diagram. Of note, a comprehensive protocol is mandatory in case of suspected malignancy.

IR-TSE = inversion recovery turbo spin echo; SSFP = steady state free precession; STIR = short tau inversion recovery.

**FIGURE 2** Sessile Myxoma of the Left Atrium

In 3-chambers (A and B) and parasagittal (C) cine-SSFP sequences the lesion shows heterogeneous low signal intensity (SI) with well-defined noninfiltrative margins. The tumor seems tightly adhered to the interatrial wall, arising from fossa ovalis. The mass has little movement during the cardiac cycle (A and B), a behavior suggesting the sessile morphology. In proton density–weighted sequences (D), the tumor is isointense to myocardium, whereas in STIR images (E) the tumor is strongly hyperintense, suggesting the presence of a myxomatous component. A parasagittal post-gadolinium IR image (F) demonstrates the heterogeneous contrast uptake of the mass. MR = magnetic resonance; other abbreviations as in Figure 1.
**FIGURE 3** Two Simultaneous Papillary Fibroelastomas

A long-axis 4-chamber cine steady state free precession sequence (A) shows 2 hypointense intracavitary pedunculated lesions in the right atrium. One of them typically arises from a valve leaflet, although with uncommon location on the atrial side of the tricuspid valve; the second has a very atypical origin from the atrial endocardium. On late-enhancement imaging, only the tumor of the atrial wall can be distinguished as a hypointense nodule (B). MR = magnetic resonance.

**FIGURE 4** Large Fibroma of the Left Ventricle

This intramural bulky mass is characterized by all the typical features of a fibroma: the intramural location with well-defined margins; the hypointense homogeneous signal on both cine SSFP (A) and T2-weighted (T2w) STIR (B) images, due to homogeneous fibrotic composition; the absence of early enhancement during the dynamic perfusion study (C), sign of hypovascular nature, and the presence of a very intense and homogeneous late-enhancement (10 min after gadolinium injection) (D), caused by contrast media entrapment in the interstitial space, expression of the predominant fibrotic composition. Abbreviations as in Figures 1 and 2.
**Figure 5** Large Hemangioma of the Right Atrium

Black-blood proton density-weighted images (A and B), respectively, on coronal and axial plane, show a well-delimited hyperintense mass growing in the right atrium posterior wall. The lesion results strongly hyperintense on axial T2w-STIR sequence (C), a typical feature characterizing all lesions of angiomatous nature. The absence of pericardial effusion and the presence of well-defined margins oriented the diagnosis toward a benign angiomatic lesion. Abbreviations as in Figures 1, 2, and 4.

**Figure 6** Paraganglioma of the Left Atrium

In this patient, referred for a catecholaminergic syndrome and negative abdominal imaging, the CMR study revealed a small broad-base mass adhered to the inferior wall of the left atrium, characterized by slightly heterogeneous high SI on black-blood T2w images both without (A) and with (B) fat suppression. This small atrial mass is compatible with a cardiac paraganglioma, usually growing within the atrial wall with an encapsulated aspect with high SI on T2w images, and possible slight heterogeneity due to hemorrhagic and/or necrotic foci. Abbreviations as in Figures 1, 2, and 4.

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