# Role of Contrast Enhanced Cardiac MRI in Differentiation between Cardiac Masses

Hesham E. El-Sheikh [a], Ibrahim M. Helmy [b], Ahmed E. Shaalan [a], Mohamed M. Shoeeb [a]

[a] Department of Radiology, Benha faculty of medicine, Benha University, Egypt. [b] Department of Radiology, National Heart Institute ,Cairo, Egypt.

**Correspondence to**: Mohamed M. Shoeeb, Department of Radiology, Benha faculty of medicine, Benha University, Egypt .

**Email:**

mohamedshoeeb2021@yahoo.com

**Received:** 11 March 2021

**Accepted**: 19 May 2021

**Abstract**

**Background**: Cardiac tumors, either benign or malignant, are rare. Malignant tumors have a poorer prognosis than benign tumors; however both are associated with significant morbidity in cases of delayed management. The goal of this study is to evaluate the diagnostic value of Cardiac MRI in tissue characterization of cardiac masses. **Methods:** we interpreted and analyzed separately the imaging data of 27 patients who met the inclusion criteria and performed CMR at MRI unit in National Heart Institute in Giza**. Results:** CMR has not only the ability to differentiate between benign and malignant lesions but also has the ability to differentiate between different types of benign tumors in most of cases by determination the location of the cardiac mass, its mobility, presence of pedicles and the variable MR signal intensity in different pre and post contrast sequences. In contrast to the malignant lesions, CMR shows a difficulty in the differentiation between different types of malignant lesions and usually needs histopathological correlation. However CMR shows a great value in determining the extent of the malignant lesions that is needed before planning the therapeutic management. **Conclusion:** CMR has a great role in evaluation of the cardiac masses by its powerful assessment of the anatomical and soft tissue characterization of the masses as well as their functional impact and so it allows the differentiation between neoplastic and non-neoplastic masses as well as between malignant and benign masses that is necessary in pre-therapeutic planning without the need of the unnecessary invasive biopsy.

**Keywords:** contrast; MRI; cardiac; mass

## Introduction

The overall frequency of cardiac tumors is quite low, with an estimated cumulative prevalence of 0.002%–0.3% at autopsy and 0.15% in echocardiographic series, (1)*;*

however they represent an important group of cardiovascular abnormalities as the early and accurate diagnosis maybe curative and sometimes avoids unnecessary surgery. (2)

Including all cardiac masses, thrombus is the most common entity followed by metastasis. While myxomas and sarcomas account for most tumors in adults, rhabdomyomas are the most frequent in infants and fibromas are the most common in children. (3)

Echocardiography is the primary modality for imaging the intra- cardiac diseases. It provides high-resolution, real-time images. However, as image acquisition with computed tomography (CT) and magnetic resonance (MR) imaging has steadily become faster, these modalities have played an increasingly important role in the evaluation of cardiac neoplasms. (4)

The variability of MR imaging parameters allows increased specificity in the evaluation of diseased tissue. (5)

Magnetic resonance imaging (MRI) provides a non-invasive and three-dimensional assessment of the masses involving the cardiac chambers, the pericardium, and the extra- cardiac structures. (6)

The goal of MRI is for assessing cardiac and para-cardiac masses including; the confirmation or exclusion of the masses suspected by any other modality as echocardiography, their location, mobility and relationship to the surrounding tissues, the degree of their vascularization, determination of tissue characteristics and the specific nature of the masses, (6) allowing differentiation between benign and malignant lesions and assessment of their functional impact. (7)

MRI has become a promising method to yield complementary diagnostic information and to guide cardiac surgeons in the design of an appropriate therapeutic strategy (6).

The goal of this study is to evaluate the diagnostic value of Cardiac MRI in tissue characterization of cardiac masses.

## Patients and methods

This is a descriptive study aimed to study the role of contrast enhanced cardiac MRI in the characterization of cardiac masses on 27 patients who were diagnosed to have cardiac masses by echocardiography or other imaging modalities from the patients attending in National Heart Institute in Giza, during the period from June 2019 to October 2020. MRI of the selected cases was done on

closed Siemens MR Systems operating at 1.5 tesla in National Heart Institute in Giza. The study was performed after approval of the Ethical committee of scientific Research.

***These patients were subjected to:***

- Personal history review including age and sex.
- Patient's complaint.
- History of present illness.
- Past history review including previous myocardial infarctions, primary malignant lesions & previous central line or porto-cath insertion.
- Surgical history review.
- Rapid clinical evaluation.
- Revising the laboratory work up.
- Revising the echocardiography or the other imaging modalities which were related to patient diagnosis of cardiac mass.

***Inclusion criteria:***

- The study was performed on patients diagnosed with cardiac masses by echocardiography or other imaging modalities and approved to participate in this study.
- Both sexes were included.
- No age predilection.

***Exclusion criteria:***

- Subjects were excluded if there was any contraindication for MRI, MRI proved absence of cardiac tumors or patients that refused to participate in the study.
- Claustrophobic patients.
- Patients with significant arrhythmias (such as atrial fibrillation or frequent premature ventricular contractions) may produce images which are degraded by cardiac motion so the arrhythmia must be treated first.
- Patients with bad general condition needing life support and those with severe hepato-renal disease.
- Patients known to have contraindications for MRI, e.g. an implanted magnetic device, pacemakers (must be adapted first) or mechanical valve (absolute contraindication).
- Patients whom contrast material safety had not been proved such as lactating and pregnant females.

- Patients with acute kidney injury, chronic kidney disease, renal failure and those who had a kidney transplant. These patients are more susceptible to develop nephrogenic systemic fibrosis. (GFR<30 ml/min or serum creatinine >1.5 mg/dl).

The informed consent form was given to the patient or his guardian directly by the main researcher before performing the examination. The patient read the form or it was been read to him /her, if he /she couldn't read, by the main researcher and the patient signed the consent form. The study was approved by the Ethical Committee of Benha Faculty of Medicine

***Patient preparation:***

1- Reassurance of the patient.

2- Respiratory training.

3- Adaptation of pacemaker if needed.

4- Shaving of chest hair.

5- Before an MRI exam, the patient was instructed to eat normally and continue to take his usual medications, unless otherwise instructed. He was typically asked to change into a gown and to remove things that might affect the magnetic imaging:

6- During the MRI scan, the internal part of the magnet produces repetitive tapping, thumping and other noises. Earplugs or music may be provided to help block the noise.

***Scanning technique:***

The study was performed with a 1.5-T MR system (Siemens MR Systems operating).

***Patient position:***

The patients were asked to lie on the MRI table in supine position. The ECG electrodes were placed on the sternum and fingers in all cases after cleaning the skin. Then, specific cardiac or torso coils were used for imaging with multi-element phased-array coils (16 channels), required for parallel imaging.

***Image acquisition:***

ECG-gated MRI of the heart was performed with leads on chest wall and some cases will be done by finger trigger. Multi-slice transverse spin-echo images was acquired with a slice thickness of 8-10 mm and an inter-slice gap of 2 mm in adults and a slice thickness of 5 mm and an inter-slice gap of 1 mm in children. TA is equal to the AR interval, and TE is 20-30 msec. The imaging

matrix is 256 x 360 with a pixel size of 1.5 x 1.5 mm. We acquired coronal, sagittal, or oblique images depending on the anatomy of the region of interest.

Additional gradient-recalled echo (GRE) dines MR images will be acquired in both transverse and coronal planes in some patients. The TA is 40-50 msec and the TE is 22 msec.

Localizer images in three orthogonal planes were taken first.

ECG steady-state free precession (balanced fast field- echo) cine sequence was used. All images were acquired during end-expiration breath hold with acquisition time about 9-13 second per breath hold.

FSE sequences (black blood pool) were taken in axial, sagittal and coronal views with the following sequence parameters;

Repetition time in msec (TR) /echo time in msec (TE), 800-1666 /28- 40; Field of view (FOV), 75.5 X 38; section thickness (ST), 3mm.

***T2 STIR sequence was taken in short axis view with the following parameters:*** Repetition time in msec/echo time in msec, 800- 1666/80; section thickness (ST), 8 mm; FOV, 103 x 51.7.

GRE sequences (white blood pool) were taken in vertical long axis (VLA), short axis (SA) and four chamber (4 CH) views with the following sequences parameters:

***Sequence parameters of VLA:***

Repetition time in msec/echo time in msec, 2.7- 2.9/1.34- 1.45; flip angle (FA), 60°; section thickness, 8 mm; FOV, 97 x 49.3.

***Sequence parameters of 4 CH:***

Repetition time in msec/echo time in msec, 2.8- 3/1.5- 1.7; flip angle, 60°; section thickness, 8 mm; FOV, 87.7 x 44.2.

**Statistical Methods:**

Data collected throughout history, basic clinical examination, laboratory investigations and outcome measures coded, entered and analyzed using Microsoft Excel software. Data were then imported into Statistical Package for the Social Sciences (SPSS version 20.0) (Statistical Package for the Social Sciences) software for analysis. According to the type of data qualitative represent as number and percentage, quantitative continues group represent by mean ± SD, the following tests were used to test differences for significance difference and association of qualitative variable by Chi square test (X2). Differences between

quantitative independent groups by t test or Mann Whitney, paired by paired t. P value was set at <0.05 for significant results & <0.001 for high significant result.

## Results

The studied population included 27 patients, 8 females (29.6%) and 19 males (70.4%). The median age group was 45 years with interquartile range (IQR) from 34 to 60 years, while the maximum to minimum range was from 1 month to 81 years (Table. 1).

48.2% (13/27) of the studied population had no relevant clinical data, 14.8% (4/27) had ISHD, 7.4% (2/27) had history of primary malignant neoplasm, 11.1% (3/27) had history of central venous line or porta-cath insertion, 11.1% (3/27) had history of both primary malignant neoplasm & central venous line or porta-cath insertion and 7.4% (2/27) had history of coagulopathy disorders. (Table. 2).

In our study the most common involved cardiac chamber by the cardiac masses was the right atrium by 51.9% (14/27) followed by the right ventricle by 29.6% (8/27). The left atrium was involved by 22.2% (6/27) and the least cardiac chamber involvement was the left ventricle by 18.5% (5/27). The inter-atrial septum was affected in 18.5% (5/27) of the cases, the inter-ventricular septum was affected in 22.2% (6/27) of the cases and the inferior vena cava was affected in 18.5% (5/27) of the cases in our study population, figure 1.

In our study we found 13 cases (48.1%) were diagnosed as non neoplastic masses (pseudo tumors), 12 cases (44.4%) were diagnosed as true tumors either benign or malignant looking and 2 cases (7.4%) were undefined and needed further investigations to recognize the nature of the cardiac masses. The two cases that showed conflict in the diagnosis of their natures were myxoma Vs thrombus and fibroelastoma Vs thrombus. This conflict was probably due to the small size of the lesions. The cross-sectional areas of the masses were $\pm$ 1.8 $cm^2$ (15 x 12mm) and 0.8 cm2 (0.9 x 0.9) respectively.

In our study 84.4% (11/13) of the masses diagnosed as pseudo-tumors were diagnosed as intra cardiac thrombus. The others were diagnosed as focal hypertrophied cardiomyopathy and hypertrophied crista terminalis. The difference between the true tumors & the pseudo-tumors as regard the demographic data, the MR characteristics as well as the clinical data were summarized in the (Table 3).

In our study the statistical significant items in the differentiation between the true and the pseudo tumors were the marginal outline, the affected cardiac chamber, and the pattern of delayed enhancement as well as the relevant clinical data. (Table 3)

In our study the statistical significant items in the differentiation between the benign and the malignant lesions were size, marginal outline, pattern of growth, and pericardial affection either infiltration or effusion. (Table 4)

Case (1): 64 year old patient with liver cirrhosis, positive hepatitis C virus and HCC. An echocardiography is requested before chemo-embolization. (Figure 2 a & b.)

The echocardiography reveals a right atrial mass Vs thrombus measuring 6x4.3cm filling right atrial cavity. CMR is recommended for better characterization of the mass. (Figure 3-6)

**Table 1:** Characteristics of the study population.

| Variable | | Number (%)/Median(IQR) |
|---|---|---|
| **Gender** | Male | 19 (70.4%) |
| | Female | 8 (29.6%) |
| **Age (years)** | | 45 (34-60); range, 1 month to 81 years |

**Table 2**: Relevant clinical data.

| Variable | | Number (%) |
|---|---|---|
| **Relevant clinical data** | Nil | 13 (48.2 %) |
| | History of ISHD | 4 (14.8%) |
| | History of 1ry tumor | 2 (7.4%) |
| | History of CVC/Porta-cath insertion | 3 (11.1%) |
| | History of 1ry tumor and CVC/Porta-cath insertion | 3 (11.1%) |
| | History of coagulopathy disorder | 2 (7.4 %) |

**Table 3:** Characteristics of true tumors and pseudo-tumors.

| Variable | True tumor (n=12) | Pseudo-tumor (n=13) | P-value |
|---|---|---|---|
| ***Age(years)*** | 41.5 (0.9 – 60) | 48 (38 – 56.5) | 0.205¶ |
| ***Cross-sectional area ($cm^2$)*** | 5.1 (1.8 – 17.5) | 1.6 (1.1 – 4.8) | 0.051¶ |
| ***Gender, M/F*** | 8/4 | 9 | 1.000§ |
| ***Multiplicity of lesions*** | 9/3 | 1 | 1.000§ |
| ***(single/multiple)*** | | 0/ | |
| ***RA involvement*** | 6 (50.0%) | 7 (53.8%) | 0.848¥ |
| ***LA involvement*** | 4 (36.4%) | 1 (7.7%) | 0.142§ |
| ***RV involvement*** | 7 (58.3%) | 1 (7.7%) | 0.011§ |
| ***LV involvement*** | 2 (16.7%) | 3 (23.1%) | 1.000§ |
| ***IAS involvement*** | 5 (41.7%) | 0 (0%) | 0.015§ |
| ***IVS involvement*** | 5 (41.7%) | 1 (7.7%) | 0.073§ |
| ***IVC involvement*** | 2 (16.7%) | 2 (15.4%) | 1.000§ |
| ***Lesion mobility*** | 4/8 | 6 | 0.688§ |
| ***(mobile/immobile)*** | | / | |
| ***Lesion pattern*** | 10/2 | 1 | 0.220§ |
| ***(Localized/diffuse infiltrative)*** | | 3/ | |
| ***Lesion outlines*** | 7/5 | 1 | 0.015§ |
| ***(regular/irregular)*** | | 3/ | |
| ***Signal pattern*** | 9/3 | 1 | 1.000§ |
| ***(homogenous/heterogenous)*** | | 0/ | |
| ***Signal intensity (black blood pool images)*** | | | 0.372§ |
| ***Hypointense*** | 4 (33.3%) | 8 (61.5%) | |
| ***Isointense*** | 7 (58.3%) | 4 (30.8%) | |
| ***Hyperintense*** | 1 (8.3%) | 1 (7.7%) | |
| ***Signal intensity (white blood pool images)*** | | | 0.320§ |
| ***Hypointense*** | 4 (33.3%) | 8 (61.5%) | |
| ***Isointense*** | 6 (50.0%) | 3 (23.1%) | |
| ***Isointense to hyperintense*** | 2 (16.7%) | 2 (15.4%) | |
| ***Pattern of delayed enhancement*** | | | <0.001§ |
| ***Nil*** | 2 (16.7%) | 12 (92.3%) | |
| ***Faint*** | 6 (50.0%) | 0 (0%) | |
| ***Moderate*** | 2 (16.7%) | 0 (0%) | |
| ***Intense*** | 1 (8.3%) | 0 (0%) | |
| ***Peripheral*** | 1 (8.3%) | 1 (7.7%) | |
| ***Pericardial infiltration*** | 2 (16.7%) | 0(0%) | 0.220§ |
| ***Pericardial effusion*** | 3 (25.0%) | 0 (0%) | 0.096§ |
| ***Associated clinical data*** | | | <0.001§ |
| ***Irrelevant*** | 11 (91.7%) | 1 (7.7%) | |
| ***History of ISHD*** | 0 (0%) | 3 (23.1%) | |
| ***History of 1ry tumor*** | 1 (8.3%) | 1 (7.7%) | |
| ***History of CVC/Portacath insertion*** | 0 (0%) | 3 (23.1%) | |
| ***History of 1ry tumor and CVC/Portacath insertion*** | 0 (0%) | 3 (23.1%) | |
| ***History of coagulopathy disorders*** | 0 (0%) | 2 (15.3%) | |

| | | | |
|---|---|---|---|
| ***Preliminary impression by MRI*** | | | 0.039§ |
| ***Benign-looking*** | 8 (66.7%) | 13 (100.0%) | |
| ***Malignant-looking*** | 4 (33.3%) | 0 (0%) | |
| ***Course by radiologic follow-up*** | | | 0.006§ |
| ***Stationary course*** | 4 (100.0%) | 0 (0%) | |
| ***Organization of thrombus*** | 0 (0%) | 4 (57.1%) | |
| ***Resolution of thrombus*** | 0 (0%) | 2 (28.6%) | |
| ***Cardiac CT & TTE confirmed diagnosis (crista terminalis)*** | 0 (0%) | 1 (14.3%) | |

Data are presented as median (interquartile range), ratio, or number (valid %).
¶Mann-Whitney test.
§Fisher's exact test.
¥Pearson chi-squared test.

**Table 4:** Characteristics of benign-looking and malignant-looking masses

.

| *Variable* | *Benign-looking(n=23)* | *Malignant-looking (n=4)* | *p-value* |
|---|---|---|---|
| ***Age (years)*** | 45 (34 – 54) | 52 (28.8 – 70) | 0.622¶ |
| ***Cross-sectional area ($cm^2$)*** | 4.4 (5.2) | 16.7 (12.0) | 0.003# |
| ***Gender, M/F*** | 15/8 | 4/0 | 0.285§ |
| ***Multiplicity of lesions*** | 17/6 | 1/0 | 0.545§ |
| ***RA involvement*** | 11 (47.8%) | 3 (75.0%) | 0.596§ |
| ***LA involvement*** | 5 (21.7%) | 1 (25.0%) | 1.000§ |
| ***RV involvement*** | 5 (21.7%) | 3 (75.0%) | 0.065§ |
| ***LV involvement*** | 5 (21.7%) | 0 (0%) | 0.561§ |
| ***IAS involvement*** | 3 (13.0%) | 2 (50.0%) | 0.144§ |
| ***IVS involvement*** | 6 (26.1%) | 0 (0%) | 0.545§ |
| ***IVC involvement*** | 3 (13.0%) | 2 (50.0%) | 0.144§ |
| ***Lesion mobility*** | 10/13 | 1/3 | 0.455§ |
| ***Lesion pattern (localized/diffuse infiltrative)*** | 23/0 | 2/2 | 0.017§ |
| ***Lesion outlines (regular/irregular)*** | 22/1 | 0/4 | <0.001§ |
| ***Signal pattern (homogenous/heterogenous)*** | 19/4 | 2/2 | 0.204§ |
| ***Signal intensity (black blood pool images)*** | | | 0.133¥ |
| ***Hypointense*** | 13 (56.5%) | 1 (25.0%) | |
| ***Isointense*** | 9 (39.1%) | 2 (50.0%) | |
| ***Hyperintense*** | 1 (4.3%) | 1 (25.0%) | |
| ***Signal intensity (white blood pool images)*** | | | 0.954¥ |
| ***Hypointense*** | 13 (56.5%) | 1 (25.0%) | |
| ***Isointense*** | 6 (26.1%) | 3 (75.0%) | |
| ***Isointense to hyperintense*** | 4 (17.4%) | 0 (0%) | |
| ***Pattern of delayed enhancement*** | | | <0.021§ |

| | | | |
|---|---|---|---|
| ***Nil*** | 16 (69.6%) | 0 (0%) | |
| ***Faint*** | 3 (13.0%) | 3 (75.0%) | |
| ***Moderate*** | 1(16.7%) | 1 (25.0%) | |
| ***Intense*** | 1 (4.3%) | 0 (0%) | |
| ***Peripheral*** | 1 (4.3%) | 0 (0%) | |
| ***Pericardial infiltration*** | 0 (0%) | 2 (50.0%) | 0.017§ |
| ***Pericardial effusion*** | 1 (4.3%) | 2 (50.0%) | 0.049§ |

Data are presented as median (interquartile range), mean (SD), ratio, or number (valid %).

¶Mann-Whitney test, #Unpaired t test, §Fisher's exact test, ¥Chi-squared test for trend.

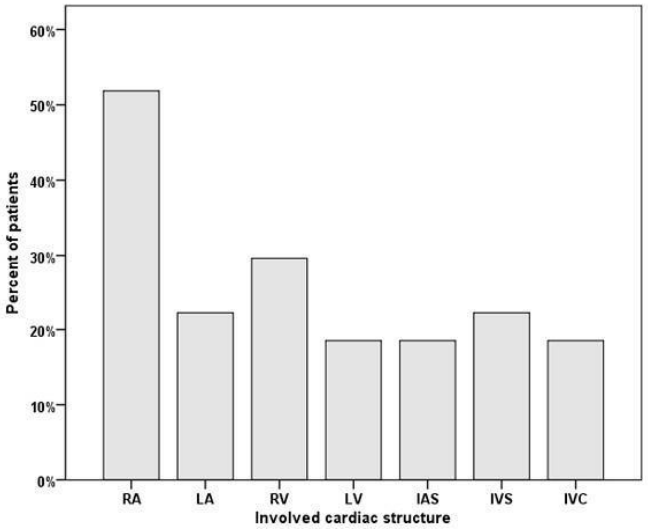
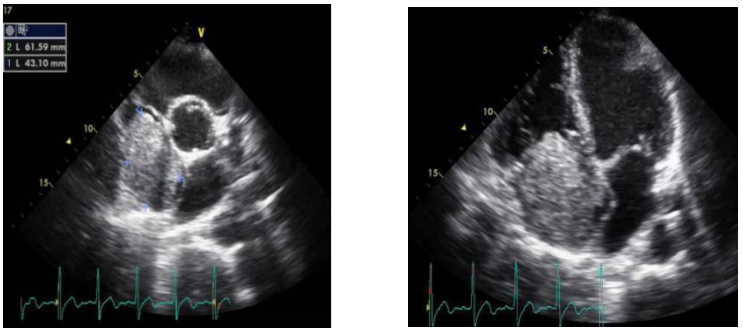
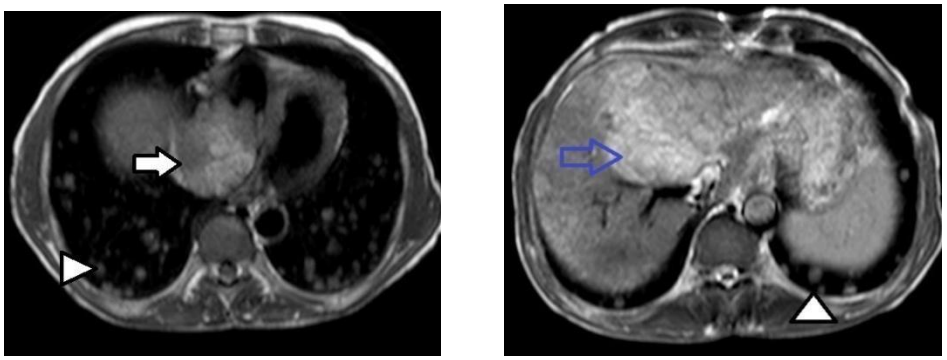



**Figure 1:** Bar chart showing the frequency of involvement of various cardiac structures in the study population.



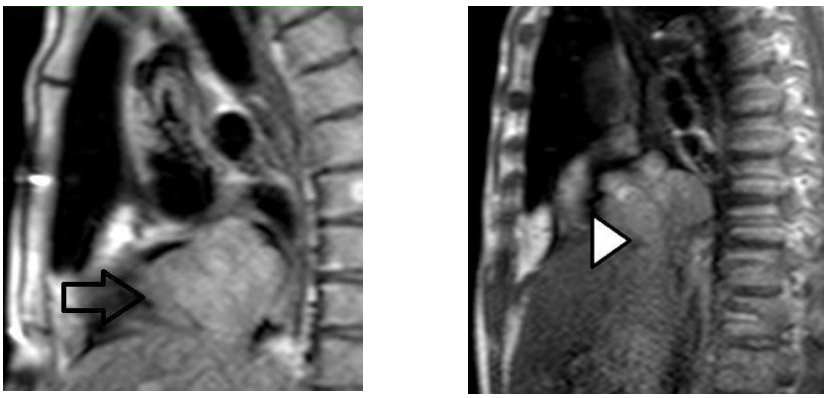
(a) (b)

**Figure 2:** (a, b) Echocardiography images show a dilated right atrium with a right atrial mass filling the right atrial cavity.



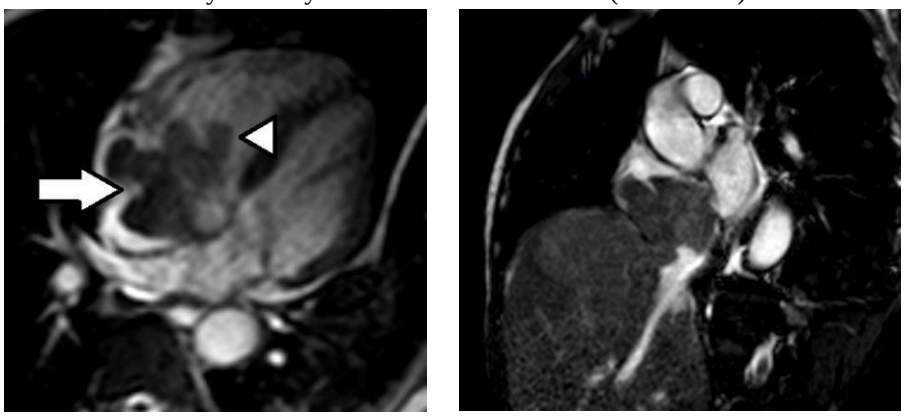
(a) (b)

**Figure 3:** (a) Axial T1WI black blood pool image reveals a large lobulated soft tissue mass lesion occupies most of right atrium measuring ± 6 x 4.7 cm (white arrow). It exhibits heterogeneously bright signal intensity to the myocardium. Multiple pulmonary metastatic deposits are also seen (arrow heads). (b) A white large hepatic focal lesion is seen at the heterogeneous right hepatic lobe (blue arrow).



(a) (b)

**Figure 4:** (a, b) Sagittal black blood pool images confirm the right atrial mass (arrow) and reveal that the IVC is dilated and totally filled by the soft tissue mass lesion (arrow head).



(a) (b)

**Figure 5:** (a) Four chamber view white blood pool image shows that the right intra atrial mass lesion (arrow) extends through tricuspid valve by a small freely mobile portion (arrow head). It exhibits a heterogeneous low to intermediate signal intensity to the myocardium. (b) Short axis view white blood pool image delineates the mass more clearly and its extension through the IVC.

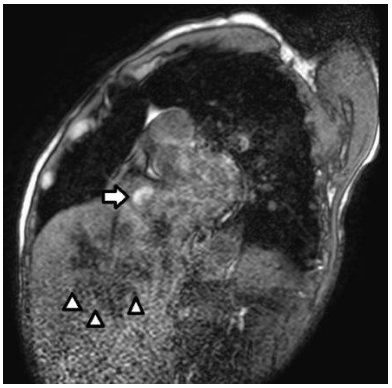


**Figure 6:** Delayed post contrast short axis view shows faint enhancement of the right atrial mass lesion suggestive of tumoral thrombotic lesion (white arrow). The hepatic focal lesion shows washout of contrast in delayed images (arrow head

## Discussion

In our study we found 13 cases (48.1%) were diagnosed as pseudo tumors, 12 cases (44.4%) were diagnosed as true tumors either benign or malignant and 2 cases (7.4%) were undefined and needed further investigations to recognize the nature of the cardiac masses.

The conflicted cases were diagnosed as myxoma Vs thrombus and fibroelastoma Vs thrombus. This conflict was probably due to the small size of the lesions and atypical criteria of the mass lesions.

As regard the location of the cardiac masses in our study the most common involved cardiac chamber by the cardiac masses was the right atrium by 51.9% while the least cardiac chamber involvement was the left ventricle by 18.5%. Figure 112 summarized the location of the cardiac masses in our study. From the 13 cases that diagnosed as pseudo-tumor, 11 of them were intra-cardiac thrombi, one of them is prominent crista terminalis & the last one was asymmetrical focal type of septal hypertrophic cardiomyopathy. These pseudo tumors needed no more diagnostic or therapeutic interventional procedures.

In our study all the pseudo tumors showed regular outline, 92.3% showed no enhancement in delayed post contrast images, with preferential affection of the right atrium and least affection of the right ventricle.

As regard the intra-cardiac thrombus, it was the most common cardiac mass in our study representing 40.7 % of the cases. The most common location was the right atrium followed by the left ventricle. There was a strong relation between the right atrial thrombi and the central line/porta-cath insertion and the left ventricle thrombi and ischemic heart changes. On CMR thrombi showed variable signal intensity (SI) in both black & white blood pool images,

mostly low SI in both black and white blood pool images. All cases showed no enhancement in delayed post contrast images apart from only one case that showed peripheral enhancement consistent with chronic thrombus.

A study in 2015 (8), stated that the thrombus is the most common cause of a cardiac mass. Right atrial thrombi typically occur in patients with underlying coagulation disorders, atrial arrhythmias, central venous catheters, pacemaker leads, or a mechanical tricuspid valve. Another study in 2013 (9), stated that a LV thrombus occurs in patients as sequel of myocardial infarction.

Most of literatures described the thrombus to have variable MR signal intensity depending on the age of the thrombus. (10 and 9) However, the most reliable MR feature is the absence of contrast uptake in the delayed contrast images as the thrombus is avascular. Rarely, large chronic thrombi may enhance peripherally due to neovascularization, and these cases can be diagnostically challenging.

So, our study and the previously mentioned studies and reviews agreed on the following items in diagnosis of intra cardiac thrombus: We also reported a case of focal hypertrophy of the septal wall that misdiagnosed by echocardiography as a septal mass. On MRI the focal hypertrophy followed the cardiac wall SI in all sequences with no enhancement in delayed post contrast images.

A group of authors in 2009 (11) stated that a mass-like hypertrophy of the left ventricular myocardium may mimic cardiac tumors. However, mass-like HOCM has more homogeneous signal characteristics and perfusion of the lesion is similar to the signal characteristics of the adjacent normal myocardium, except in the areas of fibrosis, whereas tumors often show varying degrees of signal heterogeneity before and after gadolinium administration. In addition, HOCM will show variable degrees of contractility whereas a true mass will have no contractile portion.

We reported a case of prominent crista terminalis of the right atrium which was diagnosed as cardiac thrombus by echocardiography.

A study in 2015 (8) stated that the crista terminalis is a muscular ridge in the postero- lateral aspect of the right atrium which can be mistaken for a right atrial mass by transthoracic echocardiography, particularly when prominent in size. Knowledge of the typical location and triangular appearance of the crista terminalis can prevent misdiagnosis and further unnecessary examinations.

We reported three cases of myxomas in our study, one of them was located at left atrial, the other one was bi-atrial and the last one was a case of two myxoma located at the left atria and the left ventricle. All cases were mobile lesions with regular outline apart from one case that showed villous irregular surface. They exhibited variable SI in both black and white blood pool images mostly intermediate to low SI compared to the myocardium with enhancement in the delayed post contrast images.

A group of authors in 2014 (12) mentioned that the majority cases of myxoma develop as single lesion arises from the left atrium near fossa ovalis as pedunculated lesion with villous surface while another group in 2009 (7) mentioned that the myxoma rarely arises in both atria and ventricles.

We reported two cases of fibromas. Both were intra-myocardial ventricular masses, one is located at right ventricle and the other was located at the left ventricle. They showed regular outline and exhibited low signal intensity in both black and white blood pool images. One of them show intense enhancement in delayed post contrast enhancement while the other show no enhancement.

A study in 2014 (10) mentioned that fibroma is commonly located in the ventricular septum or ventricular free wall. It is a well-defied mass that exhibits hypo to isointense on T1- weighted images and hypointense on T2-weighted images. Calcification is a relatively common feature.

Different pattern of enhancement were described for fibroma in late gadolinium enhancement (LGE). Some authors in 2013 (9) stated that on LGE sequences, the fibromas present with intense and homogeneous enhancement, explained by the overflow and retention of the contrast material in the broad extracellular space which surrounds the fibrous tissue of the tumor. Sometimes the lesion presents a central component of low signal intensity. The characteristics of T2- signal (hypointense) and LGE (prominently hyperintense) are the most specific in differentiating this lesion from cardiac rhabdomyoma.

## Conclusion

CMR has a great role in evaluation of the cardiac masses by its powerful assessment of the anatomical and soft tissue characterization of the masses as well as their functional impact and so it allows the differentiation between neoplastic and non-neoplastic masses as well as between

malignant and benign masses that is necessary in pre-therapeutic planning without the need of the unnecessary invasive biopsy with its possible hazardous complications.

## References


1. Sparrow PJ, Kurian JB, Jones TR, Sivananthan MU. MR imaging of cardiac tumors. Radiographics. 2005;25(5):1255–76.
2. Bruce CJ. Cardiac tumours: diagnosis and management. Heart. 2011;97(2):151–60.
3. Murugan MK, Gulati GS. MR and CT Imaging Spectrum of Right-Sided Cardiac Masses: A Pictorial Essay. Nepal J Radiol. 2012;2(2):96–110.
4. Araoz PA, Mulvagh SL, Tazelaar HD, Julsrud PR, Breen JF. CT and MR imaging of benign primary cardiac neoplasms with echocardiographic correlation. Radiographics. 2000;20(5):1303–19.
5. Semelka RC, Shoenut JP, Wilson ME, Pellech AE, Patton JN. Cardiac masses: Signal intensity features on spin-echo, gradient-echo, gadolinium-enhanced spin-echo, and TurboFLASH images. J Magn Reson Imaging. 1992;2(4):415–20.
6. Frank H. Evaluation of congenital heart disease and cardiac masses by magnetic resonance imaging. J FUR Kardiol. 2003;10:19–25.
7. O'Donnell DH, Abbara S, Chaithiraphan V, Yared K, Killeen RP, Cury RC, et al. Cardiac tumors: optimal cardiac MR sequences and spectrum of imaging appearances. Am J Roentgenol. 2009;193(2):377–87.
8. Malik SB, Kwan D, Shah AB, Hsu JY. The right atrium: gateway to the heart—anatomic and pathologic imaging findings. Radiographics. 2015;35(1):14–31.
9. Braggion-Santos MF, Koenigkam-Santos M, Teixeira SR, Volpe GJ, Trad HS, Schmidt A. Magnetic resonance imaging evaluation of cardiac masses. Arq Bras Cardiol. 2013;101(3):263.
10. Tao TY, Yahyavi-Firouz-Abadi N, Singh GK, Bhalla S. Pediatric cardiac tumors: clinical and imaging features. Radiographics. 2014;34(4):1031–46.
11. Kim EY, Choe YH, Sung K, Park SW, Kim JH, Ko Y-H. Multidetector CT and MR imaging of cardiac tumors. Korean J Radiol. 2009;10(2):164.
12. Hoey ETD, Shahid M, Ganeshan A, Baijal S, Simpson H, Watkin RW. MRI assessment of cardiac tumours: part 1, multiparametric imaging protocols and spectrum of appearances of histologically benign lesions. Quant Imaging Med Surg. 2014;4(6):478.


**To cite this article:** Hesham E. El-Sheikh, Ibrahim M. Helmy , Ahmed E. Shaalan, Mohamed M. Shoeeb. Role of Contrast Enhanced Cardiac MRI in Differentiation between Cardiac Masses. BMFJ 2021; 38(2): 625-639. DOI: 10.21608/bmfj.2021.67365.1396.