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Cardiac Magnetic Resonance Evaluation of Cardiac Masses in Patients with Suspicion of Cardiac Masses on Echo or Computed Tomography

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ABSTRACT

Objectives: In recent years, cardiac magnetic resonance (CMR) imaging has emerged as an important tool in the identification and characterization of cardiac masses. No imaging data on cardiac masses are available from Pakistan. We aimed to review the clinical presentation, CMR findings, and outcome of patients referred for CMR due to suspicion of cardiac masses on echocardiogram or computed tomography (CT).

Material and Methods: We reviewed all the patients referred for CMR at Aga Khan University Hospital, Karachi, from January 2011 to March 2020, with the suspicion of cardiac mass on echocardiogram and/or CT. Only those with the confirmed diagnosis of cardiac mass on CMR were included in the study.

Results: A total of 27 patients were referred for CMR from January 2011 to March 2020, with the suspicion of cardiac mass on echocardiogram and/or CT. Four patients were excluded as no cardiac mass was found on CMR. Out of 23 cases, majority (n = 15, 65%) were female, age ranging from 3 months to 70 years, with a mean age of 40 ± 22 years. Shortness of breath was the main presenting symptom (n = 19, 83%). Echocardiogram was the initial imaging modality done in all the patients while CT was also performed in 6 patients (26%). Out of 23 patients, 4 (17%) were diagnosed to have thrombus on CMR. In two cases, it was in the left ventricle with evidence of myocardial infarction on late gadolinium images. Myxoma was the most common tumor diagnosed on CMR in 6 patients (26%) followed by rhabdomyoma (n = 3, 13%) and fibroma (n = 2, 8.7%). There were three malignant primary tumors of the heart based on CMR appearances and one with tumor thrombus extension of hepatocellular carcinoma in the right atrium from inferior vena cava. Two patients were diagnosed to have non-neoplastic lesions – one with large intracardiac hydatid cyst and one with possible large fungal vegetation. Among 23 patients, 9 patients (39%) underwent surgery, 5 with myxoma, 2 with rhabdomyoma, 1 with fibroma, and 1 with fibroelastoma. Findings on surgery and histopathology matched the CMR diagnosis in all the patients except the one with the CMR diagnosis of myxoma in which histopathology was consistent with thrombus.

Conclusion: CMR can play an important role in confirming the presence or absence of a mass in the heart. It can also provide differentiation of non-neoplastic and neoplastic lesions and among different types of neoplastic lesions with reasonable accuracy. However, the limitations of CMR must be recognized.

Keywords: Cardiac masses, Cardiac tumors, Cardiac magnetic resonance, Cardiac imaging, Pakistan

INTRODUCTION

Primary cardiac tumors are rare, with an estimated prevalence of 0.001–0.03% at autopsy.[1,2] Approximately 75% of all primary cardiac tumors are benign, with myxomas being the most frequent lesions.

Cardiac tumors, although rare, are important and technically difficult to diagnose using current imaging modalities. Transthoracic echocardiography is the most readily available non-invasive imaging technique and thus remains the first-line diagnostic test when a cardiac tumor is suspected.[3] However, tissue characterization by means of echocardiography is generally limited. Cardiac computed tomography (CT) is a commonly used second-line diagnostic modality to assess cardiac masses.[4]

Cardiovascular magnetic resonance (CMR) imaging provides comprehensive information and has emerged as an important test in the identification and characterization of cardiac masses.[5-7] CMR is non-invasive, with no risk of ionizing radiation and wide field of view. It also provides information about cardiac morphology and function. Compared with CT, CMR imaging offers higher temporal resolution and additional tissue characterization.

Cardiac masses may be non-neoplastic, for example, thrombi or large vegetation. When there is clinical suspicion of a cardiac mass, proper diagnostic evaluation is necessary for appropriate treatment. CMR is important in the evaluation of such lesions due to better tissue characterization.

No imaging data on cardiac masses are available from Pakistan. We aimed to do the study to review the clinical presentation, CMR findings, and outcome of patients referred for CMR due to suspicion of cardiac masses on echocardiogram or CT. This is the first study of its kind from Pakistan. With the help of this study, we will get an idea about the clinical presentation and type of cardiac tumors present in this region and the investigative strategy which should be adapted for the workup of cardiac masses.

MATERIAL AND METHODS

Study design

This is a retrospective observational study.

Study population and data collection

The study was started after getting approval from Ethical Review Committee of Aga Khan University Hospital (AKUH), Karachi. CMR imaging was started at AKUH, Karachi, in 2011. We reviewed all the patients referred for CMR at AKUH, Karachi, from January 2011 to March 2020, with the suspicion of cardiac mass on echocardiogram and/or CT. Only those with the confirmed diagnosis of cardiac mass on CMR were included in the study. Data were collected by reviewing electronic records and patients' charts. Variables of interest were recorded using a predesigned data entry form. Follow-up data for surgery, histopathology, and death were recorded by reviewing the hospital records and telephone calls where necessary.

CMR data acquisition

CMR was performed using a 1.5T Siemens Avanto scanner. In each patient, a standard cardiac mass protocol was used which included assessment of cardiac masses by morphological, functional, and tissue characterization sequences. Images were acquired in conventional planes and also in other planes which best demonstrated the cardiac mass in each case.

A breath-hold steady-state free precession ECG-triggered sequence was used for anatomical and functional assessment. The other sequences which were obtained included turbo spin echo T1- and T2-weighted images with and without fat saturation, first-pass perfusion (FPP) images with gadolinium, and late gadolinium enhancement (LGE) images. The inversion time was optimized to null signal from the normal myocardium.

CMR data analysis

All the images were analyzed and read by an experienced reader in cardiovascular imaging, who was also present at the time of image acquisition in each case. The tumor characteristics which were assessed on CMR included tumor size, location, attachment and mobility, signal characteristics on different sequences, and the presence of pericardial effusion. Signal intensity on various sequences was assessed as hypointense, isointense, and hyperintense in relation to the normal myocardium. Perfusion of the tumor was assessed on FPP images and late enhancement on LGE images.

In addition, the left and right ventricular volumes and ejection fraction were calculated by manually drawing the endocardial and epicardial borders in end diastole and end systole, on the series of short-axis cine slices, using a third-party software – Medis QMass.

Statistical analysis

All the demographic details, presenting symptoms, CMR findings, follow-up details about surgery, histopathology, and outcome, were recorded. After creating a database, the data were encoded. All statistical analyses were performed using the Statistical Package for the Social Sciences version 24. Continuous variables were expressed as mean value ± standard deviation and categorical variables were expressed as frequencies and percentage.

RESULTS

Clinical presentation

A total of 27 patients were referred for CMR from January 2011 to March 2020, with the suspicion of cardiac mass on echocardiogram and/or CT. Four patients were excluded as no cardiac mass was found on CMR.

Baseline characteristics of these 23 patients are summarized in Table 1. Out of 23 cases, majority (n = 15, 65%) were female, age ranging from 3 months to 70 years with a mean age of 40 ± 22 years. Shortness of breath was the main presenting symptom (n = 19, 83%). Echocardiogram was the initial imaging modality done in all the patients while CT was also done in 6 patients (26%).

CMR diagnosis

Table 2 shows the differentiation and frequency of different types of cardiac masses on CMR. Out of 23 patients, 4 (17%) were diagnosed to have thrombus on CMR. In two cases, it was in the left ventricle with evidence of myocardial infarction on late gadolinium images. Rest of the two patients had a history of breast carcinoma – one showed thrombus in the right ventricle and the other in the right atrium (RA).

Table 1: Baseline characteristics.

Characteristics	Number of patients (n=23)	Percentage
Age (Mean±SD)	40±22	-
Male	8	34.8
Hypertension	8	34.8
Diabetes mellitus	2	8.7
Coronary artery disease	2	8.7
Chest pain	2	8.7
Shortness of breath	19	82.6
Palpitation	4	17.4
Syncope	3	13
Fever	4	17.4
Pulmonary embolism	5	21.7
Stroke	3	13
History of tumor	2	8.7
ST-T changes on ECG	3	13

Table 2: Diagnosis on cardiac magnetic resonance.

Diagnosis	Number (n=23)	Percentage
Thrombus	4 (+1)	17.4
Myxoma	6 (–1)	26.1
Rhabdomyoma	3	13
Fibroma	2	8.7
Hemangioma	1	4.3
Fibroelastoma	1	4.3
Probable lymphoma	1	4.3
Undifferentiated primary malignant tumor	2	8.7
Tumor thrombus extension from hepatoma	1	4.3
Intracardiac hydatid cyst	1	4.3
Possible large fungal vegetation	1	4.3

Myxoma was the most common tumor diagnosed on CMR in 6 patients (26%), followed by rhabdomyoma (n = 3, 13%), fibroma (n = 2, 8.7%), hemangioma (n =1, 4.3%), and fibroelastoma (n = 1, 4.3%). There were three malignant primary tumors of the heart based on CMR characteristics and one with tumor thrombus (TT) extension of hepatocellular carcinoma (HCC) in the RA from inferior vena cava (IVC).

One patient was diagnosed to have large intracardiac hydatid cyst embedded in the interventricular septum and occupying major part of the right ventricle. Another rare case was of possible fungal vegetation in the right ventricle attached near the tricuspid valve. It was a probable diagnosis based on a combination of clinical features of fever, hemoptysis, CT findings of large mycetoma in the lung with damaged lungs due to prior tuberculosis, and large vegetation/mass in the right ventricle on echocardiogram and CMR.

CMR characteristics

Table 3 shows the CMR characteristics of the benign and malignant tumors found in this study. The most common location was intracavitary with the RA being the most common chamber involved.

Follow-up and outcome

Among 23 patients, 9 patients (39%) underwent surgery, 5 with myxoma, 2 with rhabdomyoma, 1 with fibroma, and 1 with fibroelastoma. Findings on surgery and histopathology matched the CMR diagnosis in all the patients except the one with the CMR diagnosis of myxoma in which histopathology was consistent with thrombus.

Three patients with CMR diagnosis of primary malignant cardiac tumor died before any biopsy or surgical procedure. Unfortunately, we could not confirm the diagnosis by histopathology as all of them were very sick and died before we could have done any procedure. One had CMR features of cardiac lymphoma and the other two were non-differentiated malignant tumors in the RA with infiltrative features and the presence of pericardial effusion.

One fibroma patient died during the surgery and one myxoma patient died few months after the surgery. This patient had histologically proven right atrial myxoma with Budd-Chiari syndrome. The patient died due to complications of Budd-Chiari syndrome.

Patients with cardiac thrombi were managed with anticoagulation and showed regression in the size of thrombi on subsequent echocardiograms.

Table 3: Clinical and cardiac magnetic resonance characteristics of different types of tumors.

Characteristics	Myxoma (*n*=5)	Rhabdomyoma (*n*=3)	Fibroma (*n*=2)	Hemangioma (*n*=1)	Malignant tumors (*n*=4)
Age, mean±SD	48±17	5±2 mon.	26±17	35	47±23
Male, *n* (%)	1 (20)	1 (33.3)	1 (50)	0	2 (50)
Tumor location, *n* (%)					
Left atrium	2 (40)	0 (0)	0 (0)	0 (0)	0 (0)
Right atrium	3 (60)	1 (33.3)	0 (0)	0 (0)	3 (75)
Left ventricle	0 (0)	1 (33.3)	1 (50)	1 (100)	0 (0)
Right ventricle	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Interatrial septum	0 (0)	0 (0)	0 (0)	0 (0)	1 (25)
Interventricular septum	0 (0)	0 (0)	1 (50)	0 (0)	0 (0)
Pericardium	0 (0)	1 (33.3)	0 (0)	0 (0)	0 (0)
Pericardial effusion					
Yes	0 (0)	0 (0)	0 (0)	0 (0)	3 (75)
No	5 (100)	3 (100)	2 (100)	1 (100)	0 (0)
T1-weighted images					
Iso	3 (60)	3 (100)	1 (50)	1 (100)	0 (0)
Hypo	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Hypo to iso	1 (20)	0 (0)	0 (0)	0 (0)	0 (0)
Hyper	0 (0)	0 (0)	0 (0)	0 (0)	1 (25)
Iso to hyper	0 (0)	0 (0)	1 (50)	0 (0)	1 (25)
Indeterminate	1 (20)	0 (0)	0 (0)	0 (0)	2 (50)
T2-weighted images					
Iso	0 (0)	0 (0)	1 (50)	1 (100)	0 (0)
Hypo	0 (0)	0 (0)	1 (50)	0 (0)	0 (0)
Hypo to iso	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Hyper	2 (40)	2 (66.7)	0 (0)	0 (0)	1 (25)
Iso to hyper	2 (40)	1 (33.3)	0 (0)	0 (0)	1 (25)
Indeterminate	1 (20)	0 (0)	0 (0)	0 (0)	2 (50)
First-pass perfusion					
Yes	4 (80)	2 (66.7)	2 (100)	1 (100)	3 (75)
No	0 (0)	1 (33.3)	0 (0)	0 (0)	0 (0)
Indeterminate	1 (20)	0 (0)	0 (0)	0 (0)	1 (25)
LGE					
No	3 (60)	2 (66.7)	0 (0)	0 (0)	1 (25)
Yes – patchy, heterogeneous	2 (40)	1 (33.3)	0 (0)	1 (100)	2 (50)
Yes – homogeneous, intense	0 (0)	0 (0)	2 (100)	0 (0)	0 (0)
Indeterminate	0 (0)	0 (0)	0 (0)	0 (0)	1 (25)

DISCUSSION

Although small, this is the first study on CMR assessment of cardiac masses from this region. This study shows that CMR is excellent in excluding cardiac masses and has high accuracy in differentiating between different types of cardiac masses. However, similar to other imaging modalities, CMR also has certain limitations and some cases could be misdiagnosed. When there is uncertainty about the correct diagnosis, histopathological assessment should be considered.

Cardiac thrombi

Thrombi are the lesions which are usually confused with cardiac tumors. In our study, thrombus was found in 17% (n = 4) of the patients with confirmed cardiac mass on CMR. The left ventricle was the site in two patients, one patient had thrombus in the RA and one had it in the right ventricle. The left ventricular thrombi are seen in patients with poor myocardial contractility, usually attached to the infarcted or scarred myocardium.[8] In our study, both the patients with the left ventricular thrombus showed evidence of myocardial infarction on late gadolinium images [Figure 1a-c], which was not appreciated on echocardiogram. Rest of the two patients had a history of breast carcinoma with apparently hypercoagulable state.

The left atrium is another common site for cardiac thrombi, but in our study, no patient was found with the left atrial thrombus. The left atrial thrombi, especially in the left atrial appendage,

are seen in patients with atrial fibrillation and mitral stenosis. These are easily picked up on transesophageal echocardiogram and the patients are usually not referred for CMR.

On CMR, signal intensity of thrombi varies on different sequences according to their age. They are usually described as hypointense masses without enhancement on postcontrast images.[9] Subacute thrombi are iso- to hyper-intense on T1-weighted images and hypointense on T2-weighted images. Organized chronic thrombi are hypointense on both T1- and T2-weighted images due to the presence of hemosiderin deposits.[10,11] As neoplastic lesions usually have a vascularized tissue component and thrombi are avascular, perfusion images and LGE images are important in differentiating tumors from thrombi. However, in chronic thrombi, some peripheral enhancement have been reported on LGE images.[10,12]

Benign tumors

CMR features which allow us to differentiate between benign and malignant cardiac tumors include borders, location, and pericardial effusion. Benign tumors are usually well defined with no irregularities or infiltration.[13]

Myxoma

Myxoma is the most common benign primary cardiac tumor, found predominantly in women with the majority occurring in the left atrium.[14] This was also true for our study, where myxoma was the most common primary cardiac tumor with female preponderance, but the distribution of location was different. Three (60%) were in the RA while 2 (40%) in the left atrium [Figure 2a-c].

Myxomas are pedunculated masses, usually attached to the interatrial septum. There is heterogeneous signal intensity on various CMR sequences, depending on the content of the lesion. They are usually isointense to hypointense on T1-weighted images and hyperintense on T2-weighted images probably due to high water content in the myxomatous tissue. They usually contain myxoid material as well as necrotic or cystic and calcified material.[15] In our study, myxomas showed similar CMR features as prior reports.[7] One case of thrombus, which was misdiagnosed as myxoma on CMR was a female with history of antiphospholipid antibody syndrome and a mass in the RA near the IVC. The histopathology showed that it was a thrombus.

Rhabdomyoma

Rhabdomyoma is the most common primary cardiac tumor in infants and children.[16] Cardiac rhabdomyomas are predominantly localized within the ventricles but can be observed in the atria and may lead to obstruction of inflow or outflow tracts. They are usually asymptomatic but may also cause arrhythmias. There is a strong correlation between cardiac rhabdomyomas and tuberous sclerosis. In

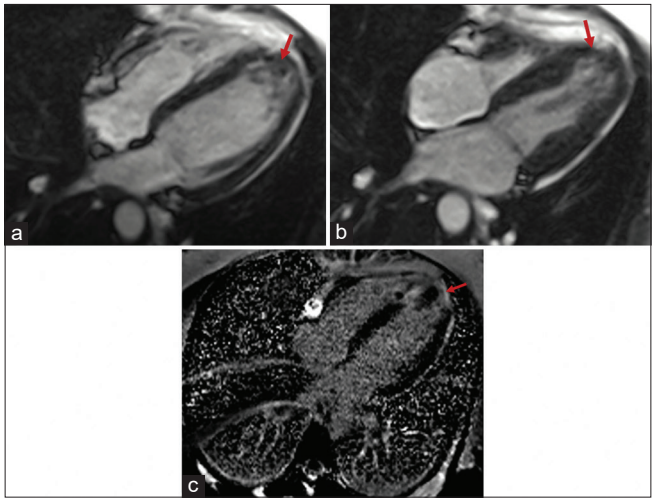

Figure 1: A 35-year-old female presented with embolic stroke, diagnosed to have left ventricular apical thrombus with evidence of myocardial infarction. (a) Cardiac magnetic resonance steady-state free precession still frame in diastole showing filling defect at the left ventricular apex (arrow). (b) Cardiac magnetic resonance steady-state free precession still frame in systole showing non-contracting left ventricular apex with filling defect (arrow). (c) Cardiac magnetic resonance delayed enhanced image with gadolinium, showing transmural enhancement at the left ventricular apex with thrombus (arrow).

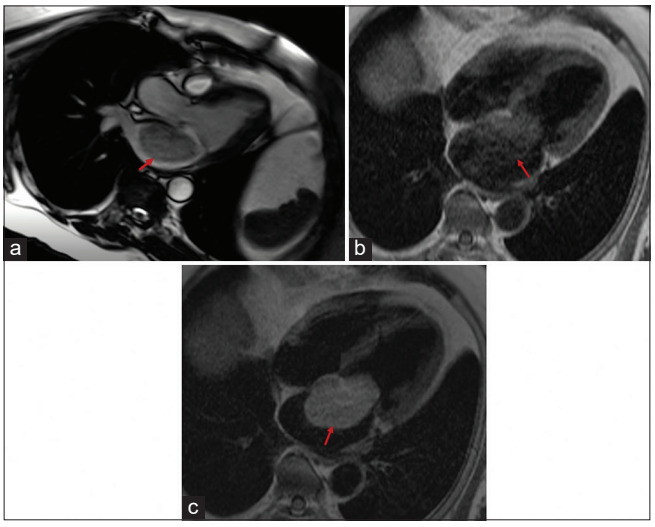

Figure 2: A 70-year-old female presented dyspnea and syncope, diagnosed to have left atrial myxoma. (a) Cardiac magnetic resonance steady-state free precession still frame showing large myxoma in the left atrium (arrow). (b) Cardiac magnetic resonance turbo spin echo T1-weighted image, myxoma showing hypointense to isointense signal (arrow). (c) Cardiac magnetic resonance turbo spin echo T2-weighted image, myxoma showing hyperintense signal (arrow).

our study, all the three cases of rhabdomyomas were children under 1 year of age [Figure 3a and b], and two of them were diagnosed to have tuberous sclerosis. One of the patients had multiple lesions involving both the left and right ventricles.

On CMR, rhabdomyomas are isointense relative to the myocardium on T1-weighted images and hyperintense on T2-weighted images. No significant enhancement is usually seen on LGE images. Surgical resection is not usually considered unless they cause symptoms of obstruction, heart failure, or arrhythmias. However, in our study, two of the cases underwent surgery due to unusual location, one occupying the pericardium and the other in the RA, with histopathology confirming the diagnosis.

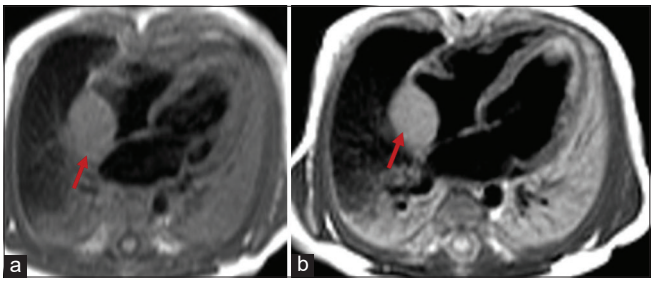

Figure 3: A 3-month-old baby girl diagnosed to have right atrial rhabdomyoma. (a) Cardiac magnetic resonance turbo spin echo T1-weighted image, right atrial rhabdomyoma showing isointense signal (arrow). (b) Cardiac magnetic resonance turbo spin echo T2-weighted image, right atrial rhabdomyoma showing hyperintense signal (arrow).

Cardiac fibroma

Cardiac fibroma is considered the second most common pediatric primary cardiac tumor, usually seen as a single lesion in an intramyocardial location.[17] In our study, both the cases present as a well-defined mass, one in the interventricular septum [Figure 4a-d] and the other in the free wall of the left ventricle. One case was a 14-year-old boy while the other was a female of 38 years.

Clinical presentation of patients with cardiac fibroma depends on the location and size of the tumor. They can present with symptoms of heart failure and arrhythmias. In our study, both presented with progressively worsening shortness of breath. In a systemic review,[18] the left ventricle was found to be the most common site of cardiac fibroma (57.3%), followed by the right ventricle (27.5%), interventricular septum (17%), RA (5.3%), and left atrium (1.8%). In our study, one was in the interventricular septum and the other in the free wall of the left ventricle.

Fibromas are isointense to hyperintense compared to myocardium on T1-weighted images and hypointense on T2-weighted images.[19] Intense and homogeneous enhancement on late gadolinium images is a characteristic finding of fibroma on CMR. This is due to the accumulation and retention of the contrast material in the wide extracellular space of the fibrous tissue of the tumor.[20]

Surgical excision of fibromas is usually difficult as these are embedded in the myocardium. One of our patients underwent surgery and died on the table.

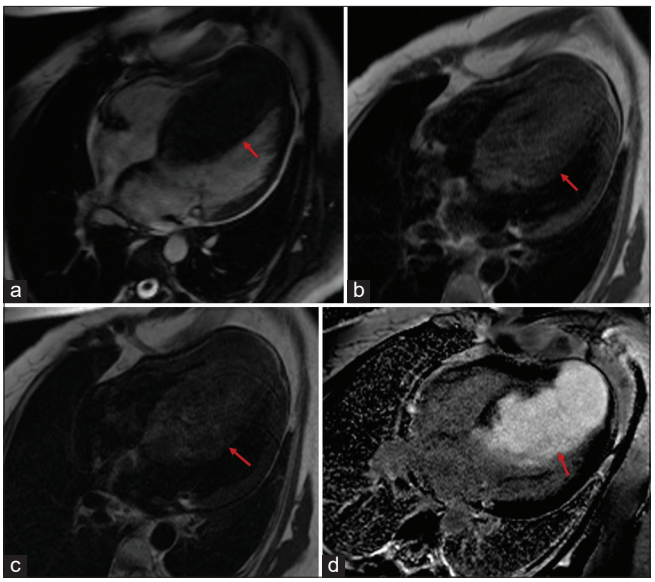

Figure 4: A 38-year-old female presented with gradually worsening dyspnea. Diagnosed to have large fibroma in the interventricular septum. (a) Cardiac magnetic resonance steady-state free precession still frame, showing large fibroma in the interventricular septum (arrow). (b) Cardiac magnetic resonance turbo spin echo T1-weighted image, fibroma showing isointense signal (arrow). (c) Cardiac magnetic resonance turbo spin echo T2-weighted image, fibroma showing hypointense signal (arrow). (d) Cardiac magnetic resonance delayed enhanced image with gadolinium, fibroma showing intense homogeneous enhancement (arrow).

Hemangioma

Cardiac hemangiomas are usually located in the ventricles and account for approximately 5% of cardiac tumors. They may occur in either endocardium, myocardium, or epicardium. On CMR SSFP cine images, cardiac hemangioma appears as a non-mobile, non-contractile mass. They are isointense on T1-weighted images and hyperintense on T2-weighted images. On LGE images, they show intense enhancement with usually heterogeneous appearance due to fibrous septum and calcification.[19] One patient had cardiac hemangioma in our study, located in the lateral wall of the left ventricle [Figure 5a-c].

Fibroelastoma

Fibroelastoma or papillary fibroelastoma (PFE) is the most common primary tumor of cardiac valves and usually

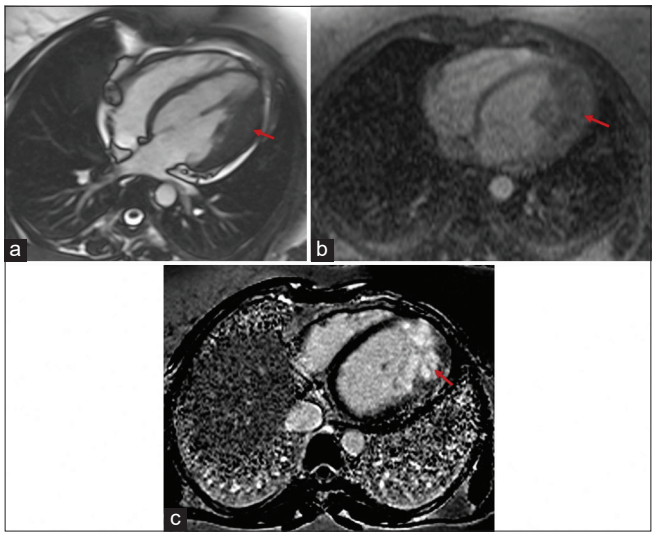

Figure 5: A 35-year-old female presented with dyspnea diagnosed to have cardiac hemangioma in the lateral wall of the left ventricle. (a) Cardiac magnetic resonance steady-state free precession still frame, showing hemangioma in the lateral wall of the left ventricle (arrow). (b) Cardiac magnetic resonance first-pass perfusion image with gadolinium showing good perfusion in the hemangioma (arrow). (c) Cardiac magnetic resonance delayed enhanced image with gadolinium, showing intense heterogeneous enhancement in the hemangioma (arrow).

located on the left side.[21] Its origin from non-valvular endocardium is extremely rare. Fibroelastomas are small, mobile, pedunculated lesions. On CMR, fibroelastomas are isointense on T1-weighted images and hyperintense on T2-weighted images. In our study, fibroelastoma was found in only one patient on CMR and was confirmed on surgery and histopathology. This was a 49-year-old man with fibroelastoma in the RA, attached to the IVC at its junction to the RA [Figure 6a and b]. Origin of fibroelastoma from the RA is extremely rare with an estimated incidence of 1.8–2.3% and non-valvular right atrial PFE is even rarer.[22] The right atrial PFEs generally remain asymptomatic until they grow larger in size. In our case, it was found incidentally on workup of liver abscess. They can be fatal due to their propensity to embolize. All symptomatic patients and patients with the right atrial PFE of more than 10 mm should undergo surgical resection.

Malignant tumors

In contrast to benign tumors, malignant cardiac tumors are more likely to be ill-defined, with invasive borders and may already be invading the pericardium at the time of diagnosis.[23] Malignant primary cardiac tumors include sarcomas, lymphomas, and mesothelial tumors. Sarcomas are neoplasia of mesenchymal origin and may involve one or more chambers as large masses occupying the entire affected

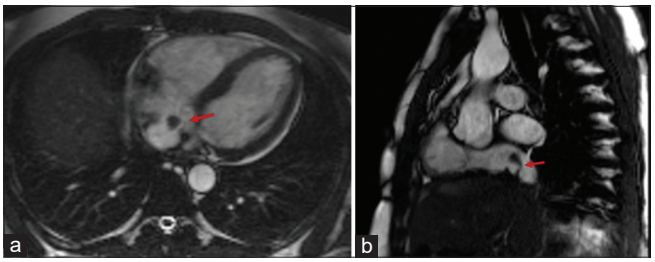

Figure 6: A 49-year-old male incidentally found to have fibroelastoma in the right atrium, during the workup of liver abscess. (a) Cardiac magnetic resonance steady-state free precession still frame, showing fibroelastoma attached to the inferior vena cava at its junction to the right atrium (arrow). (b) Cardiac magnetic resonance steady-state free precession still frame, showing fibroelastoma attached to the inferior vena cava at its junction to the right atrium (arrow).

chamber or multiple chambers, with ill-defined margins and invasive features. Associated pericardial effusion is often present. On CMR, there may be heterogeneous enhancement due to the presence of necrosis and hemorrhage.[15] Sarcomas show aggressive characteristics and usually have a fatal outcome.

In our study, there were three malignant primary cardiac tumors based on CMR characteristics. All three patients were very sick and died before any surgical procedure or biopsy. In the two cases, the RA was the site of location of the tumor with infiltrating features and presence of pericardial effusion favoring the diagnosis of malignant tumor. These were probably cardiac sarcomas, but we cannot be certain in the absence of histopathology.

Cardiac lymphomas usually present as large, bulky masses with vascular encasement without obliterating the lumen.[5,24] In our study, one patient was probably having the cardiac lymphoma based on CMR features. This was a 68-year-old man with a history of weight loss, night sweats, and shortness of breath. The tumor was involving the whole interatrial septum and the roof of both atria, further extending outside the heart to encase the great vessels [Figure 7a and b]. Mild-to-moderate pericardial effusion was also present.

Secondary metastasis to the heart frequently manifests as pericardial effusion. The tumors that can commonly metastasize to the heart are melanoma, lung, breast, kidney, and esophageal carcinomas.[25-27] Cardiac involvement may be due to direct spread, through lymphatics, hematogenic dissemination, or transvenous extension. On CMR, there is no specific appearance of metastatic lesions and signal characteristics are variable. However, postcontrast enhancement occurs in almost all types of metastatic lesions.[18]

In our study, no case of secondary metastatic lesion was found except one with TT extension of HCC to the RA through the

IVC. No case with secondary metastatic lesion may be due to the referral bias as patients with secondary metastatic lesions to the heart are usually diagnosed on echocardiogram or CT and are not referred for CMR.

HCC is an aggressive tumor with a tendency to grow into the blood vessels. IVC to the RA TT is an infrequent but well-recognized complication of HCC with an incidence of 3–4% in patients of HCC who undergo diagnostic imaging.[28] It is associated with an increased risk of pulmonary embolism, systemic metastases, and sudden cardiac arrest. The patient with TT extension of HCC from IVC to RA in our study was a known case of chronic liver disease and presented with worsening shortness of breath. Echocardiogram revealed a large irregular mass in the RA. Further, workup with CMR and CT confirmed the diagnosis of HCC, with TT extension to RA and evidence of pulmonary embolism [Figure 8a-c]. Due to lack of specific clinical signs, this condition is probably underdiagnosed. However, with the improved imaging studies, the incidence is increasing now. Patients with advanced stage of the tumor or decompensated liver disease are not suitable candidates for surgical treatment.

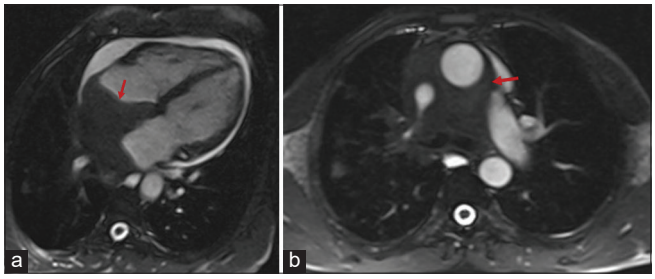

Figure 7: A 68-year-old male presented with dyspnea, weight loss, night sweats, and syncope, diagnosed to have malignant cardiac tumor (likely lymphoma). (a) Cardiac magnetic resonance steady-state free precession still frame showing malignant cardiac tumor (arrow). (b) Cardiac magnetic resonance steady-state free precession still frame showing malignant cardiac tumor extending outside the heart and encasing the great vessels (arrow).

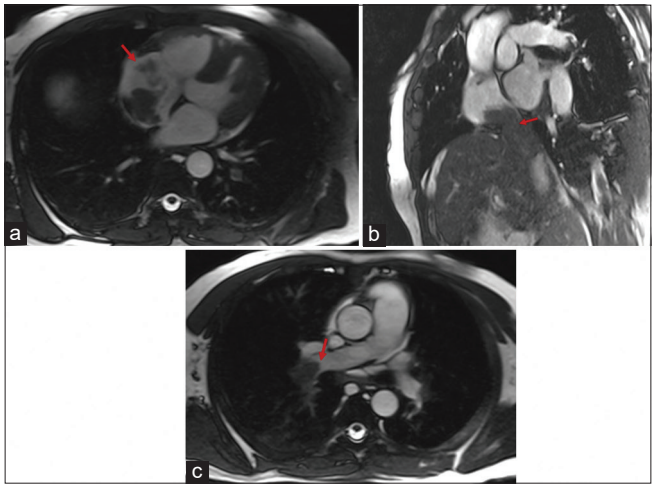

Figure 8: A 44-year-old male with chronic liver disease presented with worsening shortness of breath, diagnosed to have tumor thrombus extension of hepatocellular carcinoma from inferior vena cava to right atrium. (a) Cardiac magnetic resonance steady-state free precession still frame showing tumor thrombus extension of hepatocellular carcinoma into the right atrium (arrow). (b) Cardiac magnetic resonance steady-state free precession still frame showing tumor thrombus extension of hepatocellular carcinoma from inferior vena cava to right atrium (arrow). (c) Cardiac magnetic resonance steady-state free precession still frame showing filling defect (pulmonary embolism) in the right pulmonary artery (arrow).

CONCLUSION

CMR can play an important role in confirming the presence or absence of a mass in the heart. It can also provide differentiation of non-neoplastic and neoplastic lesions and among different types of neoplastic lesions with reasonable accuracy. However, the limitations of CMR must be recognized.

Declaration of patient consent

Institutional Review Board permission obtained for the study.

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Conflicts of interest

There are no conflicts of interest.

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