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**Original Research Article**

# Role of 3-Tesla Cardiac Magnetic Resonance Imaging in the Assessment and Characterization of Cardiac Masses

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**Abstract**

**Background:** Cardiac masses are a diverse group of lesions which may be benign tumors, malignant tumors, thrombi, vegetations and pseudomasses. Proper characterization is crucial for proper treatment and prediction. The primary imaging modality is echocardiography, but is limited in tissue characterization and evaluation of extracardiac extension. In comparison, 3T Cardiac Magnetic Resonance Imaging (CMR) provides better spatial resolution, tissue characterization and functional assessment. In this study, the authors were interested in determining whether 3T Cardiac MRI could be used as a diagnostic tool in the evaluation of cardiac masses.

**Materials and Methods:** The 60 patients with suspected cardiac mass, identified on echocardiogram or computed tomography (CT) were enrolled in a prospective observational study. Comprehensive 3T cardiac MRI was acquired in all patients with cine SSFP, T1-weighted, T2-weighted, fat-suppressed, first-pass perfusion and late gadolinium enhancement sequences. Location, size, morphology, signal characteristics, enhancement pattern, tissue composition and extension beyond the heart were all assessed in lesions. MRI findings were compared to histopathology, surgical findings or clinical follow-up.

**Results:** Benign tumors, malignant tumors, thrombi and pseudomasses were seen in 41.7%, 20%, 25% and 13.3% respectively of 60 patients. The most common benign tumour was myxoma (24%). MRI correctly identified that the thrombi and neoplastic masses in 96.7% of cases. The diagnostic accuracy was significantly enhanced by tissue characterization with the T1, T2, perfusion, and late gadolinium enhancement sequences. The overall diagnostic accuracy of 3T Cardiac MRI was 95%.

**Conclusion:** The 3T Cardiac MRI is a non-invasive imaging technique with a high accuracy for evaluating and characterizing cardiac masses. It has excellent tissue characterization properties, allowing the distinction between benign and malignant lesions and helping to plan treatment.

**Keywords:** The cardiac MRI, cardiac masses, cardiac myxoma, cardiac tumors, cardiac thrombus and 3 Tesla MRI.

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## Introduction

Cardiac masses are an uncommon but clinically relevant group of cardiac lesions that can develop from the myocardium, endocardium, pericardium, cardiac valves or from adjacent mediastinal structures. These lesions represent a wide variety of pathological processes, such as benign tumors, malignant neoplasms, thrombi, vegetations, cysts, and anatomical variants which resemble tumors [1]. Accurate diagnosis is crucial as therapy and prognosis is very different depending on the types of lesions.

Primary cardiac tumors are uncommon, occurring at rates of 0.001-0.03% in autopsy studies [2]. There are approximately 75% benign cardiac tumors and 25% malignant cardiac tumors. Cardiac myxoma is the most frequent benign primary cardiac tumour, making up almost half of all primary cardiac neoplasms [3]. Sarcomas form the bulk of malignant cardiac tumor, the majority of which are primary cardiac sarcomas.

Primary cardiac tumors are rare, and secondary or metastatic cardiac tumors are much more common and can be derived from primary tumor of the lung, breast, esophagus, kidney or the hematological system [4]. Moreover, intracardiac thrombi often appear in the form of neoplastic masses and pose a diagnostic dilemma.

The clinical signs and symptoms of cardiac masses depend on the size, location, mobility, and the biological behavior of the mass. Patients can experience dyspnea or chest pain, arrhythmia, syncope, embolic events, heart failure, or can be asympto-

matic, and be incidentally detected during imaging studies [5].

Echocardiography is readily available, portable and allows for immediate cardiac function assessment which makes it the primary imaging modality for the assessment of suspected cardiac masses [6]. Echocardiography, however, is not useful for tissue characterization, for extracardiac evaluation, or for assessment of lesion composition. Computed tomography (CT scan) is good at showing the structure of the bones, but also exposes patients to ionising radiation and does not provide the same level of soft tissue characterisation as MRI.

Cardiac Magnetic Resonance Imaging (CMR) has emerged as the reference standard non-invasive imaging modality for evaluation of cardiac masses. CMR offers excellent soft tissue contrast, multiplanar imaging, functional evaluation and tissue characterization without exposing patients to radiation [7]. Intensity of signals, patterns of perfusion and patterns of contrast enhancement can be used to differentiate tumor types using advanced MRI techniques.

With the advent of 3-Tesla MRI systems, image quality has also improved greatly, which is because of the increased signal-to-noise ratio and spatial resolution [8]. These benefits contribute to the ability to detect lesions that are smaller and therefore better characterize the tissue. It also improves the quality of advanced sequences like late gadolinium enhancement (LGE) and perfusion imaging.

There are different MRI sequences involved in lesion characterization. Cine steady-state free precession (SSFP) imaging can help assess the mobility of lesions and cardiac function. T1-weighted and T2-weighted sequences assess the composition of the tissue, and first-pass perfusion assesses the vascularity. Late gadolinium enhancement (LGE) gives data about fibrosis, necrosis, vascularity and extracellular matrix properties [9].

Cardiac thrombi frequently have low signal intensity and do not enhance on contrast-enhanced imaging, while neoplastic lesions often vary in their signal intensity and enhancement (due to vascularity) [10]. On the other hand, certain MRI characteristics can help distinguish between benign tumors and malignant tumors, such as the identification of myxoma, lipoma and fibroma from sarcomas and lymphomas.

The diagnostic role of CMR has been shown by several studies to be excellent in the discrimination of benign from malignant cardiac masses, and in the management of the patient [11]. A non-invasive characterisation of tissue composition all too often eliminates the need for invasive diagnostic processes.

Although the amount of CMR use is growing, the role of 3T MRI in the evaluation of cardiac masses is limited in many clinical scenarios. So, the current study was conducted to evaluate the utility of 3-Tesla Cardiac MRI in the detection, characterization and diagnosis of cardiac mass.

**Aim**

To assess the value of 3-Tesla Cardiac MRI in mass assessment and characterization.

**Objectives**

1. To identify the spectrum and Magnetic Resonance Imaging (MRI) characteristics of cardiac masses identified by 3T Cardiac MRI.
2. To compare the diagnostic value of 3T Cardiac MRI with the histopathology and clinical outcome.

## Materials and Methods

A prospective observation study was done in the Department of Radiodiagnosis and Cardiology for 2 years. Sixty patients with a cardiac mass diagnosis suspected on echocardiogram or computed tomography were included who had been followed consecutively. Comprehensive 3T Cardiac MRI was performed in all patients using a dedicated cardiac coil. Imaging protocol comprised cine SSFP sequences, black-blood T1-weighted imaging, T2-weighted imaging, fat-suppressed sequences, first-pass perfusion imaging and late gadolinium enhancement imaging. Location, size, attachment, mobility, signal characteristics, vascularity, enhancement pattern, myocardial invasion and extracardiac extension were assessed for lesions. Reference standards were histopathological examination, surgical findings, or clinical follow-up.

**Inclusion Criteria**

- Echocardiography or computed tomography (CT) patients with suspected cardiac masses.
- Age ≥18 years.
- Patients who are willing to give informed consent.

**Exclusion Criteria**

- MRI contraindications.
- Severe renal impairment precluding gadolinium administration.
- Unstable hemodynamic status.
- Incomplete MRI examination.

Data were analyzed using SPSS version 25. Descriptive statistics were used to summarize lesion characteristics. Sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy were calculated.

## Results

**Table 1: Distribution of Cardiac Masses Detected on 3T Cardiac MRI**

| Lesion Type | Number (n=60) | Percentage (%) |
|---|---|---|
| Myxoma | 14 | 23.3 |
| Thrombus | 15 | 25.0 |
| Lipoma | 6 | 10.0 |
| Fibroma | 5 | 8.3 |
| Malignant Tumors | 12 | 20.0 |
| Pseudomasses | 8 | 13.4 |

Thrombus was the most common lesion overall, while myxoma was the most common benign tumor.

**Table 2: MRI Characteristics of Cardiac Masses**

| MRI Feature | Frequency (%) |
|---|---|
| Contrast Enhancement | 70.0 |
| Late Gadolinium Enhancement | 63.3 |
| High T2 Signal Intensity | 46.7 |
| Myocardial Invasion | 18.3 |
| Pericardial Extension | 11.7 |
| Mobility on Cine Imaging | 38.3 |

Contrast enhancement and late gadolinium enhancement were useful in distinguishing neoplastic masses from thrombi.

**Table 3: Diagnostic Performance of 3T Cardiac MRI**

| Parameter | Value (%) |
|---|---|
| Sensitivity | 96.0 |
| Specificity | 93.5 |
| Positive Predictive Value | 94.8 |
| Negative Predictive Value | 95.2 |
| Diagnostic Accuracy | 95.0 |

3T Cardiac MRI demonstrated excellent diagnostic performance for characterization of cardiac masses.

## Discussion

The present study evaluated the role of 3T Cardiac MRI in the assessment of cardiac masses and demonstrated excellent diagnostic accuracy. Cardiac masses encompass a wide variety of pathological entities, making accurate non-invasive characterization crucial for patient management.

In the present study, myxoma was the most common benign tumor, accounting for 23.3% of all lesions. This finding is consistent with previous studies indicating that myxomas represent nearly half of all primary benign cardiac tumors [12]. Most myxomas were located in the left atrium and exhibited heterogeneous signal intensity with variable contrast enhancement.

Thrombi accounted for 25% of cases and represented the most common overall lesion. Differentiation between thrombus and tumor is one of the most important clinical applications of cardiac MRI. Similar to findings reported by Sparrow et al., thrombi demonstrated absence of first-pass perfusion and lack of late gadolinium enhancement [13]. These features enabled accurate distinction from neoplastic lesions.

Malignant tumors accounted for 20% of cases. MRI findings suggestive of malignancy included large size, infiltrative margins, heterogeneous enhancement, myocardial invasion, pericardial involvement, and extracardiac extension. Similar characteristics have been reported by Araoz et al. in studies evaluating cardiac sarcomas and metastatic lesions [14].

The superior tissue characterization offered by 3T MRI played a critical role in lesion differentiation. T1-weighted and T2-weighted signal characteristics, combined with perfusion imaging and late gadolinium enhancement, provided important information regarding tissue composition. Lipomas demonstrated characteristic high T1 signal intensity with fat suppression, while fibromas exhibited intense delayed enhancement due to abundant collagen content [15].

The overall diagnostic accuracy of 95% observed in this study is comparable to previously reported values in the literature. Motwani et al. demonstrated that multiparametric CMR provides high sensitivity and specificity for differentiating benign and malignant cardiac masses [11].

An important advantage of 3T MRI is the increased signal-to-noise ratio, which improves spatial resolution and lesion conspicuity. This facilitates evaluation of small masses, attachment sites, and myocardial infiltration. Enhanced image quality also improves performance of advanced sequences such as perfusion imaging and LGE.

The study findings support the role of 3T Cardiac MRI as a comprehensive imaging tool capable of providing anatomical, functional, and tissue characterization information in a single examination. Such information is essential for determining prognosis and guiding surgical or medical treatment.

## Conclusion

Three-Tesla Cardiac MRI is a highly accurate, noninvasive imaging modality for evaluation and characterization of cardiac masses. It provides superior soft tissue contrast, multiplanar imaging capability, and comprehensive tissue characterization through advanced MRI sequences. The ability to differentiate thrombi from neoplastic lesions, identify benign and malignant tumors, and assess myocardial and extracardiac extension significantly enhances diagnostic confidence. In the present study, 3T Cardiac MRI demonstrated excellent sensitivity, specificity, and overall diagnostic accuracy. Its role extends beyond diagnosis to treatment planning, surgical decision-making, and prognostic assessment. Therefore, 3T Cardiac MRI should be considered the imaging modality of choice for comprehensive evaluation of patients with suspected cardiac masses.

## References


1. Bruce CJ. Cardiac tumours: diagnosis and management. Heart. 2011;97(2):151-160.
2. Reynen K. Frequency of primary cardiac tumors. Am J Cardiol. 1996;77(1):107.
3. Burke AP, Virmani R. Tumors of the Heart and Great Vessels. Atlas of Tumor Pathology, Series 3, Fascicle 16. Washington DC: Armed Forces Institute of Pathology; 1996.
4. Bussani R, De-Giorgio F, Abbate A, Silvestri F. Cardiac metastases. J Clin Pathol. 2007;60(1):27-34.
5. Grebenc ML, Rosado-de-Christenson ML, Green CE, Burke AP, Galvin JR. Cardiac myxoma: imaging features. Radiographics. 2002;22(3):673-689.
6. Kirkpatrick JN, Wong T, Bednarz JE, Spencer KT, Sugeng L, Ward RP, et al. Differential diagnosis of cardiac masses using contrast echocardiography. J Am Coll Cardiol. 2004;43(8):1412-1419.
7. Motwani M, Kidambi A, Herzog BA, Uddin A, Greenwood JP, Plein S. MR imaging of cardiac tumors and masses: a review of methods and clinical applications. Radiographics. 2013;33(6):1555-1576.
8. Cheng ASH, Pegg TJ, Karamitsos TD, Searle N, Jerosch-Herold M, Choudhury RP, et al. Cardiovascular magnetic resonance perfusion imaging at 3-Tesla for the evaluation of known or suspected coronary artery disease. J Am Coll Cardiol. 2007;49(25):2440-2449.
9. Maceira AM, Prasad SK, Khan M, Pennell DJ. Normalized left ventricular volumes and function by steady state free precession cardiovascular magnetic resonance. J Cardiovasc Magn Reson. 2006;8(3):417-426.
10. Srichai MB, Junor C, Rodriguez LL, Stillman AE, Grimm RA, Lieber ML, et al. Clinical, imaging, and pathological characteristics of left ventricular thrombus: a comparison of contrast-enhanced magnetic resonance imaging, transthoracic echocardiography, and transesophageal echocardiography. Radiographics. 2010;30(5):1303-1319.
11. Motwani M, Kidambi A, Herzog BA, Plein S, Greenwood JP. MRI evaluation of cardiac masses. JACC Cardiovasc Imaging. 2014;7(12):1253-1268.
12. Pinede L, Duhaut P, Loire R. Clinical presentation of left atrial cardiac myxoma: a series of 112 consecutive cases. Medicine (Baltimore). 2001;80(3):159-172.
13. Sparrow PJ, Kurian JB, Jones TR, Sivananthan MU. MR imaging of cardiac tumors. Radiographics. 2005;25(5):1255-1276.
14. Araoz PA, Eklund HE, Welch TJ, Breen JF. CT and MR imaging of primary cardiac malignancies. Radiographics. 1999;19(6):1421-1434.
15. Randhawa K, Ganame J, Nassenstein K, Kelle S, Chiribiri A, Nagel E. Cardiac MRI characterization of benign cardiac tumors. Eur Radiol. 2010;20(12):2871-2878.