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ORIGINAL ARTICLE

The Utility of Cardiac Magnetic Resonance Imaging in the Diagnosis of Cardiac Sarcoidosis

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Background Autopsy reports suggest that cardiac sarcoidosis occurs in 20 to 25% of patients with pulmonary sarcoidosis, yet the clinical ante-mortem diagnosis is made in only 5% of cases. Current diagnostic algorithms are complex and lack sensitivity. Cardiac Magnetic Resonance imaging (CMR) provides an opportunity to detect myocardial involvement in sarcoidosis.
The aim of this study is to determine the prevalence and clinical significance of late gadolinium enhancement (LGE) on CMR in patients with sarcoidosis.

Methods Consecutive patients with biopsy-proven sarcoidosis undergoing CMR were retrospectively evaluated for cardiac sarcoidosis. Medical records were correlated with CMR.

Results Forty-six patients were evaluated. Late gadolinium enhancement was present in 22%, indicating myocardial involvement, and 70% had corresponding hyper-intense T2 signal indicating active inflammation. Late gadolinium enhancement was 18% +/− 9.7% of overall left ventricular (LV) mass and most commonly located in the basal to mid septum.
There was no association between LGE and cardiovascular symptoms or pulmonary stage. Eighty per cent of patients with LGE did not fulfill conventional diagnostic criteria for cardiac sarcoidosis. However, LGE was associated with clinically significant arrhythmia ($p < 0.01$) and a lower LVEF ($p = 0.04$).

Conclusions Using CMR, we identified a higher prevalence of cardiac sarcoidosis than previously reported clinical studies, a prevalence which is more consistent with autopsy data. The presence of LGE was highly correlated with clinically significant arrhythmias and lower LVEF.

Keywords Cardiac sarcoidosis • Cardiac magnetic resonance imaging • Late gadolinium enhancement • Arrhythmia

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Background

Sarcoidosis is a multisystem granulomatous disorder with unknown aetiology and is, in the main, characterised by pulmonary manifestations. Cardiac involvement usually involves the presence of non-caseating granulomas within the myocardium, and is reported to be clinically evident in approximately 5% of cases [1]. Autopsy series report cardiac involvement in 20 to 25% of patients suggesting that cardiac sarcoidosis is often under diagnosed [2–5]. There is also reported regional variation in the prevalence of cardiac sarcoidosis, with Japanese populations reporting cardiac involvement in up to 75% of autopsy cases [6,7]. It remains uncertain to what extent these differences are explained by differing diagnostic techniques and criteria.

Although cardiac sarcoidosis is often clinically silent, it can present as sudden cardiac death, life threatening ventricular arrhythmias, atrial arrhythmias, heart block or left ventricular failure. Less common manifestations of cardiac sarcoidosis include valvular dysfunction and coronary artery infiltration. Accurate and timely diagnosis of cardiac sarcoidosis is important as it accounts for a disproportionate number (13% to 25%) of all sarcoid-related deaths [4].

The 'gold standard' for the diagnosis of cardiac sarcoidosis has traditionally been considered endomyocardial biopsy. However, this is invasive and lacks sensitivity due to the heterogeneous distribution of granulomata within the heart. The reported sensitivity of endomyocardial biopsy in a population with a high index of clinical suspicion of cardiac sarcoid is only 19.2% [8]. Most other non-invasive cardiac investigations, such as electrocardiograms (ECGs) and transthoracic echocardiograms, lack adequate diagnostic sensitivity and specificity [2,9].

The Japanese Ministry of Health and Welfare (JMHW) developed a diagnostic algorithm for the diagnosis of cardiac sarcoidosis in 1993, which was updated in 2006 (Table 1) [10–12]. The JMHW diagnostic criteria in patients who have not had an endomyocardial biopsy requires the presence of minor and major criteria based on ECG, echocardiography and other non-invasive imaging modalities such as gallium scan and cardiac magnetic resonance (CMR). Although this is the most widely recognised diagnostic criteria for the diagnosis of cardiac sarcoidosis, recent studies have highlighted that this algorithm lacks sensitivity and hence is likely to under diagnose cardiac sarcoidosis [9,13,14].

Cardiac magnetic resonance with late gadolinium enhancement (LGE) has recently been considered to be a potentially more sensitive tool for the diagnosis of cardiac sarcoidosis [13,15]. The advantages of CMR over other imaging techniques includes the ability to characterise the myocardium for inflammatory processes at high resolution. Furthermore, CMR does not utilise ionising radiation; this is an important consideration as sarcoidosis often affects young adults requiring computed tomography (CT) for surveillance of pulmonary disease. The identification of LGE in other cardiac diseases such as hypertrophic cardiomyopathy (HCM) has been shown to be clinically significant with its presence associated with both ventricular arrhythmias and sudden cardiac death [16,17]. Recent cohort studies have also shown that in patients with sarcoidosis the presence of LGE on CMR is associated with cardiac arrhythmia and sudden cardiac death [18,19]. Therefore, we investigated the prevalence and clinical significance of LGE detected on CMR in patients with biopsy proven sarcoidosis.

Methods

Consecutive patients referred to Royal Prince Alfred Hospital, Sydney, between 2009 and 2015 with a diagnosis of biopsy proven sarcoidosis and pulmonary manifestations were retrospectively evaluated for cardiac manifestations of

Table 1 **Japanese Ministry of Health and Welfare 2006 diagnostic criteria for cardiac sarcoidosis [10].**

JAPANESE MINISTRY OF HEALTH AND WELFARE 2006 GUIDELINES FOR THE DIAGNOSIS OF CARDIAC SARCOIDOSIS		
Clinical Diagnosis	**Major Criteria**	**Minor Criteria**
• Histological or clinical diagnosis of extra-cardiac sarcoidosis plus:- 3 minor, OR - 1 major and 2 minor criteria	• Advanced AV block • Basal thinning of the interventricular septum • Cardiac gallium uptake • LVEF < 50%	• Abnormal ECG: PVCs, VT, RBBB, axis deviation or abnormal Q wave • Abnormal echocardiogram: RWMA, ventricular aneurysm, increase in wall thickness • Thallium or technetium scintigraphy: perfusion defect • CMR: late gadolinium enhancement • Endomyocardial biopsy: moderate monocyte infiltration or interstitial fibrosis

AV = Atrioventricular block, LVEF = Left Ventricular Ejection Fraction, ECG = Electrocardiogram, PVCs = Premature Ventricular Complex, VT = Ventricular Tachycardia, RWMA = Regional Wall Motion Abnormality, CMR = Cardiac Magnetic Resonance imaging.

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