

Detecting cardiac involvement in systemic sarcoidosis using a multi-contrast late-enhancement MRI technique: preliminary results

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Introduction: Sarcoidosis is a systemic disease with a predilection for pulmonary involvement. Although clinically observed cardiac involvement occurs only in 5-7% of patients with systemic sarcoidosis, the incidence of autopsy-proven disease ranges from 20% to 47%. The presence of cardiac involvement is important to recognize, as it can lead to conduction disturbances and ventricular arrhythmias [1-2]. Early detection of cardiac involvement with suitable treatment plays a critical role in the prevention of sudden death in these patients. Non-invasive imaging techniques such as echocardiography and nuclear medicine scans have been used to detect cardiac involvement in sarcoidosis but with limited success. Late-enhancement (LE) MRI using a conventional inversion-recovery fast gradient-echo (IR-FGRE) demonstrates improved sensitivity [3-4]. A newly developed multi-contrast late-enhancement (MCLE) MRI has shown the potential to identify subtle myocardial damage in myocardial infarction [5-6]. We hypothesize that this MCLE technique may be a better method to determine cardiac involvement in systemic sarcoidosis, compared to conventional IR-FGRE imaging.

Materials and Methods: The institutional research ethics board approved the study protocol and informed consent was obtained in all subjects. Eighteen patients with confirmed sarcoidosis (males 9 and females 9, average ages of 51±11years old) were enrolled. Cardiac LE-MRI studies included both MCLE and IR-FGRE pulse sequences on a 1.5T GE Signa HDx system. ECG gating and an eight-channel phased-array cardiac coil were used for data acquisition. Pre-contrast MRI included a 3-plane localizer, T2 preparation or double inversion-recovery T2W imaging, and a short-axis oblique (SAO) SSFP stack of slices covering the left ventricle (LV) and/or two- or four- chamber SSFP studies. Post-contrast IR-FGRE and MCLE in SAO and/or two- or four-chamber views were performed 10-20 minutes after a double-dose intravenous bolus injection of Gd-DTPA (0.2 mmol/kg of Magnevist). For IR-FGRE, the inversion time (TI) varied from 200 to 300 ms, depending on the null point of healthy myocardium. For MCLE, a segmented SSFP readout was used following an inversion pulse, providing 20 cardiac-phase-resolved images at varying effective TIs [5]. The in-plane resolution was 1.5x1.5 mm and the through-plane resolution was 8 mm for both IR-FGRE and MCLE. Cardiac involvement evaluation focused on the LV free wall, interventricular septum (IVS), papillary muscles (PM), right ventricular (RV) wall, and pericardium. Extra-cardiac MRI findings were also documented. Image contrast scores from MCLE and IR-FGRE were rated as excellent (3), good (2) or fair (1) based on the differentiation among hyper-enhanced lesions, blood pool, and healthy myocardium.

Results: Seven of eighteen subjects (38.9%, Figure 1) were identified by MRI to have cardiac involvement that included abnormal focal hyper-enhancement patterns in LV free wall (5/7), RV wall (3/7) with one aneurysm, PM (3/7) and IVS (2/7), as well as localized pericardial effusion or enhancement (4/7) and diffuse LV hypertrophy (1/7). In a total of 13 hyper-enhanced foci identified in MRI from LV free wall, RV, IVS and PM, MCLE showed 100% (13/13) of those foci while IR-FGRE only demonstrated 61.5% (8/13) of the foci. This detection difference may originate from the better overall contrast score using MCLE (2.72±0.46) compared to that of IR-FGRE (2.38±0.50) (n=18, p=0.01). The multi-contrast capability of MCLE facilitates an improved differentiation between blood pool and hyper-enhanced lesions. This is especially important for the detection of PM involvement since a large portion of PM extends within the LV blood pool. In the three subjects with PM involvement, IR-FGRE only depicted one focal PM abnormal enhancement. In this study the LV systolic function was preserved in sarcoid patients with cardiac involvement (n=7, LVEF=64.3±7.8%, ESV=41.7±17.6 ml, EDV=112.2±23.5 ml). Extra-cardiac MRI findings were common and present in 72% (13/18) sarcoid patients which included pulmonary lesions, hilar and mediastinal lymph node enlargement, pleural effusion, hepatic and spleen lesions.

Conclusions: Compared to conventional LE-MRI, MCLE imaging provides better contrast between blood pool, healthy myocardium, and hyper-enhanced lesions, thus improving the determination of cardiac involvement in patients with sarcoidosis and prompting early initiation of treatment. These tools also potentially improve the capacity to follow disease progression.

Reference: 1. Mihailovic-Vucinic V, et al. *Atlas of sarcoidosis* (2005):77-81. 2. Lannuzzi MC, et al. *NEJM* 2007; 357: 2153-65. 3. Schulz-Menger J, et al. *heart* 2006; 92: 399-400. 4. Smedema JP, et al. *JACC* 2005; 45: 1683-90. 5. Yang Y, et al. *Proc. Intl. Soc. Mag. Reson. Med.* 17 (2009): 3736. 6. Detsky JS, et al. *MRM* 2007; 58:365.

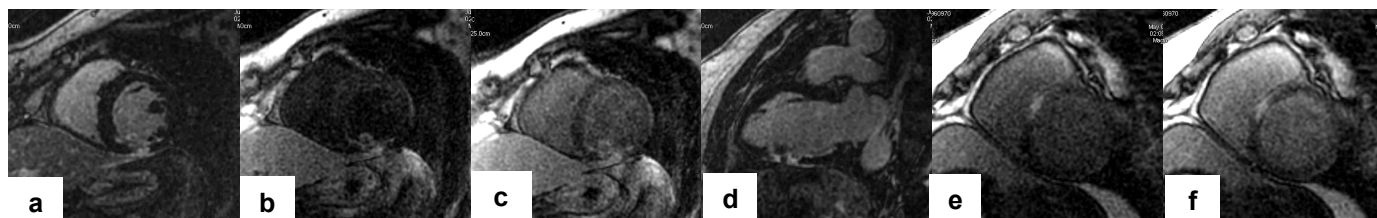


Figure.1: Cardiac involvement in sarcoid patients. Fig.1a-d. Inferior left ventricular wall and papillary muscle involvement (a,d-2D IR-FGRE images, b,c-MCLE images); Fig.1e,f. Basal interventricular septum involvement (e, f-MCLE images).