Current guidelines for the diagnosis of cardiac sarcoidosis (CS) include late gadolinium enhancement (LGE) cardiac magnetic resonance (CMR), which provides the excellent negative predictive value for ruling out future cardiac events (1,2). However, early diagnosis of CS remains clinically challenging due to limited LGE sensitivity prior to myocardial scar development, which may occur late in the process of cardiac involvement. Therefore, improved diagnostic testing to identify patients with early stages of CS prior to development of myocardial scarring is an unmet clinical need. Several investigators (3,4) have demonstrated the potential of single-slice native T1 and T2 mapping for detecting CS. Given a potential patchy CS appearance and predominant focal involvement of the left ventricular (LV) basal and free wall, the disease may remain undetected by this approach. Also, considering the potential of native T1 mapping to quantify or detect myocardial scarring, native T1 mapping alone may yield a clinically robust application for the diagnosis of CS. Accordingly, the 2-fold purpose of this study was to investigate whether 5-slice myocardial native T1 can reliably characterize focal myocardial scarring or fibrosis in systemic sarcoidosis patients, using different signal intensity thresholds and to assess the diagnostic performance of myocardial native T1 and T2 mapping for detecting confirmed CS and possible CS which will subsequently develop overt CS.

This study enrolled 58 consecutive patients with biopsy-proven systemic sarcoidosis who were referred for CMR secondary to suspicion of cardiac involvement and 58 age- and sex-matched control subjects who underwent CMR for evaluation of suspected cardiovascular diseases but were free of any cardiovascular diseases. The study was carried out with approval from Beth Israel Deaconess Medical Center Institutional Review Board. Written informed consent was obtained from all subjects. CMR was performed at 1.5-T, including assessment of global longitudinal strain (GLS) by CMR tracking, LGE, and 5-slice T1 and T2 mapping. Segmental native T1 and T2 values were measured over the 16 myocardial segments from 5 slices. Segments 1 to 6 were obtained from the most basal slice, whereas segment T1 values in segments 7 to 12 and segments 13 to 16 were calculated by averaging of 2 mid-ventricular slices and 2 apical slices, respectively. The extent of abnormal native T1 and T2 values was quantified by the number of segments with increased signal intensity based on the described 16-segment model. Different signal intensity thresholds (i.e., 2, 3, 4, and 5 standard deviations [SD]) above the mean native T1 and T2 values were applied, where mean and SD values were derived from the control subjects. All patients were followed at 3- to 6-month clinical visits or by a telephone interview. CS was diagnosed by 1 or more findings of the 7 major criteria of the Heart Rhythm Society Expert Consensus Statement.

Eleven patients (19%) were identified with CS. During a median follow-up of 28 months, 6 possible CS patients (10%) without any LGE abnormalities on baseline CMR developed overt CS. LV contractile dysfunction was evident in 2 patients; high-grade atrioventricular block in 1 patient; fatal ventricular arrhythmia in 1 patient; new results using LGE on CMR showed in 1 patient; and focal uptake of fluorine-18-labeled fluorodeoxyglucose positron emission tomography showed in 1 patient. In patients with systemic sarcoidosis, abnormal native T1 and T2 values (>2SD) were more prevalent in basal slice segments (Figure 1A). Segmental but not global native T1, assessment discriminated among possible, confirmed, and absence of CS. An increase in the extent of native T1 (>2SD) but not T2 values correlated well with both impaired GLS and LV ejection fraction (coefficient $r = 0.49; p < 0.001$; and $r = 0.54; p < 0.001$, respectively). Impaired GLS of more than $-17\%$ was associated with native T1 (>2SD) burden of $>4$ segments, whereas LV ejection fraction $<50\%$ was best defined by a burden of $>8$ segments. With a C-statistic of 0.89 (95% confidence interval [CI]: 0.76 to 0.96), native T1 (>2SD) burden of $>3$ segments was the strongest predictor for development of overt CS. The C-statistic of T2 (>2SD) extent and GLS for predicting possible CS were 0.77 (95% CI: 0.62 to 0.88) and 0.66 (95% CI: 0.50 to 0.79), respectively. On the other hand, a native T1 (>2SD) burden associated strongly with LGE volume ($r = 0.87; p < 0.001$) and provided a C-statistic of 0.84 (95% CI: 0.71 to 0.92) for detecting myocardial scarring (Figure 1B).

In accordance with an autopsy study of 113 cases (5), a higher prevalence of abnormal myocardial native T1 and T2 values were found in basal slice segments in systemic sarcoidosis. Segmental native
**FIGURE 1** Prevalence of $T_1 > 2SD$ and Diagnostic Performance of Native $T_1$ for CS

(A) Bull’s eye plots show the distribution of abnormal $T_1$ values, defined as $>2SD$, from the mean native $T_1$ values in the controls according to the segment in 58 sarcoidosis patients. (B) Diagnostic performance of native $T_1$ values mapping for possible CS and confirmed CS. AUC = area under the curve; CS = cardiac sarcoidosis; GLS = global longitudinal strain; $T_2 > 2SD$ = abnormal native $T_1$ and $T_2$ values.

$T_1$ analysis, rather than global or septal $T_1$, had better discriminatory ability for non-CS and for possible CS with subsequent development of overt CS. On the other hand, GLS or LV ejection fraction reflected global rather than local or subtle contractile dysfunction, resulting in a less sensitive predictor for possible CS. Studies suggest that changes in LV myocardial tissue can theoretically occur before subclinical LV dysfunction and changes shown in electrocardiography results; thereby, segmental $T_1$ assessment for suspected patients with CS is of great interest. The excellent predictive performance of possible CS on a segmental basis underlines the value of the present approach as a possible screening test for CMR referrals. Furthermore, a thresholding approach to 5-slice native $T_1$ mapping strongly associates with focal scarring in confirmed CS, suggesting that native $T_1$ mapping may provide useful information in patients with contraindications for gadolinium-based contrast agents. Given the excellent prognostic value of myocardial scarring on LGE CMR, future studies are needed to determine the incremental diagnostic and prognostic roles of native the $T_1$ mapping technique. The present study has
several limitations. First, the rate of patients with negative LGE who subsequently developed symptoms or signs of CS was higher than expected. However, despite the high negative predictive value of LGE CMR, there were rare cases of patients with myocardial inflammation who do not have any underlying fibrosis on CMR. Second, there was a lack of uniformity in follow-up testing. Further studies in larger cohorts are warranted to confirm whether early diagnosis and medical treatment based on segmental native T1 analysis can provide better risk stratification beyond the current guidelines as well as other imaging techniques.

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Prospective Comparison Between Saline and Radiocontrast for Intracoronary Imaging With Optical Coherence Tomography

One of the primary reasons for under-use of optical coherence tomography (OCT) is the need for administration of radiocontrast to clear blood from the imaging field. The additional radiocontrast required to acquire OCT images is undesirable, particularly in patients with chronic kidney disease. Ideal features of an alternative flushing medium are the ability to generate image quality comparable to that of contrast while minimizing damage to kidneys.

In a prospective study of consecutive patients with clinical indication for OCT, the efficacy of saline OCT to generate high-quality images was examined, and the effects of correcting for the difference in refractive indices of saline versus radiocontrast on measurement of vascular dimensions were assessed. Coronary arteries were imaged twice in succession using 12 to 14 cc of radiocontrast medium by manual injection or 20 cc of 0.9% saline (5 cc/s) using an automatic delivery system (CVI, ACIST, Eden Prairie, Minnesota) in randomly allocated succession. The Institutional Review Board approved the study. Recordings were made using the Ilumien Optis intravascular OCT imaging system (Abbott, Santa Clara, California) at a speed of 20 mm/s. Coregistration was performed by automated re-advancement of the OCT catheter.

Recordings were analyzed at 1-mm intervals by designating images as optimal (i.e., completely clear vessel lumen and visible lumen contour for 360° of vessel circumference), acceptable (i.e., visible lumen contour ≥270°), or unacceptable quality (i.e., visible lumen contour <270°). A clear imaging field (CIF) was defined as visible lumen contour ≥270°. Adequately imaged vessel length was determined as the segment of recording containing all frames with CIF and further categorized as continuous length or proportional length. For paired frames with CIF, mean lumen area and diameter were compared between saline and contrast OCT. In vitro manufacturer-derived correction indices (1.085 for lumen diameter and 1.176 for lumen area) were used to adjust the luminal measurements of saline OCT compared to those of contrast OCT.

A total of 13,964 cross-sections were analyzed from 37 paired acquisitions in 20 patients. There were no complications related to saline or contrast administration for OCT imaging. Normal and pathological morphology such as fibrous, calcific, or lipid

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