CASE STUDY

Detection of Pseudoaneurysm of the Left Ventricle by Fast Imaging Employing Steady-State Acquisition (FIESTA) Magnetic Resonance Imaging

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ABSTRACT

This report highlights the importance of interpreting images throughout the course of a dobutamine MRI stress test. Upon review of the baseline images, the left ventricular (LV) endocardium was not well seen due to flow artifacts associated with low intracavitary blood-flow velocity resulting from a prior myocardial infarction. Physicians implemented cine fast imaging employing steady-state acquisition (FIESTA) technique that was not subject to low flow artifact within the LV cavity. With heightened image clarity, physicians unexpectedly identified a LV pseudoaneurysm.

Key Words: Magnetic resonance imaging; Stress test; False aneurysm; Left ventricular dysfunction.

A 72 year old man with angina who sustained an anterior myocardial infarction was referred for dobutamine stress magnetic resonance imaging (DSMRI) to exclude inducible ischemia. Due to low blood flow within the left ventricular (LV) cavity in the region of the infarct, the endocardium in the LV apex was not well visualized at baseline with fast gradient echo (FGRE) cine imaging. Cine images of the LV apex were then repeated with a fast imaging employing steady-state acquisition (FIESTA) sequence. Using FIESTA imaging, a small pseudoaneurysm of the left ventricle was noted in the distal 1/3 of the LV apex (Fig. 1). The stress portion of the study was canceled and the patient was referred for cardiac catheterization to confirm the presence of the pseudoaneurysm, and exclude the presence of significant coronary arterial luminal narrowings. Extravasation of contrast outside the LV cavity.

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through a narrow orifice was noted during the left ventriculogram of the cardiac catheterization procedure (Fig. 2).

**DISCUSSION**

During a DSMRI exam, apical and short axis cine images of the left ventricle are obtained at baseline, and then repeated during 5 minute infusions of dobutamine administered at rates of 5, 10, 20, and 40 μg/kg/min (± atropine) (Hundley et al., 1999). Previously, Hundley et al. (1999), described the detection of an untoward medical condition (such as aortic dissection or large mobile apical thrombus) discovered after reviewing the baseline images of a DSMRI study. Importantly, they recommended that a physician be present during testing to monitor patients for wall motion abnormalities indicative of ischemia, and to assist in the management of patients with unexpected findings. In this study, physician review of the FGRE images acquired at baseline revealed imperfect visualization of the endocardium of the LV apex. Further investigation with an alternative imaging sequence led to improved endocardial visualization and the somewhat incidental discovery of a LV pseudoaneurysm.

LV pseudoaneurysm is defined as a rupture of the free wall of the left ventricle contained by overlying adherent pericardium or scar tissue (Brown et al., 1997; Frances et al., 1998). It is important to differentiate a LV pseudoaneurysm from a true aneurysm (a bulging of the left ventricular free wall) because surgery is usually required to repair a pseudoaneurysm. Contrast ventriculography, radionuclide ventriculography, magnetic resonance imaging, and echocardiography have been utilized to diagnose LV pseudoaneurysm (Brown et al., 1997; Frances et al., 1998). Because MR images can be acquired in multiple imaging planes with high spatial resolution, their interpretation is useful for determining the size, location, and the extent of a pseudoaneurysm (Brown et al., 1997; Frances et al., 1998).

To date, the majority of studies performed for visualizing LV wall motion during a stress test incorporate a FGRE imaging sequence (Table 1) in which the moving blood provides contrast between the LV cavity and the endocardial surface. With this form of imaging, the intensity of the signal from blood is proportional to the blood flow velocity within the LV cavity. In situations (such as a region of LV dyskinesis due to a prior infarction) in which the in-plane velocity of
Detected of Pseudoaneurysm

Table 1. Parameters of fast gradient echo (FGRE) and fast imaging employing steady-state acquisition (FIESTA) sequences.

<table>
<thead>
<tr>
<th></th>
<th>FGRE</th>
<th>FIESTA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Echo time (msec)</td>
<td>4.4</td>
<td>1.3</td>
</tr>
<tr>
<td>Repetition time (msec)</td>
<td>8.3</td>
<td>3.3</td>
</tr>
<tr>
<td>Flip angle (°)</td>
<td>18</td>
<td>40</td>
</tr>
<tr>
<td>Field of view (cm)</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Slice thickness (mm)</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Matrix size</td>
<td>$256 \times 128$</td>
<td>$224 \times 224$</td>
</tr>
<tr>
<td>Views per segment</td>
<td>6</td>
<td>18</td>
</tr>
</tbody>
</table>

blood within the LV cavity is low, the cavity/endocardial surface can be difficult to visualize with a FGRE sequence (Carr et al., 2001).

Recently, white blood images with high signal intensity and blood-myocardial-contrast-to-noise ratios have been reported using a FIESTA imaging strategy. This technique, which utilizes short repetition times, is advantageous for several reasons. First, the time needed to acquire high (1 mm² pixel dimensions) spatial resolution cine images of LV wall motion is 33% shorter than with a FGRE sequence of similar spatial resolution. For this reason, the duration of breath holds can be reduced, and patients with decreased breath-holding capacity may better tolerate the procedure (Carr et al., 2001). Second, because FIESTA is less susceptible than FGRE imaging to in-plane flow motion artifacts, precise endocardial definition may be easier to achieve in apical views of the left ventricle when a regional wall motion abnormality or cavity dilatation is present (Carr et al., 2001; Miller et al., 2002). Third, due to intravoxel fat-water phase cancellation, crisp boundary definition occurs along fat-water interfaces. Prior studies report improved delineation of the pericardium from epicardial fat (Carr et al., 2001; Miller et al., 2002).

The use of FIESTA has several limitations. First, high-performance gradients (rate of change of the magnetic field $\approx 61$ Tesla/second) on the scanner are required (Carr et al., 2001). Second, the enhancement of signal and contrast within the image depends on the coherent transverse magnetization. Factors that disrupt this magnetization (such as main field nonuniformity, eddy currents, and inhomogeneous magnetic susceptibility) result in off-resonance effects that cause dark stripes (or ghosting artifacts) to appear on the images (Carr et al., 2001). These artifacts can be pronounced in patients with hyperdynamic LV function at rest, or after inotropic and chronotropic stimulation during a cardiac stress test. Third, some investigators have reported that a pulsatility artifact from the aorta and great vessels can occur during imaging. Although the mechanism of this artifact is not yet fully understood, it can be problematic if the artifact overlays a structure of interest within the image. Fourth, measurements of LV function can be influenced by parameters used to adjust the spatial and temporal resolution of the sequences. Miller et al. (2002), measured LV function parameters in 15 healthy volunteers with varying spatial (1–3 mm) and temporal (21–90 msec) resolutions. A spatial resolution of $>3.0$ mm resulted in a significant increase in the measurement of LV end-diastolic volume (with a corresponding decrease in LV ejection fraction) due to partial volume effects at the junction of the blood pool and the endocardial surface. Temporal resolutions of $>45$ msec reduced the fidelity of quantitative measures of ventricular volumes and forward cardiac output. Their conclusion was that when incorporating FIESTA imaging strategies, a spatial resolution between 1 and 2 mm, and a temporal resolution between 21 and 45 msec should be used to assess LV volumes and ejection fractions (Miller et al., 2002).

In conclusion, this case highlights the importance of interpreting images throughout the course of DSMRI; review of the baseline images led to an important discovery pertinent to the management of a patient. In addition, the application of cine FIESTA imaging strategies may be useful for identifying the endocardium in apical views of the left ventricle when low cavity blood-flow velocity is present.

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REFERENCES