Arterial spin labeled MRI detects clinically relevant increases in myocardial blood flow with vasodilatation

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**Objective**
This study sought to demonstrate the potential for arterial spin labeling (ASL) to differentiate normal and ischemic myocardial segments based on increase in myocardial blood flow (MBF) with vasodilatation.

**Background**
Myocardial ASL is a promising technique for the assessment of MBF because of the absence of contrast agents. Patients with end-stage renal disease cannot tolerate contrast agent, and therefore stand to potential benefit from myocardial ASL. MBF in healthy myocardium is known to increase by 4 times during vasodilator-induced stress, compared to at rest [1].

**Methods**
Twenty nine patients were recruited from those scheduled for routine cardiac MR (CMR) exams. All MRI experiments were performed on a GE Signa 3T scanner. Myocardial ASL measurements were obtained from a single mid short-axis slice, using flow-sensitive alternating inversion recovery (FAIR) tagging and balanced steady-state free precession (SSFP) imaging [2]. Rest-stress myocardial ASL scans were incorporated in CMR exam including first-pass imaging during adenosine infusion of 0.14 mg/kg/min (Figure 1). Based on CMR results, patients who were suspected to have severe ischemic heart disease also underwent X-ray angiography.

**Results**
Among 29 patients, fifteen patients were found to be normal based on having no visible perfusion defect on first-pass MRI and no significant stenosis on X-ray angiogram. Ten patients had both perfusion defects and stenosis. Four remaining patients showed perfusion defects but no stenosis. Table 1 summarizes the perfusion analysis performed in both whole myocardium and myocardial segments after excluding subjects with signal-to-physiological-noise ratio<2.0 [2]. The normal segments included all six segments [3] of the whole myocardium in normal patients and ischemic segments included the most ischemic segments in the patients with stenosis confirmed by X-ray angiography. MBF increase with adenosine in the global and segmental myocardium in normal patients were both statistically significant with p<0.0001 while MBF increase with...
adenosine in ischemic segments were not statistically significant with \( p = 0.1032 \), based on paired t-test. Difference in perfusion reserve \( (\frac{\text{MBF}_{\text{stress}}}{\text{MBF}_{\text{rest}}} ) \) between normal and ischemic segments was statistically significant with \( p = 0.0296 \), based on unpaired t-test.

**Conclusion**

This study has demonstrated that myocardial ASL is able to capture adenosine-induced MBF increase in normal myocardium while detecting insignificant increase in ischemic myocardium. This suggests that myocardial ASL with vasodilation has a potential to diagnose angiographically significant heart disease.

**Table 1 MBF at rest and during stress (ml/g/min) and perfusion reserve**

<table>
<thead>
<tr>
<th>Subject</th>
<th>Normal whole myocardium</th>
<th>Normal myocardial segments</th>
<th>Ischemic myocardial segments</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>12</td>
<td>66</td>
<td>11</td>
</tr>
<tr>
<td>Condition</td>
<td>Rest</td>
<td>Stress</td>
<td>Rest</td>
</tr>
<tr>
<td>MBF</td>
<td>1.19±0.46</td>
<td>3.99±1.39</td>
<td>1.20±0.88</td>
</tr>
<tr>
<td>Reserve</td>
<td>4.21±3.44</td>
<td>2.87±2.10</td>
<td>1.48±0.46</td>
</tr>
</tbody>
</table>

References


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