Combined Adenosine Stress Perfusion and Tagging Protocol for Detection of Coronary Artery Disease at 3 Tesla

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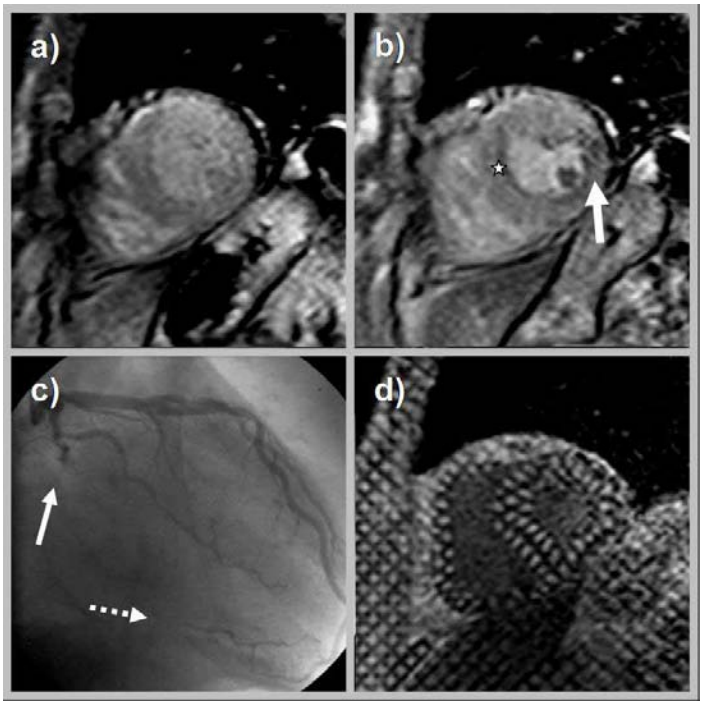
Introduction:
While adenosine-stress perfusion imaging is a very sensitive technique for the detection of coronary artery disease (CAD), its specificity is rather low. In contrary the use of standard adenosine-stress cine imaging lacks high sensitivity, but is very specific for detection of CAD (1). Detection of wall motion abnormalities (WMAs) can be improved by the use of myocardial tagging techniques (2). Both, myocardial perfusion imaging and myocardial tagging benefit from high field strength due to increased CNR, SNR as well as improved tag persistence and tag definition, allowing for high image resolution and combination with parallel imaging techniques (3,4).

Purpose
1. To integrate myocardial tagging into a comprehensive adenosine-stress-protocol for detection of coronary artery disease (CAD) at 3 Tesla.
2. To investigate the additive value of myocardial tagging in a combined adenosine-stress perfusion-tagging protocol for detection of significant CAD in a mixed patient population (known or suspected CAD).

Methods
Patients with known or suspected CAD, admitted for non-invasive adenosine stress cardiac magnetic resonance (CMR) imaging, were included. The study protocol was approved by the local ethics committee. Adenosine-stress perfusion and adenosine-stress tagging images were acquired in 3 identical short axis locations. Sequence parameters were as follows: Slice thickness 8mm, FOV 320-380 mm, reconstructed matrix 256^2, sense factor 2-2.5 for both sequences. TE 3.0 ms, TR 1.4 ms, α 15°, 3 slices/RR-interval, shared sat-prepulse for the perfusion scan as well as TE 3.7 ms, TR 2.2 ms, α 10°, 16 cardiac phases, 8mm tag separation, grid-tag pattern, for the tagging scan. A patient to patient and a vessel to vessel analysis were performed. A positive catheter - finding at invasive coronary angiography (CA, refererence standard) and thus significant CAD was defined as a luminal stenosis or flow limiting restenosis >70% in native and graft vessels. A true positive CMR – finding was defined as one or more perfusion deficits or new WMA during adenosine-stress in angiographically corresponding regions.

Results
To date we evaluated 22 patients (♂: 16, ♀: 6; median age: 63; 5 patients with suspected, 17 patients with known CAD), where both CMR exams and invasive CA were completed. The tagging sequence extended imaging time by 1.5-3 min and was well tolerated by all patients. In the figure a stress-induced perfusion deficit is shown in the lateral wall (arrow, b). A dark rim artefact (asterisk, b) can already be observed under resting conditions (a). The catheter shows an interruption of the posterolateral branch (full arrow, c) with retrograde inflow (dotted arrow, c). The tagging sequence (d) did not demonstrate any WMAs. Sensitivity and specificity for detection of significant CAD by adenosine stress perfusion were 0.92 and 0.70 respectively. The sensitivity of adenosine stress tagging was less (sens. 0.67), while the specificity was very high (spec. 1.0). The vessel-to-vessel analysis yielded lower values for sensitivities, but higher values for specificities for both perfusion (LAD: sens. 0.57, spec. 0.87; RCA: sens. 0.83, spec. 0.94; CX: sens. 0.86, spec. 0.93) and tagging imaging (LAD: sens. 0.57, spec. 1.0; RCA: sens. 0.67, spec. 1.0; CX: sens. 0.43, spec. 1.0). The combination of both techniques did not increase sensitivity.



Conclusion
The implementation of a combined adenosine stress perfusion and tagging protocol at 3 Tesla is feasible and well tolerated by patients. The application of the protocol to a mixed patient population (known or suspected CAD) for detection of significant CAD yields good values for sensitivity and specificity. While the sensitivity of adenosine stress tagging is rather poor compared to perfusion imaging, its specificity is very high. This technique should thus prove very useful in cases of inconclusive perfusion studies (e.g. in the presence of artefacts), to help avoid false positive results.

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