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Feasibility of high-dose dobutamine stress SSFP cine MRI at 3 Tesla with patient adaptive local RF shimming using dual-source RF transmission: initial results

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Introduction

Cine SSFP sequences have become the gold standard for assessment of myocardial function at 1.5T. However, cine imaging at higher-field strengths is hampered by SAR limitations, the increased inhomogeneity of the B1 (RF) and B0 field and the high sensitivity of SSFP sequences to off-resonance artefacts. The effect is even more pronounced in HDDS studies, which are associated with a significant increase in heart rate and consequently more complex and faster blood flow. Previously, spoiled gradient-echo sequences have been proposed as an alternative for stress studies at 3T. Recently, the introduction of a dual-source RF transmission system with patient-adaptive local RF-shimming has lead to a significant improvement of image quality of SSFP imaging at 3T during resting conditions and may thus allow for reliable imaging of cardiac function even at high heart rates.

Purpose

To investigate the feasibility of high-dose dobutamine stress (HDDS) imaging using SSFP sequences at 3T employing patient-adaptive local RF-shimming using a dual-source RF transmission system.

Methods

8 Patients with suspected CAD underwent a HDDS protocol on a 3T MRI scanner (Achieva 3.0T-TX, Philips Healthcare, Best, Netherlands), equipped with a dual-source RF transmission system. SSFP cine sequences at every stress level were performed in the short (SA), vertical (VLA) and horizontal long axis (HLA) using patient-adaptive local RF-shimming (RF-S) and compared to cine images acquired with identical sequence parameters at rest and maximal stress, without additional shimming. Overall image quality was evaluated on a 4-point grading scale (4: excellent, 1: non-diagnostic) and number of non-diagnostic segments assessed. Contrast between interventricular septum and blood pool was calculated $[(SI_B\text{-}SI_M)/(SI_B+SI_M)]$.

Results

All HDDS studies were completed successfully. RF-S lead to a significant improvement of overall image quality at stress (SA 3.62+/-0.52 vs. 2.13+/-0.64; VLA 2.88 +/-0.35 vs. 1.75+/-0.46; HLA 3.13+/-0.64 vs. 1.5+/-0.76; $p<0.05$) and in both long axis at rest (VLA 3.38+/-0.52 vs. 2.88+/-0.35; HLA 3.63+/-0.52 vs. 2.75+/-0.71; $p<0.05$) compared to sequences without RF-S. The amount of non-diagnostic segments was significantly reduced when using RF-S at rest (0 vs. 20, $p<0.05$) and maximum stress (4 vs. 77, p0.05) with RF-S, the difference was not statistically relevant.

Conclusion

Patient-adaptive local RF-shimming using a dual-source RF transmission MRI system allows for reliable SSFP imaging in a clinical high-dose dobutamine stress

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protocol. RF-S significantly improves image quality and reduces the number of non-diagnostic myocardial segments.

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