High Resolution MRI of the Carotid Arteries With a 4-channel Phased Array Surface Coil: First Clinical Results With Improved Dark Blood Sequences

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Introduction

Recently, MRI has emerged as a promising noninvasive imaging technique for the assessment of atherosclerotic lesion in the carotid arteries. The purpose of the present clinical study was to perform high-resolution vessel wall imaging of the carotid arteries with a combination of a phased-array RF surface coil and improved fast multislice dark-blood imaging sequences to evaluate those sequences for plaque imaging.

Methods

Scanning was performed on a 1.5 Tesla MR system (Sonata®, Siemens, Erlangen, Germany) with maximum gradient amplitude of 40 mT/m and maximum slew rate of 200 mT/m/msec. A four-channel phased-array carotid coil (two two-element bilateral coils) (PACC-SS15, MACHNET B.V., Netherlands) was used for signal reception. Twenty patients with suspected carotid stenosis by ultrasound-imaging underwent the following protocol: 3D time-of-flight bright-blood imaging technique, cardiac-triggered multislice dark-blood axial T1-weighted turbo spin-echo sequence with fat suppression ([0.6x0.6x3.0], scan time 2:59 for 15 slices, SL3mm, TR/TE 676/7.5 ms, flip angle 180°), cardiac-triggered multislice dark-blood axial T2-weighted turbo spin-echo sequence with fat suppression ([0.6x0.6x3.0], scan time 2:59 for 15 slices, SL 3mm, TR/TE 676/45 ms flip angle 180°), sagittal images were additionally acquired. The protocol was completed with a 3D contrast enhanced MR angiography. MRI images were correlated with multislice CT-angiography and or conventional angiography (DSA).

Results

18 of the 20 examined patients showed atherosclerotic plaques in either one or both carotid arteries. CT-angiography and or DSA confirmed carotid stenosis in these cases. With high resolution MRI imaging it was possible to differentiate between the vessel wall and the plaque using the multislice dark-blood protocols (Fig. 1). Fat suppression was used in all sequences in order to remove the strong signal of the subcutaneous fat and to improve the vessel wall conspicuity. Image quality was sufficient to quantify the plaque burden on multislice images [1]. In 2 patients a wall thickening of the carotid bulb respectively of the common carotid artery was found possibly caused by inflammation commonly known as carotidynia. Those two patients showed in the follow-up exams clinical improvement, which was confirmed with high-resolution MRI (Fig. 2).

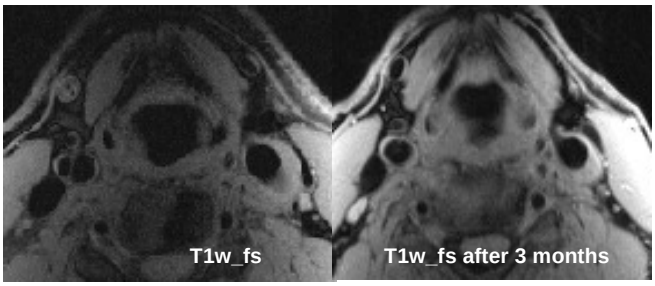

Figure 2: Thickening of the left carotid artery in a patient with carotidynia. Follow-up examination after medical therapy shows a good response to therapy.

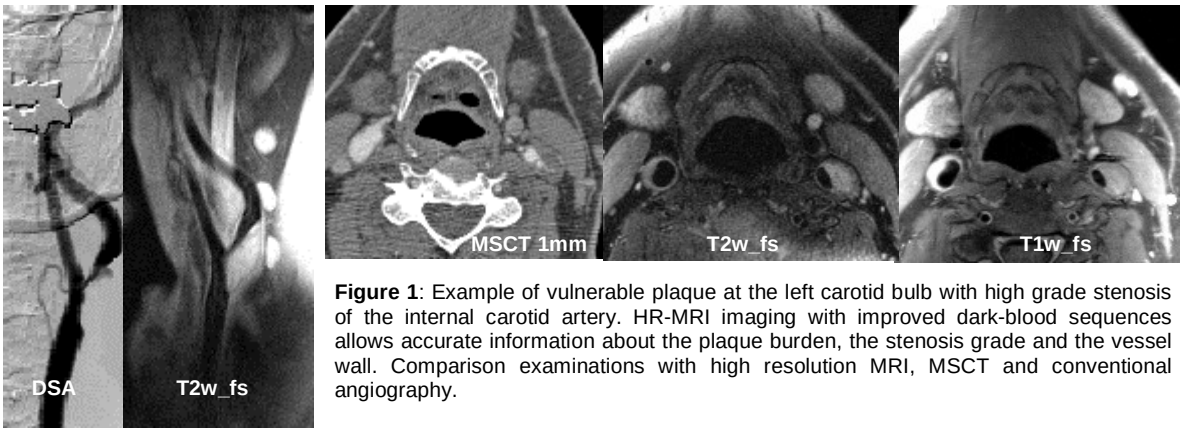

Figure 1: Example of vulnerable plaque at the left carotid bulb with high grade stenosis of the internal carotid artery. HR-MRI imaging with improved dark-blood sequences allows accurate information about the plaque burden, the stenosis grade and the vessel wall. Comparison examinations with high resolution MRI, MSCT and conventional angiography.

Discussion

It has been demonstrated that MRI of the carotid arteries with phased-array surface coils in combination with cardiac triggered dark-blood multislice sequences provides high-resolution vessel wall imaging with high image quality. Dark-blood sequences in conjunction with cardiac gating and fat suppression in all sequences improved the conspicuity of the vessel walls by removing the blood signal and the strong signal of subcutaneous fat. With the improved multislice sequences the acquisition of 15 interleaved slices was possible within short acquisition times. Using high spatial resolution it has become possible to measure the plaque burden and according to new reports [2] it might be possible in the near future to estimate the vulnerability of the arteriosclerotic lesions. Furthermore it is possible to distinguish between wall thickening caused by inflammation - such as carotidynia - and plaques.

References

1. Yuan C. et al; Arterioscler Thromb Vasc Biol 1997;17:1496-1503
2. Kerwin et al; Circulation 2003;107:851-856