

SUBTRACTIONLESS FIRST-PASS SINGLE-DOSE PERIPHERAL MRA USING TWO-POINT DIXON FAT-SATURATION

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Introduction

First-pass contrast-enhanced magnetic resonance angiography (CE-MRA) of the peripheral vascular tree is typically performed by imaging 3-4 consecutive fields of view (FOV) during first arterial passage of a double dose of contrast material (0.2 mmol/kg). In order to better visualize vascular structures in maximum intensity projections, signal from background tissue is suppressed by subtraction of non contrast-enhanced scans with identical geometry (1-3). Since fat has the shortest T1 among the background tissues and thus appears brightest, we hypothesized that intrinsically fat-suppressed T1-weighted imaging such as multi-gradient-echo Dixon imaging is capable of providing sufficiently adequate vessel-to-background contrast without subtraction. The purpose of this study was to investigate the feasibility of subtractionless single contrast medium dose (0.1 mmol/kg) first-pass CE-MRA of the peripheral arterial tree using two-point Dixon water-fat separation (mDixon) (4), and to compare image quality with the conventional subtraction technique.

Materials and methods

17 patients (6M/11F; mean age: 59.1±17.7 years) with suspected peripheral arterial disease were examined on a 1.5T Ingenia scanner (Philips Healthcare, Best, The Netherlands). Prior to and during injection of 0.1 mmol/kg Gadobutrol (Bayer Healthcare, Berlin, Germany), source datasets of the first pass of the contrast agent were acquired in three stations, each with a FOV of 430x350x150 mm³, using a T1-weighted spoiled dual-gradient-echo sequence with a TE1/TE2 of 1.8ms / 3.0-3.2 ms. The actual spatial resolution varied from 1.3x1.3x2.8 mm³ in the aortoiliac station to 1.0x1.0x1.5 mm³ in the lower leg station. Different coils with about 30 elements per station were automatically selected and supported an 8- to 10-fold acceleration by parallel imaging, leading to scan times between 16 s for the first station and 25 s for the third station. From these source datasets combined water and fat images were generated, as well as water only images. Subtracted datasets were created by subtracting non contrast-enhanced images on a partition-by-partition basis from images acquired during injection of contrast. Vessel to background ratio was calculated for 21 named vessel segments from the aortoiliac arteries down to the ankles by dividing the signal intensity in the artery by the standard deviation of homogeneous background signal adjacent to the artery of interest. In addition, the frequency of fat-water swapping artifacts was assessed.

Results

Except for 1 disturbing fat-water swapping artifact in the lower legs all images acquired with the mDixon technique could be evaluated. Mean vessel-to-background contrast was uniformly high for both the subtraction and subtractionless mDixon techniques (figure). Mean vessel to background ratios (±SD) for the subtraction technique were 23.6±1.1 (aortoiliac); 23.2±1.1 (upper legs) and 10.1±0.5 (lower legs). Corresponding values for the subtractionless mDixon technique were 68.4±4.6 (aortoiliac); 50.5±16.2 (upper legs) and 22.8±2.4 (lower legs) for the subtractionless mDixon technique (P<0.01 for all stations).

Discussion and Conclusions

The feasibility of subtractionless mDixon imaging for first-pass contrast-enhanced fat-suppressed peripheral MRA is demonstrated. At a contrast dose of 0.1 mmol/kg vessel-to-background contrast is substantially improved over conventional subtraction based approaches. In addition, the mDixon approach represents substantial timesavings over the conventional subtraction-based approach to peripheral MRA and avoids potential subtraction misregistration artifacts.

References

- 1) Ho et al. Radiology 1998;206:683-692; 2) Meaney et al. Radiology 1999;211:59-67; 3) Leiner et al. JMRI 2001;14:724-33; 4) Eggers et al. MRM 2011;65:96-107.

Figure 1. Single dose CE-MRA of runoff vessels without subtraction (left), with the conventional subtraction technique (middle) and subtractionless mDixon technique (right). Note improved vessel to background contrast, especially in the lower legs.

