Evaluation of a New Hybrid Technique with Sagittally Acquired Images of the Calf: Elimination of Venous Contamination in 3D-CE Peripheral MRA Examination.

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Introduction: The lower cost, lack of invasiveness and its superb evaluation of the lower extremity vessels [1] make the three dimensional contrast enhanced (3D-CE) peripheral magnetic resonance angiography (MRA) an attractive alternative to conventional angiography in the evaluation of peripheral vascular disease. Generally, peripheral MRA is performed with an automated moving table as a bolus chase technique. The timing of the bolus is optimized for the first station (abdomen and pelvis), and then imaging is performed as rapidly as possible to try to keep up with the flow of gadolinium chelate down the peripheral arteries. This technique results in an excellent image quality for the first station and second station (thighs), however, can be suboptimal for the evaluation of the last station (calves and feet) due to venous contamination. The popliteal and infrapopliteal arteries are key vessels for evaluation before planning any distal surgical revascularization procedure [2].

Purpose: The aim of this study is to introduce a new hybrid 3D-CE peripheral MRA that will totally eliminate venous contamination and provides better demonstration of the calf and plantar vessels. This provides more accurate anatomic information for precise surgical planning.

Methods:

Subjects: The new hybrid 3D-CE peripheral MRA technique was implemented on twenty five consecutive patients (12M:13F, Age 41-78 yrs, mean 69 yrs) referred for peripheral MRA.

Imaging Protocol: All examinations were performed with a 1.5-T MR system (Magnetom Symphony; Siemens Medical Solutions, Erlangen, Germany) equipped with Quantum gradients (30mT/m gradient strength) and a dedicated bilateral lower extremity phased array coil. The study is performed as a two staged procedure.

Stage one: Following a timing bolus at the level of the popliteal arteries, high resolution 3D images of the calves and feet are obtained using two separate sagittal slabs. The data is acquired using parallel imaging with an acceleration factor of 2 (GRAPPA) and interleaved acquisition. The total imaging acquisition time is 16 seconds.

Stage two: A standard three station automatic moving table bolus chase CE MRA was performed from the renal arteries to the feet.

Contrast: 20 cc of gadodiamide is used for stage one. 40 cc of gadodiamide is injected in a biphasic manner during stage two acquisition.

Post processing: Included subtraction and Maximum Intensity Projection (MIP).

Image analysis: For the purpose of this study only the third station coronal images of the calf obtained from the standard bolus chase technique were compared to the sagittal images of the calf acquired using the new hybrid technique. The images were evaluated for the degree of venous contamination. Post processed MIP images were used.

Results: Venous contamination was rated from 1 (definitely contamination) to 5 (definitely no contamination). Ratings were performed with sagittal and coronal images of both legs at the proximal calf, mid calf, distal calf, and foot. The distributions of differences between ratings for sagittal and coronal images were tested for normality with

a Shapiro-Wilk W test. Differences were also tested with paired t tests and Wilcoxon signed-rank tests.
Differences between ratings for sagittally acquired images with the new hybrid technique and coronally acquired images with the standard bolus chase technique ranged from 2.12 to 2.71 rating units and were non-normality distributed ($p < 0.01$, Shapiro-Wilk W tests). Coronal images for all comparisons had significantly higher ratings for venous contamination than did sagittal images ($p < 0.01$, paired t tests and Wilcoxon signed-rank tests).

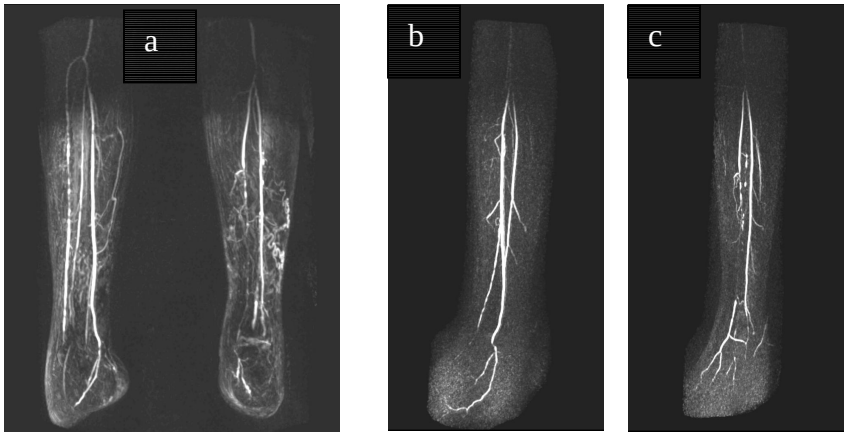

Figure 1. (a) Coronal, (b) sagittal right and (c) sagittal left MIP images demonstrating the extent of venous contamination with the coronal acquisition technique in comparison the virtually free venous contamination with the sagittal acquisition.

Conclusion: Initial acquisition of the sagittal images of the calf using high spatial resolution and rapid image acquisition makes complete elimination of venous contamination a possibility. The combination of parallel imaging and interleaved acquisition make it possible to obtain these images in under 16 seconds with a 1 mm voxel size. The acquisition in the sagittal plane allows better visualization of the feet vessels.

References:

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