3D contrast-enhanced MRA of the runoff vessels: value of image subtraction

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Introduction: Diagnostic accuracy and cost will determine the success of contrast-enhanced 3D MRA in replacing catheter-based digital subtraction angiography (DSA) as the modality of choice for assessing the peripheral run-off arteries. Image subtraction, proposed by some investigators as a way to enhance diagnostic accuracy (1), lengthens data acquisition and post-processing times and therefore contributes toward a considerable increase in cost.

Purpose: We evaluated the diagnostic gain associated with image subtraction for contrast-enhanced 3D MRA of the pelvic and lower extremity arteries. 3D MRA data were collected with an optimized single injection, two station protocol using a dedicated lower extremity vascular coil.

Subjects and Methods: DSA and MRA were performed on 23 patients with suspected peripheral vascular disease. Voxel-by-voxel signal intensity subtraction of the MRA image sets obtained before and during dynamic infusion of a paramagnetic contrast agent was performed on an Advantage Windows Workstation. On a segment based analysis non-subtracted and subtracted MRA image sets were assessed for the presence of occlusive disease using DSA as the standard of reference. In addition, SNR and CNR were recorded of each vascular segment on both the non-subtracted and subtracted images.

Contrast enhanced MRA was performed within 72 hours of DSA on a 1.5 T MR system (Signa EchoSpeed, GE Medical Systems), equipped with a high performance gradient system. Patients were wrapped in a multi-channel quadrature/phased array peripheral vascular coil (Ontician). The imaging strategy was based on the acquisition of two 3D data sets, each time using two adjacent coil elements extending over 48 cm. Based on broadly spaced 2D TOF images the two 3D data sets were prescribed. Section thickness was individually adapted ranging from 2.4 to 2.8 mm. A 3D spoiled gradient recalled echo (egre) sequence with the following parameters was employed: TR/TE 5.2/1.5ms, TI 28ms, flip 30°, FOV 48x36x12cm. Gd-DTPA-BMA (Omniscan; Nycomed Amersham SA, Oslo, Norway) was administered at a flowrate 0.5 - 0.7 ml/second (0.3mmol/kg) over 70 seconds followed by a saline flush of 20 ml using an automated injector (MR Spectris, Medrad, Philadelphia).

For image interpretation rotated MIPs of the non-subtracted and subtracted data sets were rendered from -60° to +60° and documented on film. Occlusive disease was graded on a 5 point scale: 0 - normal, 1 - vessel irregularity (lumen reduction < 10%), 2 - mild stenosis (lumen reduction 10-49%), 3 - severe stenosis (lumen reduction 50-99%), or occlusion (100%). In addition a quantitative evaluation was performed by determining both SNR- and CNR-measurements for each displayed vascular segment.

Results: As was to be expected, SNR remained unaffected by image subtraction. Reflecting subtraction of background signal, CNR values of subtracted images exceeded those measured in non-subtracted images (p<0.05). This difference did not however translate into any measurable diagnostic gains. For the detection of hemodynamically significant disease non-subtracted MRA provided an overall sensitivity and specificity of 90.2 and 95.1%, while subtracted image sets were associated with sensitivity and specificity values of 90.3 and 95.6%. Concordance between non-subtracted and subtracted MRA was excellent (kappa = 0.86).

Conclusion: Subtracted MRA yields higher arterial CNR but does not enhance diagnostic accuracy in the assessment of the pelvic and lower extremity arteries. The additional cost incurred by image subtraction can thus be eliminated.

Reference: