QUALITATIVE AND QUANTITATIVE EVALUATION OF CONTRAST-ENHANCED MR VENOGRAPHY (MRV) OF THE LOWER EXTREMITIES WITH A BLOOD POOL AGENT COMPARED TO NONCONTRAST MRV

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Background: MR venography (MRV) of the IVC, pelvic veins, and lower extremities for the detection of deep venous thrombosis (DVT) is classically performed using noncontrast techniques. Although MR angiography classically relies on contrast administration, imaging of the lower extremity veins with contrast is difficult due to the slow flow and high volume capacity, which results in poor venous opacification using conventional gadolinium. Gadofosveset, a gadolinium-based blood pool agent, is retained in the vascular system markedly longer compared to all other gadolinium agents, which may allow better visualization of the venous system. Therefore, the purpose of this study is to qualitatively and quantitatively evaluate the use of gadofosveset for imaging the lower extremity venous system compared to a conventional noncontrast gradient recalled echo (GRE) sequence, which has been proven to be highly sensitive and specific for the detection of DVT.

Materials and Methods: 25 consecutive patients with concern for DVT within the abdomen, pelvis, or lower extremities underwent MRV. Both conventional GRE and contrast-enhanced (CE) T1-weighted sequences were performed. The contrast agent utilized was gadofosveset at 0.03 mmol/kg. The imaging studies were retrospectively reviewed by six blinded radiologists of varying experience levels. The venous system was divided into 13 segments from the IVC to the popliteal veins. All venous segments were scored for vein visualization (1: poor; 4: excellent), venous signal homogeneity (1: poor; 4: excellent), presence of DVT, and confidence pertaining to the presence or absence of clot (1: unsure; 4: confident). The reference standard for the presence of DVT was determined in consensus by the two senior level radiologists using all available imaging. Signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) measurement was performed on each venous segment. The image acquisition time and reader interpretation time was also determined for each study.

Findings: A total of 325 venous segments were analyzed. Acute DVT was present in eight segments in three patients. Chronic DVT was present in 35 segments in eight patients. Vein visualization measured 3.1 for GRE and 3.7 for CE images ($p<0.001$). Vein homogeneity measured 2.8 for GRE and 3.7 for CE images ($p<0.001$). Diagnostic confidence measured 3.2 for GRE and 3.8 for CE images ($p<0.001$). The overall sensitivity for the detection of DVT for GRE images was 72% compared to 78% for CE images. The overall specificity was 93% for GRE and 96% for CE images. However, for the two readers with the least experience, the sensitivity improved from 69% to 75% and the specificity improved from 83% to 95%. The average interpretation time for each study measured 10.1 +/- 4.1 min for GRE and 5.5 +/- 2.8 min for CE ($p<0.001$).

Quantitative analysis revealed that the SNR was significantly higher for CE images compared to GRE images for all segments except the IVC. The CNR of CE images was significantly higher for the internal iliac vein, distal femoral vein, and popliteal vein; there was no significant difference in the other venous segments. The mean image acquisition time of the abdomen and pelvis for the GRE sequence 16.8 minutes compared to 7.1 minutes for the contrast-enhanced sequence ($p<0.001$).

Conclusions: Images from contrast-enhanced MR venography using a blood pool agent were qualitatively rated higher for venous visualization, signal homogeneity, and confidence levels for assessing for the presence of DVT when compared to a standard noncontrast technique. The sensitivity and specificity for the detection of DVT was modestly but significantly higher for contrast-enhanced images. This improvement was more pronounced for the less experienced readers. Quantitatively, the SNR and CNR of the contrast-enhanced images were as good as or significantly better than GRE images. The vessel homogeneity, radiologist interpretation time, and image acquisition time were also both significantly improved with CE imaging.

References:
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