

Deep Venous Thrombosis: Diagnostic Value of Non-contrast-enhanced MR Venography Using Electrocardiography-triggered Three-dimensional half-Fourier FSE

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PURPOSE

Non-contrast-enhanced MR venography techniques, Flow-Refocused Fresh-Blood Imaging (FR-FBI) and the Swap Phase-encode Arterial Double-subtraction Elimination (SPADE), have been reported to achieve venous run-off images in the iliac to calf regions [1]. SPADE and FR-FBI were developed for the 0.5 Tesla system which allows patients to undergo MRI examinations without a risk of RF heating of metallic orthopedic implants resulting from marked reduction in the whole-body averaged specific absorption rate (SAR). The purpose of our study is to prospectively assess the diagnostic accuracy and interobserver variability of non-contrast-enhanced MR venography using FR-FBI and SPADE to detect deep vein thrombosis (DVT) in the lower extremities in 32 patients compared with the use of conventional X-ray venography as the reference standard.

MATERIALS and METHODS

Forty-one legs of 32 consecutive patients (eight men, 24 women; mean age±SD, 69.4±15.3 years) suspected of having DVT and thus examined using conventional X-ray venography, underwent MR venography using FR-FBI and SPADE. Twenty-five of the 32 patients had non-magnetizing, metal implants they had received during hip or leg surgery. Of these patients, 20 underwent MR examination within 14 days following surgery. All non-enhanced MR imaging was performed on a 0.5-T clinical imager (FLEXART/Hyper, Toshiba, Japan). A whole-body QD coil was applied for all studies. The 3D images were acquired in three separate regions (pelvic, thigh, and calf). For the thigh and calf, non-contrast-enhanced MR venograms were obtained using the FR-FBI technique. For the pelvic veins, the SPADE technique was performed. Typical parameters for the 3D acquisition were as follows: 3 RR intervals; TE_{eff} = 78 ms; TI = 140 ms; ETS = 6.5 msec; matrix = 256 × 256; NAQ = 1; section slice thickness = 2.7–3.5 mm; FOV = 42 × 42 cm; 2 shots; 25–35 section encodings. Following the acquisition, the source images of SPADE and FR-FBI underwent an MIP procession. The venous system was divided into 17 segments for image analysis. Two radiologists independently assessed the MR venograms as either diagnostic or non-diagnostic and with either the presence or absence of thrombi. The sensitivity and specificity of the FR-FBI and SPADE images for the diagnosis of thrombus in each venous segment were calculated. Interobserver agreement for the two reviewers was evaluated using κ statistics.

RESULTS and DISCUSSION

The overall sensitivities for the diagnosis of DVT were 100% (53 of 53 segments) for both reviewers. Corresponding specificities were 100% (238 of 238 segments) and 99.6% (237 of 238 segments). The overall interobserver agreement was almost perfect for both reviewers (κ = 0.92; 95% CI. = 0.87–0.97) regarding the presence and absence of thrombi and as being non-diagnostic on

non-contrast-enhanced MR venography. Representative examples of conventional X-ray and non-contrast-enhanced MR venography are shown in Fig. 1. In these cases, the presence and location of thrombus confirmed by conventional X-ray venography were depicted very similarly on non-contrast-enhanced MR venography. However, conventional X-ray venography did not provide a definition of the upper extent of thrombosis in the 5 patients who were diagnosed as having CIV thrombosis on SPADE MR venography. The SPADE technique allowed depiction of the proximal extent of the thrombosis in all cases, such as showing in Fig. 2.

In conclusion, Non-contrast-enhanced MR venography using SPADE and FR-FBI is highly accurate and reproducible for diagnosing DVT. This is especially advantageous for patients who have received non-magnetizing, metal implants during orthopedic surgery.

REFERENCES: [1] Ono A, et al., Magn Reson Med 61:907–917, 2009.

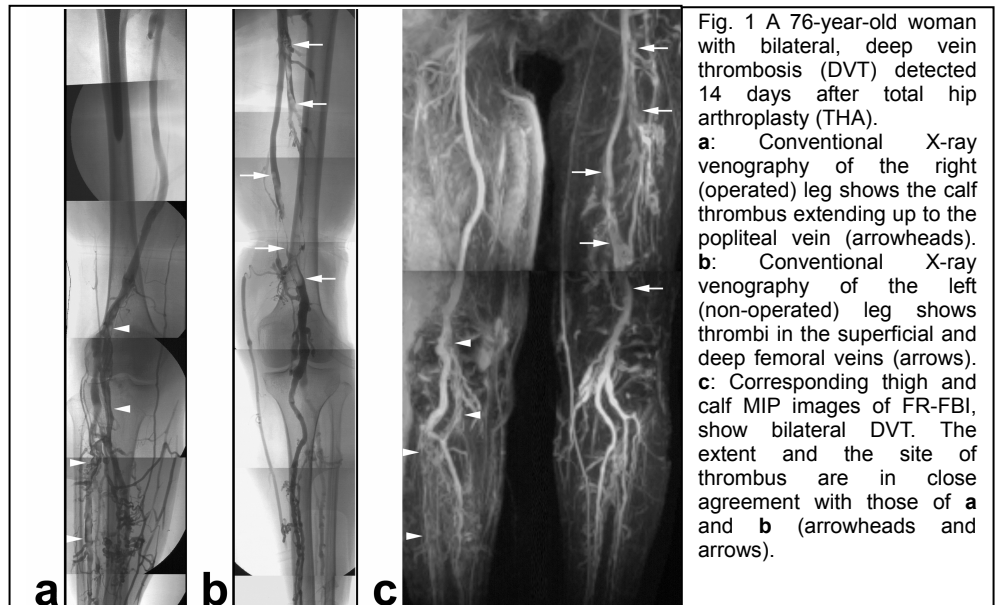


Fig. 1 A 76-year-old woman with bilateral, deep vein thrombosis (DVT) detected 14 days after total hip arthroplasty (THA). **a:** Conventional X-ray venography of the right (operated) leg shows the calf thrombus extending up to the popliteal vein (arrowheads). **b:** Conventional X-ray venography of the left (non-operated) leg shows thrombi in the superficial and deep femoral veins (arrows). **c:** Corresponding thigh and calf MIP images of FR-FBI, show bilateral DVT. The extent and the site of thrombus are in close agreement with those of **a** and **b** (arrowheads and arrows).

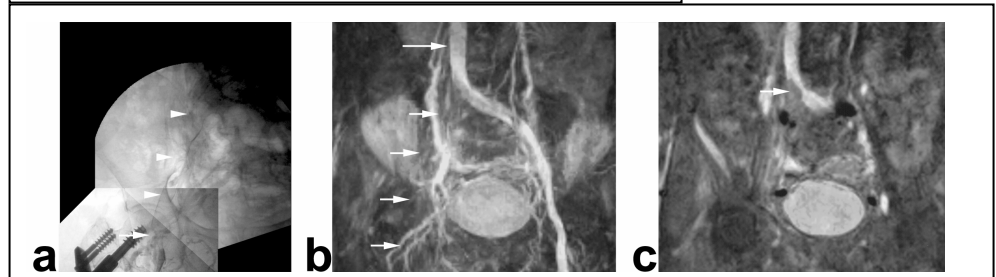


Fig. 2 An 84-year-old woman with extensive DVT noted 1.5 years after surgery for hip fracture. **a:** Conventional X-ray venography shows filling defects in the common femoral vein (short arrows). The upper limit of the thrombosis is not visualized (arrowheads). **b:** Corresponding pelvic MIP image of SPADE shows the thrombi as a hypointense signal extending from the common femoral vein to the common iliac vein (short arrows) and as high-signal intensity in the IVC (long arrow). **c:** Source image of **b** clearly shows the proximal extent of the thrombosis (short arrows).