EVALUATION OF THE FEMORAL ARTERIES: BEFORE OR AFTER TUMOR TREATMENTS USING NON-CONTRAST MRA USING SUBTRACTION

Method based on Velocity Encoding Technique

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Introduction: Dynamic contrast MR angiography (C MRA) has been used for the evaluation of the atherosclerotic diseases. For evaluation of patients with renal insufficiency or history with adverse reactions, MR contrast media cannot be used. So far, Non-contrast (NC) MRA with several techniques has been introduced. In the lower extremities, subtraction method between images in diastolic and systolic phases using fast spin echo technique has been used [1]. And in other word, flow preparation pulse (Flow-Prep) based on bipolar velocity encoding to distinguish artery from vein and background has been used with FISTE and promising results have been obtained [2]. However, inhomogeneous magnetic field especially for lower extremities and slower flow velocity in the artery, FSE based sequence may be utilized. Based on subtraction technique for selective visualization of the artery and vein, Flow Saturation Preparation (Flow-Sat-Prep) technique was utilized [3]. Accordingly, the purpose was to evaluate abilities of NC MRA using Flow-Sat-Prep FSE with subtraction technique for demonstration of superficial femoral arteries compared with C MRA.

Theory: In Flow-Sat-Prep method, Non-selective RF pulses sandwich Velocity ENCoding (VENC) and crusher gradients to saturate multi dimensional flows. Flow void occurs along crusher gradient axis because the crusher gradients give different first moment between stimulated echoes and spin echoes of the flow signals. VENC gradient inverts the flow signals. Reference images are required for image subtraction. To match the contrast of the backgrounds, preparation pulse for the reference images should be simple MLEV-4 without VENC and crusher gradients. Preparation pulse was applied in systolic phase. 3D FSE data acquisition was applied after around 200-300 ms waiting time from Preparation pulse. Arterial and venous signal separation in FSE was obtained with image subtraction between the Flow-Sat-Prep and reference images. STIR was applied to suppress fat signals.

Materials and Methods: Population: 20 patients (6 men, 14 women, mean age 55.6 years) were included, who underwent contrast enhanced MR imaging for evaluation of the femoral tumor or femoral arteries. Pathologies were soft part tumor in the thigh in 6, status post surgical resection of the tumor with artery graft in 6, status of post surgical resection of the tumor with recurrence in 4 or without recurrence in 3, and trauma in one. MR imaging: All images were obtained on a 1.5T MR (HDx or HDe, GE, Milwaukee) with 8 channel phased array multicoils. NC MRA was obtained with two steps: firstly, peripheral arterial gated axial 2D PC cine MR imaging of the femoral artery was obtained and the arterial peak flow velocity and its delay time for triggering on wave were measured. With use of obtained data, peripheral arterial gated Flow-Sat-Prep and reference 3D FSE images were obtained in the coronal plane with TR/TE/ FOV/slice thickness/overlap/matrix; 1600-2400ms/ 51ms/ 35cm2/2-3mm/1-1.5mm/200x224-256, 0.5 NEX and reduction factor (RF) 2. Imaging time was 2-4 min to acquire both Flow-Sat-Prep and reference images. C MRA was obtained with 3D gradient echo sequence (EFGRE) using 2.9-3.7ms/0.8-2.8ms/20 deg/35cm2/2-3mm/256x160-192/one NEX/Spec IR/RF2, centric k space ordering, 0.1mms/kg of gadolinium was injected (0.3ml/sec) and 3D EFGRE was obtained in 24 seconds. Data analysis: Image quality, artifacts (blurring), and overlap of the femoral artery and veins were ranked with 5 -point scale (form 1 undiagnostic, bad to 5 excellent, no artifacts). Recognitions of upper, middle and lower portions of the superficial femoral artery were ranked with 5-point scale (1 bad to 5 good). Patency of the arteries with/without stenosis was also evaluated. Two radiologists performed subjective evaluations. Wilcoxon signed rank test was used for comparison between C MRA and NC MRA. All evaluation were made on workstation (Advantage workstation 4.4, GE) and MIP images were generated from each data using MPVR under flexible volume thickness and its orientation changeable by readers.

Results: In all 20 patients, NC MRA and C MRA were diagnostic and overall image quality and artifacts were not significantly different between two, respectively (NC/C=4.1:4.3, Fig 1).

Recoginition of upper-lower portions of the superficial femoral artery was equally made on both MRAs (Fig 2, 3, 4). Selective visualization of the artery was successful in both MRAs (Fig 2, 3, 4). Patency of the grafts after resection of the tumors was confirmed on NC MRA in all the 6 cases (Fig 3). Reference images of NC MRA demonstrated arteries and veins as well as the pathological changes including the tumor and fluids (Fig 4).

Summary: NC MRA based on “Flow-Sat-Prep” FSE subtraction images could demonstrate superficial femoral arteries and graft vessels. NC MRA provided identical information to that of C MRA. Besides no risk of side effects related contrast agents, one of the advantages of NC MRA is feasibility of repeated acquisition of MRA even with different parameters for better quality of images. In conclusion, for the evaluation of the femoral arteries before and after the tumor treatments, anatomical information of the vasculature can be successfully obtained with NC MRA using Flow-Sat-Prep FSE technique.