

Evaluation of renal vessels, comparison between 2D FIESTA imaging and dynamic contrast 3D fast SPGR imaging with ASSET

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Introduction

In order to evaluate renal vessels, gadolinium-enhanced dynamic MR angiography with rapid imaging acquisition such as 3D fast spoiled gradient-recalled acquisition in the steady state (SPGR) sequence has been one of the most useful and non-invasive studies. However, non-contrast examinations must be chosen when patients refuse or have contraindications to use intravenous contrast media such as bronchial asthma. Although 2D or 3D time of flight sequence is most common in non-contrast-enhanced MR angiography techniques, this sequence takes long acquisition time more than one minute, which may result in poor image quality due to motion and respiratory artifact concerning abdominal vessels. 2D steady-state Free Precession (FIESTA) sequence provides good image quality with high signal on vascular structures within a second per slice. Therefore, we tried to apply fat-saturated FIESTA sequence with multi-planar volume reconstruction (MPVR) to non-contrast MR angiography.

Methods

This study included 21 patients who underwent renal MR imaging (male: 13, female: 8, age range 28-72 years old; mean age 55.4 years old). MR imaging was performed with a superconducting magnet operating at 1.5T (Signa Infinity Excite; General Electric Medical Systems, Milwaukee, WI). All MR images obtained in the coronal plane with field of view of 35x35 cm by using a phased array multicoil. FIESTA imaging was performed with the following parameters: TR /TE /TI /FA: 2.9 /127 /1.2 /50, matrix size: 224*128, thickness / gap: 5/0 mm, acquisition time of 20 locations per 40 second with two breath-holds. Chemical selective sat-saturation was applied. Dynamic contrast enhanced 3D fast SPGR imaging obtained during the arterial, venous, and equilibrium phases of contrast enhancement, was performed with a chemical shift selected fat saturation pulse and MR smart prep technique using the following imaging parameters: TR /TE /TI /FA: 2.9-3.0 /0.8-0.9 /12 /20, matrix size: 256*160 with in-plane zip, section thickness 4mm with 2mm of slice zip. Array Spatial Sensitivity Encoding Technique (ASSET) was applied. Dynamic contrast-enhanced study was performed with an MR-compatible power injector using 0.1mmol / kg of gadolinium, followed by 20 mL of saline, both injected at a rate of 3 mL / sec; delay time from trigger to acquisition = 5 sec; imaging time = 17 sec; interscan duration; 10-15 sec. FIESTA and three phases of 3D fast SPGR images were evaluated using MPVR technique on a cine display. The qualitative analysis was conducted by evaluation of the degree of image quality degradation due to motion artifact and overall image quality independently, using a 5-point scale. Furthermore, visualization of vessels as follows; aorta, proximal and distal part of right and left renal artery, IVC, and proximal and distal part of right and left renal vein, was evaluated, respectively. The quantitative analysis was conducted by using operator-defined region-of-interest measurements of the standard deviation of air (SDB) and mean signal intensity (SI) in the above vessels. Signal-to-noise ratio (SNR) and Contrast-to-noise ratio (CNR) were calculated, respectively.

Results

The qualitative results indicated that FIESTA imaging was free from motion artifacts, and was comparable to 3D dynamic fast SPGR imaging with overall image quality (Table 1). On the delineation of arteries, the arterial phase of 3D dynamic fast SPGR imaging was superior to the others. 2D-FIESTA imaging was comparable to the venous and equilibrium phases of 3D fast SPGR imaging (Table 2). 2D FIESTA imaging also equals venous and equilibrium phases for visualization of venous structures. The quantitative results are summarized in Table3. The mean SNR of arteries on the arterial phase of 3D fast SPGR imaging was highest of all, those of arteries and veins on 2D FIESTA imaging were equal or superior to the venous and equilibrium phases.

Discussion and conclusion

In our study, the arterial phase of 3D dynamic fast SPGR sequence provided best renal arterial images of all sequence. 2D FIESTA sequence was comparable to the venous and equilibrium phases, especially to evaluate aorta and venous structures. When non-contrast-enhanced MR angiography should be chosen, 2D FIESTA sequence might be an alternative choice of method.

Table1. Detection of vessels with 2D FIESTA and three phases of 3D fast SPGR imaging (mean / standard deviation)

	2D-FIESTA	arterial phase	venous phase	equilibrium phase
Aorta SNR	29.2 / 7.2	48.8 / 9.2	19.9 / 4.8	17.4 / 5.1
Right renal artery SNR	22.5 / 7.1	34.3 / 9.8	16.6 / 5.9	15.9 / 6.6
IVC SNR	30.8 / 8.4	4.1 / 2.0	15.8 / 4.7	14.8 / 4.3
Right renal vein SNR	26.9 / 6.5	10.5 / 6.6	18.1 / 5.0	15.4 / 3.9
Aorta-to-fat CNR	22.5 / 6.6	44.7 / 8.4	15.7 / 4.1	13.2 / 4.9
Right renal artery-to-vein CNR	4.8 / 4.1	23.8 / 11.3	3.7 / 2.9	2.1 / 2.6

Table 2. Qualitative assessments with 2D FIESTA and three phases of 3D fast SPGR imaging (mean / standard deviation)

	2D-FIESTA	arterial phase	venous phase	equilibrium phase
Motion artifacts	5.0 / 0.0	4.0 / 0.5	4.4 / 0.5	4.3 / 0.6
Overall image quality	4.4 / 0.5	4.7 / 0.6	4.6 / 0.5	4.6 / 0.6

Table 3. Quantitative assessments with 2D FIESTA and three phases of 3D fast SPGR imaging (mean / standard deviation)

	2D-FIESTA	arterial phase	venous phase	equilibrium phase
Aorta	4.5 / 0.6	5.0 / 0.0	4.6 / 0.5	4.5 / 0.6
Proximal part of right renal artery	3.9 / 0.8	5.0 / 0.0	4.2 / 0.6	3.9 / 0.6
Distal part of right renal artery	3.4 / 0.9	4.9 / 0.3	4.0 / 0.7	3.4 / 0.7
IVC	4.1 / 1.0	1.5 / 1.0	3.9 / 0.8	3.7 / 0.8
Proximal part of right renal vein	3.9 / 0.9	1.5 / 1.0	4.4 / 0.7	4.1 / 0.7
Distal part of right renal vein	3.5 / 1.0	1.8 / 1.1	4.0 / 0.7	3.8 / 0.7