Evaluation of Venous Extension in Renal Cell Carcinoma Using a 2D Fat-Saturated Steady State Free Precession Sequence

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Purpose: Evaluation of abdominal-pelvic venous disease with MRI is widely accepted. Conventional contrast-enhanced 2D and 3D SPGR sequences are very accurate in detecting venous thrombus; however, given growing concerns regarding the use of gadolinium-based contrast media in patients with renal dysfunction, non-contrast techniques have become increasingly important. We investigated venous staging of 14 patients with renal cell carcinoma using an overlapping fat-saturated steady state free precession sequence, and compared the results with a more traditional contrast-enhanced 3D SPGR sequence.

Methods: 2D fsFiesta (**F**ast **I**maging **E**mploying **ST**eady-state **A**cquisition) is a fully balanced fat-saturated steady state coherent imaging pulse sequence designed to produce high SNR images at very short repetition times (TR). Both sequential overlapping 2D fsFIESTA images and dynamic contrast enhanced 3D SPGR (CE-LAVA (Liver Acquisition with Volume Acceleration)) images were acquired in 14 patients referred for MRI (1.5T Signa HDx GE Healthcare, Waukesha WI) for staging of renal cell carcinoma. 2D fsFIESTA sequence parameters included: TR 3.6 ms, TE 1.6 ms, flip angle 75, bandwidth 125 kHz, matrix 192x256, slice thickness 4-5 mm acquired at 3mm intervals, FOV 28-42 cm. Acquisition time was approximately 1 sec/image, and the number of images acquired per breath hold was adjusted according to the patient's breath holding ability. Sequences were evaluated in random order by two board certified radiologists experienced in abdominal MRI in a consensus review. Each sequence was evaluated for presence of thrombus in the renal veins and inferior vena cava (IVC), perceived contrast between blood pool and thrombus, presence and extent of artifact, and overall image quality on a scale of 1-5, where a score of 5 represents the optimal image in all cases. Additionally, sequences were ranked in order of preference for each case. The presence or absence of thrombus was noted and any discrepancies between sequences recorded.

Results: There was near complete agreement in venous staging between fsFIESTA and LAVA sequences (Fig. 1). In one discrepant case LAVA images were indeterminate, and fsFIESTA images were convincingly negative for involvement of the IVC (Fig. 2). In another discordant case, renal vein thrombus was seen on fsFIESTA images and not on LAVA images; and, in two cases both bland and tumor thrombus were identified in the IVC on LAVA images and only tumor thrombus on fsFIESTA images. There was no significant difference in the ratings for blood pool/thrombus CNR, artifacts, and overall image quality between fsFIESTA and LAVA images (Table 1). LAVA was the preferred sequence in 7 cases, and fsFIESTA was preferred in 7 cases.

Discussion: Venous staging of renal cell carcinoma in this cohort of patients using the fsFIESTA sequence was nearly identical to the 3D CE LAVA sequence. fsFIESTA images were preferred in 50% of cases, when LAVA images were degraded by motion artifact, and when contrast enhancement of the infrarenal IVC was limited. LAVA images were preferred for their superior spatial resolution and for their ability to distinguish tumor thrombus from bland thrombus. The fsFIESTA sequence is an attractive alternative for diagnostic evaluation of abdominal pelvic veins in patients who are not candidates for gadolinium-based contrast agents. Additionally, the rapid sequential acquisition of fsFIESTA images is less affected by respiratory motion artifacts, particularly in patients unable to suspend respiration.

Table 1.	CNR	Artifacts	Image Quality	Preferred Sequence
fsFIESTA	4.00±0.88	3.50±0.85	3.86±0.77	7/14
CE-LAVA	4.14±0.77	3.43±0.51	4.14±0.66	7/14
p value	0.77	0.70	0.42	

Table 1: There was no significant difference in the ratings for blood pool/thrombus CNR, artifacts, and overall image quality between fsFIESTA and LAVA images

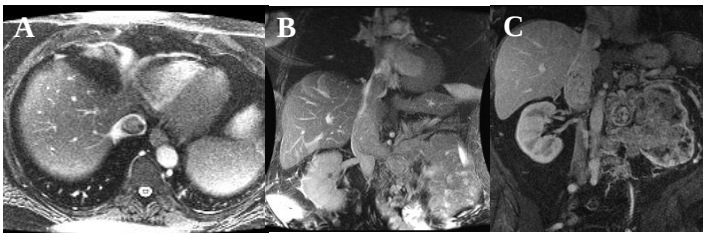

Figure 1: Axial (A) and coronal (B) fsFIESTA images in a patient with renal cell carcinoma and extensive thrombus in the renal vein and IVC. Coronal LAVA image (C) demonstrates similar findings.

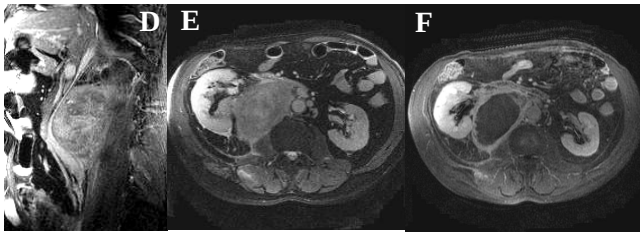

Figure 2: In this case, fsFIESTA images (D, E) were convincingly negative for tumor involvement of the IVC compared to LAVA images (F), which were indeterminate.