

## Comparison of non-contrast in-flow inversion recovery (Inhance) steady state free precession renal MRA at 1.5T and 3T

D. W. Stanley<sup>1</sup>, J. F. Glockner<sup>2</sup>, N. Takahashi<sup>2</sup>, S. L. Williams<sup>2</sup>, M. R. Wood<sup>2</sup>, N. Takei<sup>3</sup>, and S. Wei<sup>4</sup>

<sup>1</sup>GE Healthcare, Proctor, MN, United States, <sup>2</sup>Mayo Clinic, Rochester, MN, United States, <sup>3</sup>Applied Science Laboratory Japan, GE Yokogawa Medical Systems, Hino, Tokyo, Japan, <sup>4</sup>MR Engineering, GE Healthcare, Waukesha, WI, United States

**Purpose:** Contrast-enhanced MR Angiography (CE-MRA) is a widely accepted technique for evaluation of the renal arteries; however, recent concerns regarding the development of nephrogenic systemic fibrosis (NSF) after gadolinium contrast agent administration in patients with reduced renal function have emphasized the need for robust non-contrast MRA methods. One such technique is steady state free precession with in-flow inversion recovery (Inhance). In early evaluation, Inhance has produced accurate and reliable images of the renal arteries in a variety of patients at 1.5T. Inhance at 3T offers both potential advantages (improved SNR) and limitations (increased image artifact). We compared image quality and diagnostic accuracy of Inhance at 1.5T and 3T in a series of volunteers and patients.

**Methods:** Inhance is an angiographic method to utilize inflow effect during the inversion time of a slab inversion pulse (IR). The IR pulse was respiratory-triggered and applied to the image volume region. The pulse was designed to suppress signal from veins such as the inferior vena cava and from static tissues of kidneys and to avoid saturating upstream arterial blood from the heart and thoracic aorta. Data were acquired in an axial 3D volume that includes the renal arteries using a steady state free precession sequence (FIESTA). It provides high blood signal and T2-like contrast.

**Experiment:** An investigational version of the Inhance inflow IR pulse sequence was compared on both 1.5T and 3T MR scanners (GE Healthcare, Waukesha WI, USA) using the following protocols: 1.5T: TE/TR 2.0/4.0 msec, TI 200 msec, flip angle 70 degrees, receiver bandwidth 125kHz, FOV 30-42 cm, slice thickness 2 mm, number of view 56, imaging matrix 256x256, with parallel imaging acceleration factor 2, spectral spatial saturation pulse, and respiratory triggering. The protocol for 3T was identical with the following exceptions: TE/TR; 2.6/5.2 msec and TI 240 msec. 8 channel torso phased array coils were used for both field strengths. **Volunteer study:** Five normal volunteers with no known renal artery disease were evaluated on both 1.5T and 3T using the Inhance protocol. Two radiologists rated images by consensus for renal artery visualization, artifacts and overall image quality using a five-point scale (1 = uninterpretable; 5 = perfect image). CNR and SNR were measured for renal arteries. **Patient study:** 50 patients were evaluated on either 1.5T (n=34) or 3T (n=16) using the Inhance protocol. Two radiologists rated images by consensus for renal artery visualization, artifacts, and overall image quality using the criteria described above. Clinical data (age, gender, eGFR) were compared between patient groups who underwent 1.5T and 3T exams.

**Results:** Results of the volunteer study are summarized in Table 1 (Fig 1). Results of the clinical patient study are summarized in Table 2 (Fig 2 & 3). Patient age, gender and eGFR showed no statistical difference between 1.5T and 3T groups.

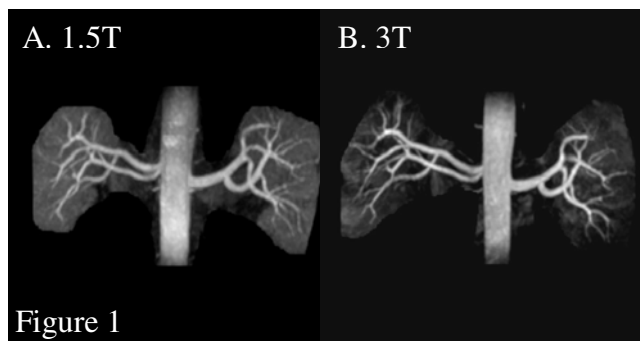
<b>Table 1</b>	1.5T	3.0T	p-value
Visualization	4.9	4.4	0.02
Artifacts	4.0	3.0	0.01
Overall IQ	4.0	3.5	0.18
CNR	21.7	30.1	0.00002
SNR	26.3	34.5	0.0002

**Table 1:** Results from volunteer study comparing Inhance at 1.5T and 3T

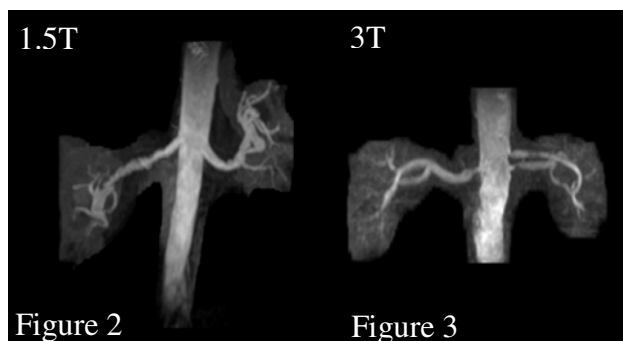
<b>Table 2</b>	1.5T	3T	p-value
Proximal RA visualization	3.9	3.7	0.21
Distal RA Visualization	3.5	3.5	0.75
Intra RA Visualization	3.1	2.9	0.44
Artifacts	3.7	3.1	0.02
Overall IQ	3.9	3.6	0.26

**Table 2:** Results from patient study comparing Inhance at 1.5T and 3T

**Discussion:** Results of the volunteer study showed slightly superior renal artery visualization at 1.5T relative to 3T. This is probably a reflection of the greater incidence of artifacts at 3T, despite higher CNR and SNR. The clinical study did not show significant differences in visualization of renal arteries between 1.5T and 3T, although artifacts were again more pronounced at 3T. The steady state free precession sequence (FIESTA) is known to be more susceptible to artifacts at higher field strengths due to field inhomogeneities, and this is the likely explanation for the greater degree of artifacts at 3T in our study. We noticed that artifacts were more severe near air-filled bowel loops or orthopedic devices in the spine. However, visualization of renal arteries was not significantly affected in the clinical study. Our preliminary results suggest that non-contrast renal MRA using Inhance can be performed effectively at both 1.5T and 3T for evaluation of patients with contraindications for gadolinium-based contrast agents.



**Fig. 1.** MIP images from Inhance renal MRA in a normal volunteer scanned at both 1.5T (A) and 3T (B).



**Fig. 2.** MIP images from Inhance renal MRA performed at 1.5T on a patient with fibromuscular dysplasia. **Fig. 3.** 3T Inhance MRA MIP image from patient with bilateral renal artery stenosis.