Non-Contrast-Enhanced Renal MRA using Inflow-Enhanced, Inversion-Recovery at 3T

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INTRODUCTION: Arterial hypertension is a widespread disease. Exclusion and evaluation of possible renal artery stenosis is a fundamental part of the diagnostic workup in patients with hypertension. Because of recent concerns over the association between gadolinium-based contrast material and nephrogenic systemic fibrosis (NSF), there has been a renewed interest in using non-contrast-enhanced MR angiography (NCE-MRA) techniques (1, 2). The purpose of this work was to evaluate the utility of an inflow-enhanced, inversion-recovery balanced steady state free precession (bSSFP) based non-contrast-enhanced MRA (NCE-MRA) method for assessment of renal arteries at 3T in patients with suspected renal artery stenosis (RAS) or with a history of renal artery transplant.

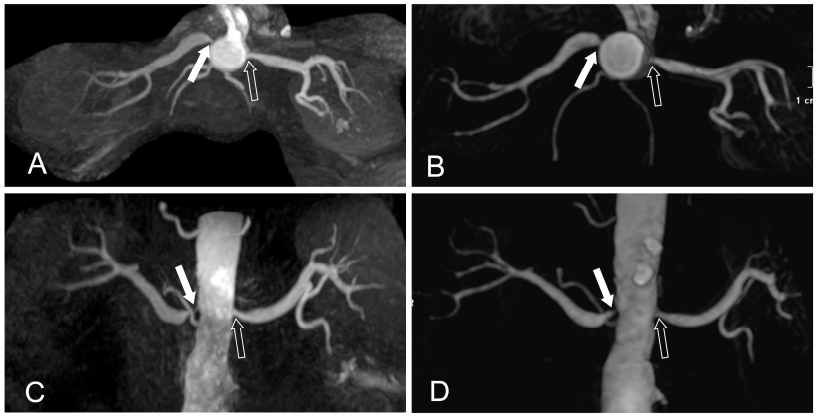

Figure 1. Maximum intensity projections of NCE MRA (A and C) and CE MRA (B and D) in a 79 year old male patient with severe renal artery stenosis on the right (arrows in A and C) and less severe renal artery stenosis on the left (light arrows in B and D). The extent and severity of the renal artery stenoses can be equally appreciated in both MRA techniques.

MATERIALS AND METHODS: Following institutional review board approval, 24 consecutive patients with suspected renal artery or renal transplant artery disease received NCE and CE-MRA at 3 Tesla. Parameters of the bSSFP based NCE-MRA sequence include: TR/TE/TI=5.1/2.5/1300msec, BW=±125kHz, FOV=340x272mm^2, 54 slices, matrix=256x256 with 2.0mm slices for true spatial resolution of 1.32x1.06x2.0mm^3, interpolated to 0.7x0.7x1.0mm^3, axial acquisition, scan time = 3:18min. CE-MRA (0.1mmol/kg Gd-BOPTA injected at 2.0ml/s) was performed according to standard clinical protocol for evaluation of the renal arteries. Images were reviewed independently in randomized order by 2 expert cardiovascular radiologists on a PACS workstation. CE-MRA was used as the reference standard and the CE-MRA studies were reviewed more than three months after reviewing the NCE-MRA studies. Reviewers graded the severity of the renal artery stenosis and assessed (A) the number of visible segmental renal artery branch vessels; (B) the overall image quality for the renal arteries, (C) the presence of noise, and (D) the presence of artifacts. Cohen's Kappa statistics was used to determine the degree of agreement between CE-MRA and NCE-MRA for grading renal artery stenosis. Wilcoxon signed-rank test was used to test statistical significance of differences in qualitative assessments between CE-MRA and NCE-MRA.

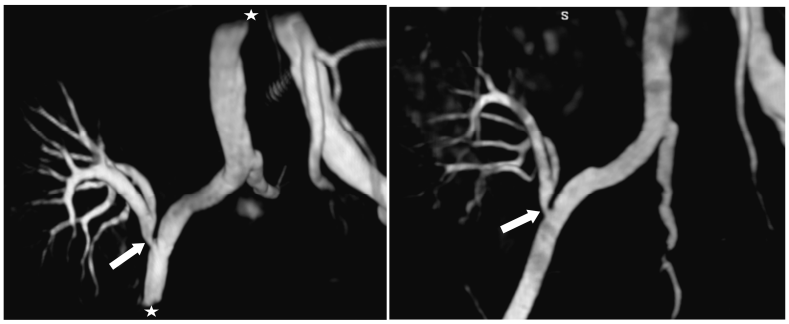

Figure 2. NCE MRA (A) and CE MRA (B) in a 73 year old male patient with moderate renal transplant artery stenosis (arrows in A and B). Note how the signal in NCE MRA vanishes in the cranial and caudal end of the image (asterisks in A) whereas arteries in CE MRA are "cut off". With the exquisite image appearance of NCE MRA images this may be the only discernible difference of CE MRA and NCE MRA.

RESULTS: NCE-MRA and CE-MRA images of renal vasculature and transplant renal vasculature were successfully obtained in all cases (Fig. 1,2). 18 accessory renal arteries and 3 renal transplant arteries were identified. Image quality was rated excellent in 75%, good in 12%, moderate in 8%, partially non-diagnostic in 0%, and non-diagnostic in 1 case. Third degree branch vessels were identifiable in 78%. There was no statistically significant difference between NCE-MRA and CE-MRA for these qualitative scores. Cohen's statistics revealed substantial agreement between CE-MRA and NCE-MRA with Kappa values of 0.45 and 0.49 for the two readers for assessment of renal RAS >50%. Inter-reader agreement was 0.73 for NCE-MRA and 1.0 for CE-MRA.

DISCUSSION: This study demonstrates the feasibility of the inflow-enhanced, inversion-recovery renal NCE sequence to evaluate renal arteries at 3T. The NCE-MRA sequence produced consistent results and demonstrated moderate agreement with CE-MRA for both readers. Substantial inter-observer agreement was found when reading the NCE-MRA studies as compared to almost perfect inter-observer agreement when reading the CE-MRA studies. With increasing experience in reading studies performed with this NCE-MRA technique the interobserver variability will presumable increase further. Further trials with higher incidence of RAS are warranted to further evaluate this technique.

REFERENCES: 1. Miyazaki M. et al., Radiology 2008;248:20-43 2. Potthast S. et al., MRI Clin North America 2008:16:573-84