MR Assessment of Renal Artery Stenosis compared to conventional X-ray Angiography: Clinical Experience in 134 patients

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Introduction: Contrast enhanced MRI is an attractive method for imaging renal artery disease because it is non-invasive, uses non-nephrotoxic contrast media, offers true three dimensional data that can be reformatted, and is a relatively simple procedure that entails minimum patient discomfort [1]. In addition, the phase contrast imaging can be used to assess the hemodynamic significance of the stenosis when present [2]. This has prompted the rigorous evaluation of the sensitivity and specificity of MRI as a diagnostic modality in assessing renal artery stenosis [1]. In this work, we present results from 134 patients imaged over a three year period who had both CE-MRA as well as XRA.

Materials and Methods:

MRI Imaging: All imaging was performed on a commercially available Philips 1.5T NT-Intera scanner using a 4-element surface coil array for signal reception. Specific CE-MRA acquisition parameters were: TR/TE/flip=5 msec/2 msec/40 deg; acquired voxel size: 1.14 – 2.3 x 1.14 – 2.3 x 2-4 mm before zero padded interpolation; 30-40 slices were acquired depending on patient anatomy and were reconstructed as 60-80 slices. A centric phase encoding order in k-space was used for data collection in all patients, and the data collection was initiated after confirming the arrival of the contrast bolus using real-time fluoroscopic monitoring. A gadolinium-chelate (0.2 mmol/kg) was administered and the patients held their breath at end-expiratory position during the acquisition. Following CE-MRA, an ungated 3D phase-contrast MR angiogram was collected with a velocity encoding value of 50 cm/sec along all three directions; two signal averages were acquired. The phase contrast imaging volume was positioned to cover the renal arteries visualized from the CE-MRA acquisition.

Patient Population: A total of 134 patients (68 male, age: 69.4 ± 10.7 years) were imaged over a three period. The mean difference between the CE-MRA procedure and XRA procedure was 49.7 ± 82.6 days. 106/134 patients (79%) had CE-MRA procedure prior to XRA.

Data analysis: Using both CE-MRA data and phase contrast imaging, the renal artery stenosis severity was assessed and graded on a score of 0 through 5: 0: 0% stenosis; 1: 1-25% stenosis; 2: 26-49%; 3: 50-70%; 4: 71-99%, and 5: 100%. The degree of stenosis in XRA was assessed using QCA by an experienced interventionalist blinded to MRI results. The MR images were transferred to a commercially available post-processing workstation and stenoses were graded by a CVMR radiologist blinded to XRA results by reviewing the source images as well as reformatted CE-MRA images.

Statistics: All results are reported as mean ± 1 sd. A p-value of < 0.05 was assumed to be statistically significant. The sensitivity and specificity of MR for diagnosing a main renal artery stenosis of > 50% was evaluated.

Results: A total of 253 renal arteries (126 right, and 127 left) were evaluated in MRI and a total of 259 renal arteries were evaluated in XRA (129 right and 130 left). A total of 249 main renal arteries were evaluated after excluding 19 renal arteries (7% of total) due to prior stenting, or lack of selective cannulation during angiography. Polar arteries and branches were excluded from the analysis. The average score for the degree of stenosis was 1.96 ± 1.67 for MR versus 2.07 ± 1.68 for XRA, and revealed good correlation between the two measurements ($r=0.84$, $p<0.001$). The sensitivity and specificity for diagnosing renal artery stenosis of > 50% was 90% and 91%, respectively. The positive and negative predictive values were 86% and 94%, respectively. Sensitivity and specificity for diagnosing renal artery stenosis > 70% was 91% and 78%, respectively.

Discussion: A main limitation of the study is the selection bias resulting in a high prevalence of significant renal artery disease (92% of patients with $\geq$1 RA with >50% stenosis). Despite high prevalence, the specificity for detecting RA stenosis > 50% was 91%.

Conclusion: MRI is an excellent, non-invasive diagnostic tool for assessing the presence of renal artery disease (defined as > 50% stenosis in the main renal artery) in patients suspected of renovascular disease using a combination of CE-MRA and phase contrast imaging with a sensitivity and specificity of 90% and 91%, respectively.

References:

1. Tan et al. Clinical Radiology 2002:57:617-24; 2.Schoenberg et al. Radiology 1997; 203:45-53