Renal Artery Stenosis: Semiquantitative Assessment of Perfusion Parameters with Gd-enchanced Magnetic Resonance SR-TurboFLASH Sequences

H. J. Michaely[1], S. O. Schoenberg[1], N. Oesingmann[2], C. Buhlig[1], J. Rieger[1], M. F. Reiser[1]

[1]Institute for Clinical Radiology, Klinikum Grosshadern, Munich, Germany, [2]Siemens Medical Systems, Erlangen, Germany

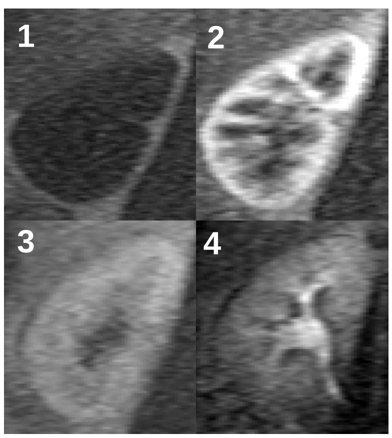
Purpose: Quantification of perfusion parameters with magnetic resonance imaging to assess the impact of renal artery stenosis on the parenchymal perfusion.

Materials and Methods: 89 kidneys in 46 Patients (18 to 81 years) with suspected renal artery stenosis (RAS) underwent MRA and renal MR-perfusion measurements on a 1.5T MRT system (Magnetom Sonata, Siemens Medical Solutions; Erlangen, Germany). The degree of stenosis ranged from 0 % to occlusion (no stenosis n=66/ low-grade stenosis n=11/ haemodynamically-significant stenosis n=12).
MR-perfusion measurements were done using an SR-TurboFLASH sequence (TR/ TE/ TI/ α/ Matrix /Slice thickness /Slices/ Averages/ Measurements/ Temporal Resolution - 254ms/ 1.04ms/ 131ms/ 256x110/ 8mm/ 4/ 1/ 350/ 1 image per second) with a bolus of 0.1 mmol/kg BW Omniscan® (Amersham Health, Little Chalfont, U.K.). A series of three 90° pulses in a phase angle of 90° was applied for magnetization preparation. Data were postprocessed using dedicated software (Siemens Medical Solutions) on a pixel by pixel basis with automated motion correction. Based on a Gamma variate fit, the mean transit time (MTT), maximal upslope steepness (MUS) and time to maximal signal intensity (Tmax) were calculated. The degree of renal artery stenosis was assessed by high-resolution MRA using a fast 3D-GRE sequence with parallel acquisition techniques (TR/ TE α/ Matrix/ Slab/ Slices per slab/ Voxel size - 3.79ms/ 1.39ms/ 512x410/ 1/ 80/ 1 x 0.8 x 1mm³). Statistical analyses were conducted using a Wilcoxon-test with Bonferoni correction for multiple comparisons.

Results: Significant differences in perfusion between healthy kidneys and kidneys with haemodynamically significant stenosis > 75% could be found in MTT ($p = 0.0007$) and Tmax ($p = 0.0014$). No difference could be found between healthy kidneys and those with stenosis without haemodynamic relevance <75%. The MUS did not show significant differences either. The high temporal resolution allowed exact tracing of the contrast bolus arrival. Segmental perfusion differences were detected in kidneys with segmental artery stenosis. Perfusion measurements could be performed without artefacts in all patients. No inflow-effects occurred due to the pulse train preparation. Good signal-to-noise ratio was obtained.

Conclusion: Semi-quantitative Gd-enhanced MR-perfusion measurements are able to detect the impact of RAS on the renal perfusion. The MTT yields more reliable results than the MUS which is commonly used in simple perfusion assessments. MR-perfusion measurements can complement MRA and MR-flow measurememts for a better differentiation of haemodynamically significant stenoses from those without compromised renal function. They may thus better define kidneys which may benefit from intervention.

A



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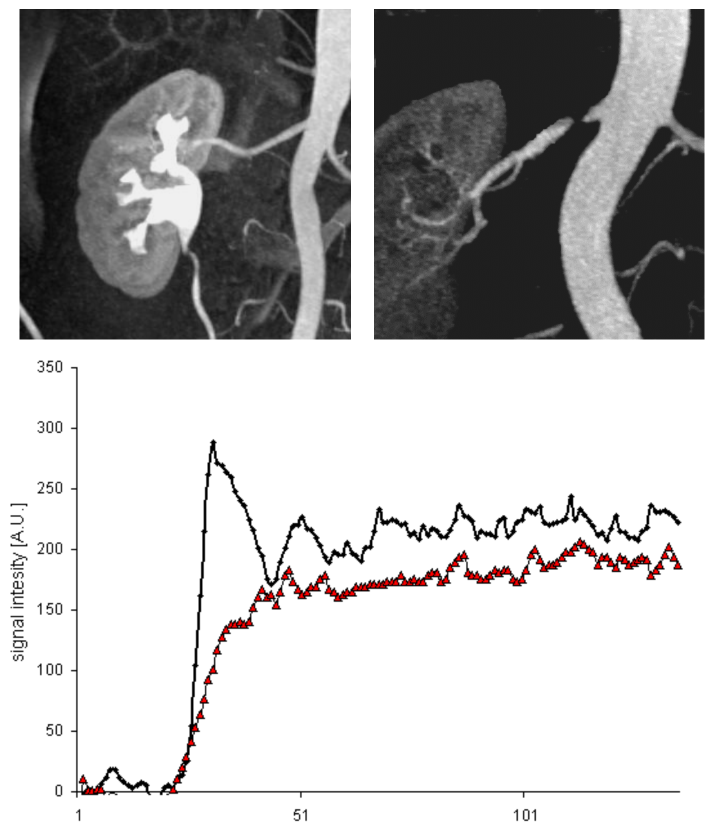

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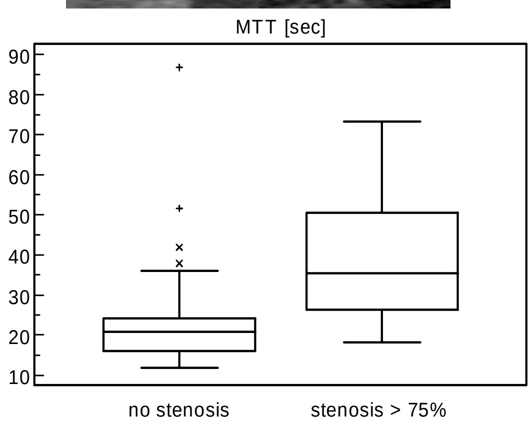

Figures: A Screenshots of the perfusion measurement showing: **1** – baseline before contrast agent arrival, **2** - cortical perfusion, **3** – medullary phase and **4** –excretory phase. **B** Perfusion curve of a healthy kidney without RAS (upper, black curve) and perfusion curve of a kidney with renal artery stenosis (lower, red curve). The curve of the kidney with RAS shows a lowered and delayed upslope and a lacking peak. MTT/MUS of the healthy kidney was 12.6s/33.1 whereas the MTT and MUS were 32.9s respectively 9.4 in the diseased kidney. **C** Box and Whiskers plot demonstrating the significant difference in MTT between healthy (left) and stenosed (right) kidneys.