Comprehensive Morphologic and Functional MR Assessment of Kidneys and Urinary Tract in Clinical Routine using a Novel MRI System with 32 Independent Reveiver Channels and iPAT

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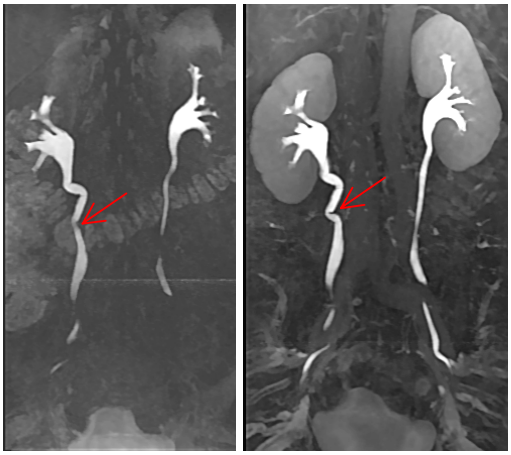
Introduction: For identifying impaired renal function and evaluating the underlying causes a comprehensive diagnostic work-up including renal morphology, perfusion and function as well as visualization of the entire urinary tract is necessary. MR imaging has the particular advantage to provide both high-resolution anatomical details and information about perfusion and function [1-3]. Moreover, the intravenous contrast agent Gd-DTPA, which is freely filtered by the glomerulus without tubular secretion or resorbtion, is neither nephrotoxic nor radioactive and shows a very low rate of unwanted side effects enabling examination and follow-up in a large number of patients with varying renal disease. Goal of this study was to implement a comprehensive MR protocol on a novel whole-body MRI system with 32 independent receiver channels utilizing iPAT technology.

Materials and Methods: Patient examinations were performed on a novel 1.5T whole-body scanner designed for complete head-to-toe coverage (MAGNETOM Avanto, Siemens Medical Solutions, Erlangen, Germany). The scanner provides 32 independent receiver channels with the option to simultaneously connect 76 array coil elements. For urographic studies a combination of the spine matrix coil with 8 clusters and the 2 body matrix coils with 4 clusters was used. Each cluster consists of 3 coil elements in left-right orientation. Renal morphology was evaluated using axial T1- weighted FLASH and T2w-weighted turbo-spin-echo MR imaging. Dynamic MR imaging was performed after 5 ml intravenous bolus injection of Gd-DTPA over a period of 7 minutes using a saturation recovery turbo-flash sequence (TR/TE=300ms/1.1ms; slice resolution 1.6mmx2.8mm; slice thickness 8mm; 200 repetitions). Renal cortex and medulla enhancement curves were analysed using software provided by the manufacturer. For MR urography a breath-hold 3D FLASH protocol with an iPAT acceleration factor of 2 (GRAPPA, [4]) was implemented (TR /TE=3.7ms/1.1ms; 400 mm FoV, slab thickness 115mm; base resolution 512 with 256 lines, 40 partitions with slice resolution of 2.88 mm and in-plane pixel size of 1.56mmx0.78mm; acquisition time < 16 sec). A large FoV in phase direction or phase oversampling was selected to limit wrap-over artifacts from the arms. The sequence was repeated several times after additional intravenous injection of 15 ml Gd-DTPA for multiphase MR angiography and MR urography. Up to now 12 patients with unilateral renal disease were included in the study: 8 patients with hydronephrosis due to different causes, 2 patients with renal cell carcinoma, 2 patients with cirrhosis of the kidney.



Results: The comprehensive MRI protocol was successfully performed in all patients with a total examination time of les than 1 hour. Information about renal perfusion and function as well as high resolution images of renal arteries, kidneys and the urinary tract could be recorded in all cases. Relative values of total kidney function could be determined easily by evaluating signal-time curves from regions-of-interests outlining both kidneys separately. iPAT for data acquisition enabled to acquire high-resolution MR images within comfortable breath-hold intervals of less than 16 sec. No signal-to-noise impairment of the image quality due to the iPAT reconstruction could be observed. Figure 1 shows a representative example of contrast enhanced 3D high-resolution MR urography.

Figure 1: 3D high-resolution MR urography after injection of 5 ml Gd-DTPA for dynamic MR imaging (left) as well as additional 15 ml Gd-DTPA for MR angiography (right) showing slight pelvic dilatation and a kink of the urether on the right (arrow).

Discussion: Comprehensive morphologic and functional evaluation of kidneys is feasible in clinical routine using the advanced coil technology and iPAT. Because T1-values of urine become significantly shorter than any other tissue of the body due to concentration of Gd-DTPA, kidneys and urinary tract can be imaged with high spatial resolution even after injecting a small amount of contrast agent. T1-weighted urography after intravenous Gd-DTPA administration has furthermore the advantage of reflecting excretory renal function as compared to static T2-weigthed MR-urography, which exclusively shows static images of the urinary tract.

References:

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