Clinical value of MR-based quantification of renal perfusion parameters with a separable two-compartment model

U. Attenberger[1], H. Michaely[2], S. Sourbron[3], M. Notohamiprodjio[3], C. Glaser[3], M. Reiser[3], and S. Schoenberg[2]

[1]Institute of Clinical Radiology, University Hospitals Grosshadern, Ludwig-Maximilians University Munich, Munich, Germany, [2]Insitute of Clinical Radiology, University Hospital Mannheim, University of Heidelberg, Germany, [3]Institute of Clinical Radiology, University Hospitals Grosshadern, Ludwig-Maximilians University Munich, Germany

Background

So far, there is no ideal technique for direct measurement of renal function. Most commonly used laboratory tests like the determination of serum creatinine level and endogenous creatinine clearance reflect renal perfusion and filtration only indirectly. MR-based determination of renal functional values has received increasing interest in the literature over the last years [1,2]. The combination of MR angiography and MR perfusion (MRP) measurements offers a promising method for detection of macrovascular and microvascular renal renal disease in a single exam. The aim of this study was to evaluate the combined diagnostic accuracy of a MR-based quantification of renal functional parameters in combination with high-spatial resolution MRA in comparison to the final clinical diagnosis.

Material and methods

After IRB approval and informed consent 25 patients (12w/ 13m, mean age 52.8±14.4 years) underwent combined renal exam including a renal MRA and renal perfusion measurements on a 3.0T MR-system (Siemens Magnetom Tim Trio). MR perfusion imaging was performed with a SR-TurboFLASH sequence and a temporal resolution of 5 slices/s after intravenous bolus injection of 7 ml Gd-BOPTA (Multihance®, Bracco) at 4 ml/s. The sequence parameters of the 3D MRA sequence were: TR/ TE [ms] 3.11/ 1.09, flip angle 23º, bandwidth [Hz/Px] 510, matrix 512x85%, FOV [mm^2] 400x81.3%, phase oversampling [%] 8, interpolated slice thickness 0.9 [mm], voxel size [mm^3] 0.65, spatial resolution [mm^3] 0.9x0.8x0.9, scan time [s] 19. The sequence parameters of the SR-TurboFLASH sequence were: TR / TE/ TI [ms] 203/0.90/101, flip angle 12º, bandwith [Hz/Px] 900, matrix 192x134, FOV[mm^3] 450x373, temporal resolution [slice/s] 5, parallel imaging GRAPPA 2. MR perfusion measurements were analyzed with a two-compartment model, from which the quantitative renal first pass perfusion parameters: F_P (plasma flow) characterizing the first pass perfusion was used for further analysis. A F_P which was more than one standard deviation below the mean value was considered as pathologic. The presence of pathologic findings was assessed by two radiologists on the MRA source data. Patients were either classified as healthy or ill. Patient-based sensitivity, specificity, and diagnostic accuracy of MR perfusion imaging and MR angiography were calculated based on final clinical outcome data as standard of reference.

Results:

Based on the clinical outcome data 15 patients were classified as ill (3 patients with renal artery stenoses, 5 patients with renal insufficience in compensated retention, 7 patients after renal transplantation with postoperative complications). MRA alone had a sensitivity of 73% and specifity of 90%. With MRA 4 patients with renal parenchymal affections were classified as false negative. MRP reached a sensitivity of 100% and a specifity of 70% respectively. In contrast to MRA, the 4 patients with renal parenchymal affections were correctly detected. In contrast, 3 healthy patients were wrongly classified as positive with MRP. In combination MRA and MRP revealed a sensitivity of 100% and specifity of 90%. Vascular and parenchymal pathologies were detected correctly in 15 out of 15 patients by using this combined MR imaging protocol. Particularly patients with renoparechymal diseases could be additionally correctly classified as ill by the MRP.

Conclusion

We could show that the combined approach of MRP and MRA increases overall diagnostic accuracy. The combination of MRA and MRP offers appealing possibilities to assess and probably also to differentia renovascular and renoparenchymal diseases highly sensitive and specific in a single exam.

References

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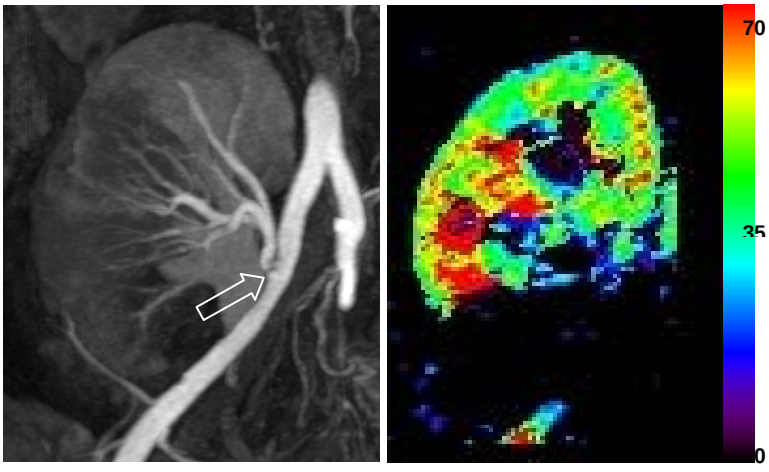

a **b**

Figure 1(a, b) - These figures show a case of a 20 year old female patient after renal transplantation, which develops a significant stenosis of the graft artery (arrow). In consequence a defective area on the caudal pole of the renal graft is seen (**a**). The perfusion map of this kidney shows corresponding to the renal MRA a low perfused area on the caudal pole of the renal graft (**b**).