Renal BOLD-MRI does not reflect renal function: a prospective study in 368 patients

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Introduction:

Renal blood oxygen level-dependent (BOLD) magnetic resonance imaging allows to non-invasively monitor changes of cortical and medullary renal oxygen concentration. BOLD-MRI has been employed to differentiate transplant kidneys with allograft rejection or acute tubular necrosis from normal transplants[1, 2]. No studies have examined the association of R2*-values measured with BOLD-MRI and various factors such as patient's age, gender and renal function. Therefore the aim of this prospective study was to investigate whether the BOLD-derived R2*-values are dependent of the patients' age, gender and renal function.

Methods and Materials

In this IRB approved study 368 consecutive patients (237 @ 1.5T Siemens Avanto, 131 @ 3T Siemens TimTrio) scheduled for abdominal imaging underwent transversal BOLD-measurements with a multi-echo GRE with 12 echo times (TR=106ms, TE=5-33ms, 1.4x1.4x4mm³ spatial resolution, PAT 2). For these patients serum creatinine levels were available for 246 patients (164 @ 1.5T and 84 @ 3T). Using the OsiriX 3.7 software T2*-maps were generated in which regions of interest were placed in the medulla and cortex of the left and right kidney by one blinded reader. R2* was calculated as R2*=1/T2*. Individual R2*-values were correlated to the patients eGFR (MDRD), age and gender for 1.5T and 3.0T separately. In addition the patients were classified according to their renal status of chronic kidney disease (CKD) according to the National Kidney Foundation system. T-tests were performed to test for statistical differences.

Results:

Measured R2* values at 3.0T were on average 50% higher than at 1.5T ($p<0.0001$). At both field strengths no differences in R2* of cortex and medulla were found between male (R2* medulla 22.6s^{-1} at 1.5Tl) and female (22.3s^{-1}) patients ($p>0.05$). At both field strengths, there was no correlation of the R2*-values of cortex and medulla with patients age ($r=0.02$) or with the eGFR ($r=0.007$, Figure 1). No statistically significant differences in R2* were found between the different CKD-stages (medullary R2* range 27-33s^{-1} at 3T and 21-22s^{-1} at 1.5T, $p>0.05$) while there was a slight trend towards higher medullary and cortical R2*-values with impaired renal function.

Conclusion:

BOLD MRI is capable to determine regional changes in oxygenation but fails to discriminate between patients with various CKD-stages most likely due to superimposed external factors such as degree of hydration, medications and renal perfusion. R2*-values for women and men are comparable and not age dependent. In view of these results, a large-scale clinical application of renal BOLD-MRI to assess renal function needs to focus on pharmacodynamic studies with assessment of intraindividual changes[3].

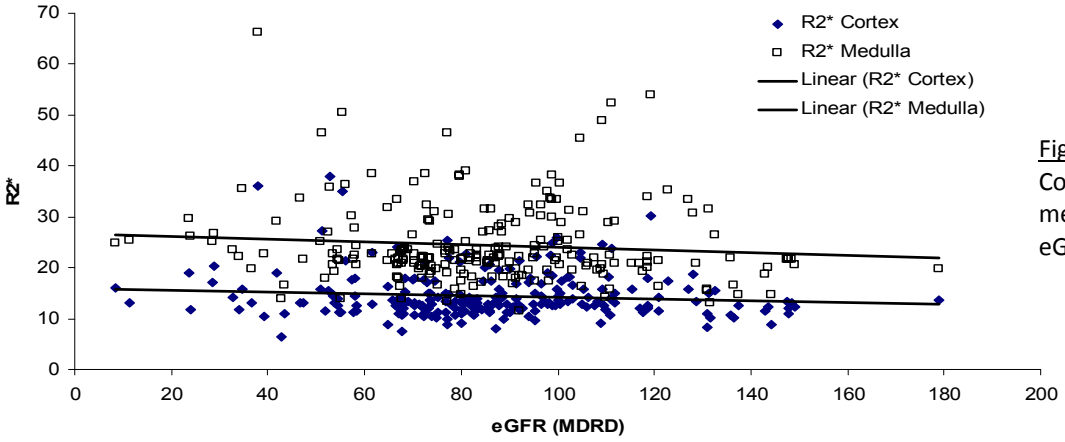

Figure 1:
Correlation between cortical and medullary R2*-values and the eGFR (1.5T and 3T data)

References

1. Sadowski EA et al. *Radiology* 2005
2. Djamali A et al. *Am J Physiol Renal Physiol* 2007
3. Prasad PV, et al. *Kidney Int 1999*