Acute Ureteral Obstruction: Monitoring Treatment by Blood Oxygenation Level-Dependent MRI

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Introduction:

Blood Oxygenation Level-Dependent (BOLD) MRI yields the relaxation rate R2*, which is inversely related to tissue pO_2, assuming that all other factors are kept constant [1]. A recent BOLD MRI study demonstrated reduced R2*, indicating increased oxygen content, in renal cortex and medulla of patients with acute unilateral ureteral obstruction, suggesting reduced function of the affected kidney [2].

The aim of this study was to determine prospectively whether BOLD-MRI is able to monitor response to treatment by assessing changes in intrarenal oxygenation after release of ureteral obstruction.

Subjects and Methods:

Thirteen male and one female patients (age: 46±16years) with unilateral acute flank pain due to a distal ureteral calculus diagnosed by unenhanced CT underwent BOLD-MRI of the kidneys on a 1.5 Tesla MR-unit at admission to the hospital and at a mean time of 3 months (range: 1-6 months) after successful stone treatment.

Coronal BOLD-MRI was performed using a mGRE-sequence with 12 different TE (6-52ms), TR=65ms, FOV=40x40cm^2. Total examination time including three morphological sequences was 15 minutes. R2* was calculated and circular ROIs were delineated in cortex and medulla separately for the obstructed and the non-obstructed kidney.

For statistical analysis a non-parametric Wilcoxon signed rank test was employed for paired samples comparing the affected with the unaffected kidney during acute ureteral obstruction and after release of ureteral obstruction.

Results:

During acute obstruction, R2* was significantly reduced in the medulla ($p<0.001$) and in the cortex ($p<0.001$) of the affected kidney compared to the contralateral non-obstructed kidney suggesting increased oxygenation levels during obstruction (Fig.1). After release of ureteral obstruction by successful stone treatment, R2* increased significantly in the previously obstructed kidney from 11.9±2.2 to 16.7±1.2 in medulla ($p<0.001$) and from 10.6±0.8 to 12.2±0.7 in cortex ($p<0.001$) to values similar to those found in the non-obstructed kidneys (Fig.2). Thus, following release of ureteral obstruction, the oxygenation of the obstructed kidney turned back to normal.

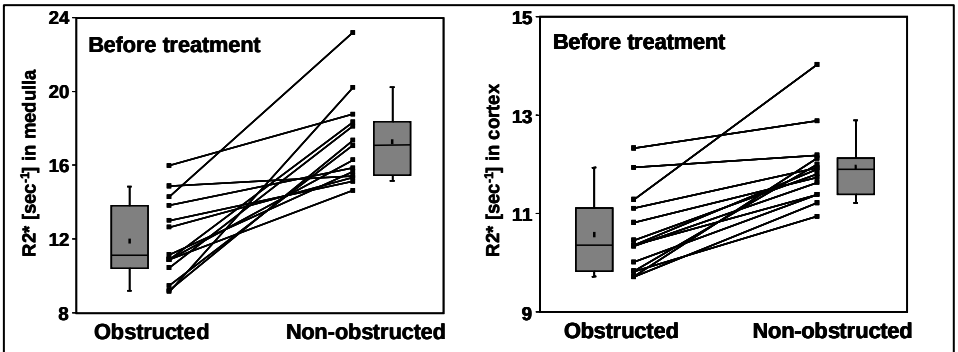

Fig 1: R2* before treatment in medulla and cortex of the obstructed kidney versus the contralateral non-obstructed kidney.

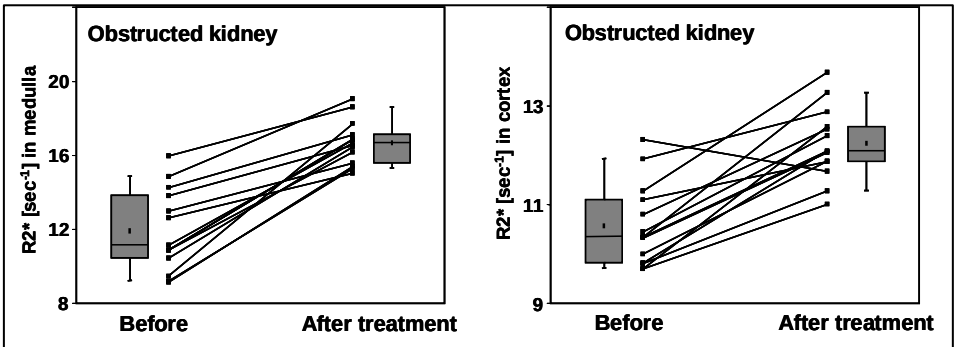

Fig 2: R2* of the obstructed kidney in medulla and cortex before treatment versus after treatment.

Discussion/Conclusion:

BOLD-MRI has the potential to non-invasively assess changes in intrarenal oxygenation indirectly via changes in R2* during acute obstruction and its normalization after successful treatment. This method might therefore be helpful to determine the need of intervention in patients with acute ureteral obstruction and to monitor response to treatment.

References:

1. Prasad PV, et al. Circulation 94:3271 (1996)
2. Thoeny HC, et al. Radiology 47:754 (2008)

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