Blood Oxygen Level-Dependent (BOLD) MRI of Diabetic Nephropathy

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Introduction: Previously it has been shown that Blood Oxygen Level-Dependent (BOLD) MRI has potential to assess renal function [1]. Two previous studies evaluated the intrarenal oxygenation as measured by BOLD MRI in patients with mild diabetes without overt nephropathy [2,3]. These investigators did not find any differences in baseline renal oxygenation between the diabetic patients and healthy controls. Recently, Zhen JW et al. showed that the medullary R2* values were lower in patients with diabetic nephropathy compared to healthy volunteers. However, none of the published studies examined intrarenal oxygenation in patients with diabetic nephropathy [4]. The purpose of our study was to evaluate BOLD MRI in patients with diabetic nephropathy.

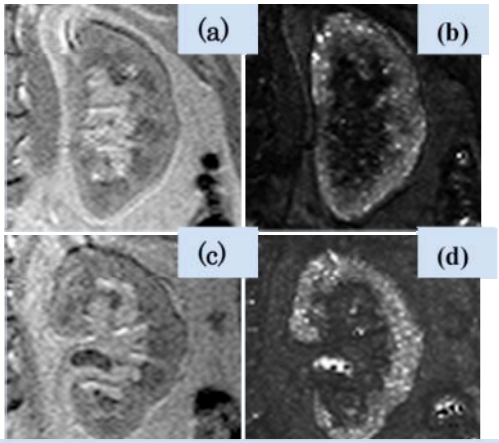


Fig. 1 53-year-old-woman and eGFR=22.14 ml/min/1.73 m^2 (a) (b) and 71 year-old-man and eGFR=20.04 ml/min/1.73 m^2 (c)(d)

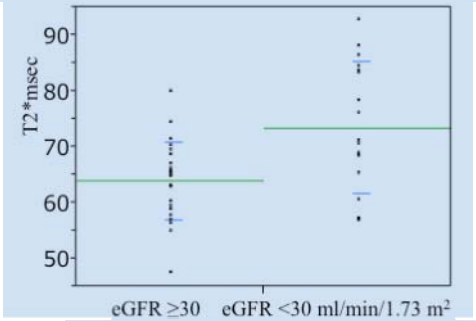
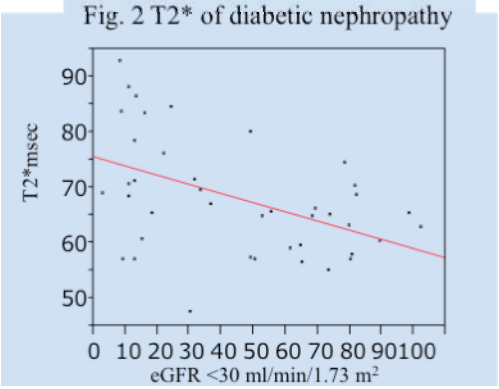


Fig. 2 T2* of diabetic nephropathy



Materials and Methods: Forty consecutive patients of diabetic nephropathy (29 male, 11 female, age=60.6±10.6, range=32y-85y) were on a 1.5T whole-body MR scanner (Siemens Sonata, Erlangen, Germany). BOLD MRI was performed with a multiple gradient-recalled eco sequence at TE = 4.76, 9.53, 14.3, 19.1, 23.8, 28.6, 33.3, 38.1, 42.9, 47.6, 52.4 and 57.2 msec. Twelve T2*-weighted images corresponding to the 12 different gradient echoes were acquired with 26-second breath holds. The imaging parameters were TR= 500m sec, a field of view of 40x40cm^2, matrix= 256x256, slice thickness=5 mm, flip angle=30 degree and three coronal slices. Six regions of interest (ROI) per patient were placed in both renal medulla and cortex separately. Patients were divided by using estimated glomerular filtration rate (eGFR) into 2 groups: eGFR ≥30 (n = 21) and eGFR <30 (n = 19) ml/min/1.73 m^2. Mean T2* values and eGFRs were compared between these groups of diabetic subjects by unpaired t-test ($p<0.05$). T2* values vs. eGFRs were analyzed by linear regression using commercially available software (JMP, SAS Institute Inc.).

Results: Typical in-phase T1 weighted image and BOLD MRI were shown as Fig. 1. The mean medullary T2* values were higher in patients with diabetic nephropathy of eGFR <30 compared to diabetic nephropathy of eGFR ≥30 (73.4±11.4 vs. 63.9±7.0, p=0.006) (Fig.2). The cortical T2* values were not significantly different between the two groups (70.8±7.1 vs. 74.5±10.7, p=0.7). Medullary T2* correlated significantly with eGFR ($R = 0.48$, $p < 0.05$), however the cortical T2* showed no significant correlations (Fig.3).

Discussion & Conclusions: Renal BOLD MRI can be performed within acceptable scan times and provides comprehensive information including changes in intrarenal oxygenation. We showed increased medullary T2* values in patients with diabetic nephropathy of eGFR <30 compared to eGFR ≥30. These findings could show higher medullary T2* values suggesting higher oxygenation in our patients with severe diabetic nephropathy. Further mudullary T2* could serve as biomarkers to identify diabetics at risk of diabetic nephropathy progression. In conclusion, this study suggests that changes in medullary BOLD MRI may serve as indicators of diabetic nephropathy.

References

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