NON-INVASIVE ASSESSMENT OF THE WHOLE KIDNEY BY MOLLI T1 MAPPING IN CHRONIC KIDNEY DISEASE PATIENTS

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Introduction

Chronic kidney disease (CKD), defined as kidney injury and/or loss of kidney function is a significant worldwide health problem with increasing medical cost as the disease worsens. There is an important need of non-invasive biomarkers to monitor, in situ, the CKD evolution. In this study, we investigated a Modified Look-Locker Inversion Recovery (MOLLI) T1 mapping sequence in CKD patients. We hypothesized that a MOLLI T1 mapping sequence would enable the difference between healthy volunteers and CKD patients.

Methods

20 healthy volunteers (age 28±4 years) without known diseases and 36 CKD patients (age 54±14 years) including 33 transplanted and 3 native kidneys with a wide range of percentage of fibrosis (up to 80%, average 33±26%) and eGFR (range 10-88ml/min/1.73m^2, average 31±2488ml/min/1.73m^2) with were scanned at 3T on a MR Siemens Magnetom Trio Tim system. The MR parameters of the MOLLI T1 mapping sequence were: six coronal-oblique slices of 5mm covering the kidney with a resolution of 2×2×5mm, a TR/TE of 711/1.09ms, an echo spacing of 2.6ms, a flip angle of 35°, three inversion times of 161, 241, 321 ms and a bandwidth of 930 Hz/pixel. Each inversion-recovery image was acquired in free breathing. Quantitative T1 motion corrected maps were automatically generated on a voxel-by-voxel basis. Image analysis was done on an external workstation using OsiriX 5.5.2 (©Pixmeo Sarl, OsiriX Open source http://www.osirix-viewer.com/). Regions-of-interest (ROIs) were positioned in the upper, middle and lower pole of the kidney. The cortex and medulla were analyzed separately. Statistical analysis was carried out using one-way analysis of variance (ANOVA) with post-hoc Bonferroni (SPSS software, version 21.0; Chicago, Illinois, USA). A value of $p < 0.05$ was taken as statistically significant.

Results

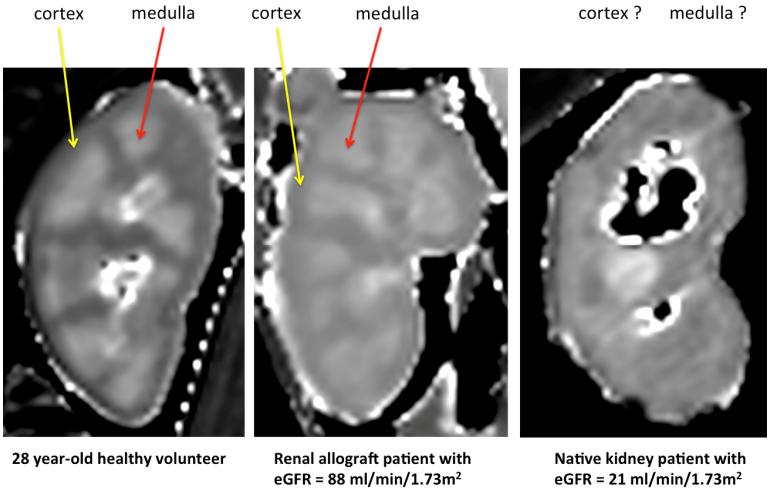

Figure 1 *Comparison of cortico-medullary difference with coronal T1 map of the kidneys at the same window level. In healthy volunteer, the cortico-medullary difference is clearly well delineated. The 2nd image shows the T1 map of a transplanted kidney (eGFR = 88ml/min/1.73m^2) of 52 year-old male. The cortico-medullary contrast is still well defined. However, in the right hand image, native kidney of a 58 years old female (eGFR = 21ml/min/1.73m^2), this difference is absent.*

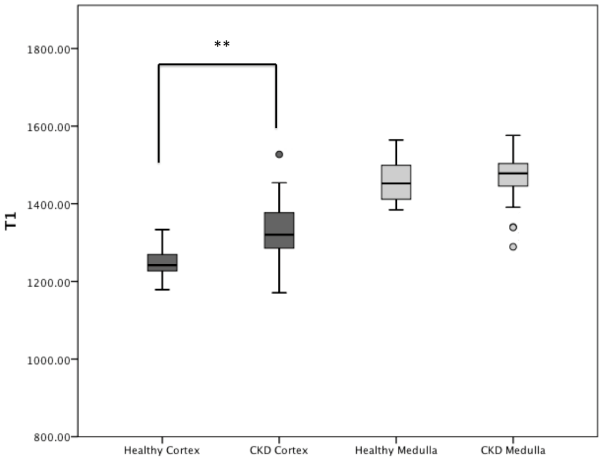

Figure 2 *Box plot illustrating the difference in mean T1 [ms] between the cortex and medulla with the MOLLI sequences. Data were obtained in both kidneys in 20 volunteers and in transplanted and native kidney patients, with P<0.001 (**). A highly significant difference is revealed between the cortex of healthy volunteers and patients.*

Figure 1 shows the in vivo images of healthy volunteer and two CKD patients. These images illustrate the change in cortex T1, and the lack of change in medulla T1, with the cortico-medullary contrast diminishing with increasing disease state. In patients with a poor renal function, the cortico-medullary difference was less pronounced, as show in figure 1, with the example of a native kidney patient with eGFR = 21ml/min/1.73m^2 who suffers from diabetic and vascular nephropathy that have resulted in 75% of fibrosis. The cortico-medullary difference was significantly higher (P<0.001) in healthy volunteers than in patients with in average 201 ± 57 in healthy volunteers and 139 ± 52 in patients.

Figure 2 shows the mean T1 [ms]. Values measured in all healthy volunteers were 1247 ± 35 for the cortex and 1458 ± 51 for the medulla, and for the patients it was 1331 ± 71 for the cortex and 1469 ± 65 for the medulla. The cortical T1 (p<0.001) but not the medulla T1 (p=0.236) allows differentiation of CKD from healthy volunteers.

Discussion and Conclusions

This study has demonstrated the ability of free breathing MOLLI T1 motion corrected map for distinguishing between normal kidneys from CKD patients. Our preliminary results justify further clinical studies on the use of MOLLI T1 mapping in kidney patients.