T₁ρ mapping for assessment of fibrosis in renal allografts

Stefanie Hectors¹,², Octavia Bane¹,², Paul Kennedy¹,², Fadi El Salem³, Madhav Menon⁴, Maxwell Segall¹,², Rafael Kham¹,⁴, Veronica Delaney⁴, Sara Lewis¹,², Bachir Taouli¹,²

¹Radiology, ²TMII, ³Pathology, ⁴Recanati/Miller Transplantation Institute, Icahn School of Medicine at Mount Sinai

INTRODUCTION

• Renal fibrosis, associated with the deposition of collagen in the cortical interstitial space, is considered an important predictor for allograft prognosis and can be used to adapt treatment.

• T₁ρ mapping, which is sensitive to the interactions between water molecules and macromolecules including collagen, may be a suitable MRI technique for noninvasive assessment of renal fibrosis.

• While T₁ρ has shown to be sensitive to the degree of fibrosis in the liver¹,², there are no reports in which T₁ρ is assessed as potential biomarker for prediction of fibrosis in the kidney.

Objective:

To investigate the utility of T₁ρ MRI for the assessment of fibrosis in renal allografts.

METHODS

• Prospective IRB-approved single center study

  28 patients with renal allografts
  1 patient excluded (unstable allograft function)
  27 included patients
  15 patients with stable allograft function M/F 9/6, mean age 56 y (28–68y)
  Average GFR 71.1 (50.1–108) ml/min/1.73 m²
  12 patients with chronic allograft dysfunction and biopsy-confirmed fibrosis M/F 6/6, mean age 51 y (27–69y)
  Average GFR 30.1 (11.3–68.3) ml/min/1.73 m²

• T₁ρ mapping at 1.5T during 4 x 10 s breath holds in a single coronal slice
  - Spin-lock prepared FLASH sequence
  - Spin-lock strength 500 Hz
  - Spin-lock time 4.8, 9.6, 19.2, 38.4 ms
  - Repeatability of T₁ρ measurement, as determined by coefficient of variation (CV) measurements, was tested in 4 patients (time between scans 17-45 days)
  - Average T₁ρ values in ROIs in renal cortex and medulla recorded
  - In 16 patients who had renal biopsy within 1 year of the MRI exam, collagen content was assessed by quantitative analysis of Masson’s trichrome stained sections.
  - Statistical analysis
    - Mann-Whitney U tests to assess differences in T₁ρ between stable and fibrotic allografts
    - ROC analysis to determine diagnostic performance of T₁ρ for differentiation between functional and fibrotic allografts
    - Spearman correlation analysis to determine association of T₁ρ with estimated glomerular filtration rate (eGFR) and histopathological collagen measurement

RESULTS

• T₁ρ measurements were more repeatable in the cortex than in the medulla (mean CV T₁ρ cortex 7.4%, medulla 13.3%).

• While T₁ρ values in the medulla were not significantly different between functional and fibrotic allografts, significant differences were observed in the cortex (Fig. 1).

• Representative T₁ρ maps and Masson’s trichrome images and segmentations of functional and fibrotic allografts are shown in Fig. 2.

• Cortical T₁ρ measurements were significantly negatively associated with eGFR (Fig. 3A) and significantly positively associated with Masson’s trichrome stained fractions (Fig. 3B).

CONCLUSIONS

• In this preliminary study, we observed significant elevation of cortical T₁ρ in fibrotic renal transplants.

• The significant correlation between cortical T₁ρ and Masson’s trichrome stained fraction suggests a direct association of cortical T₁ρ with collagen content.

REFERENCES