

T_{1ρ} mapping for assessment of fibrosis in renal allografts



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INTRODUCTION

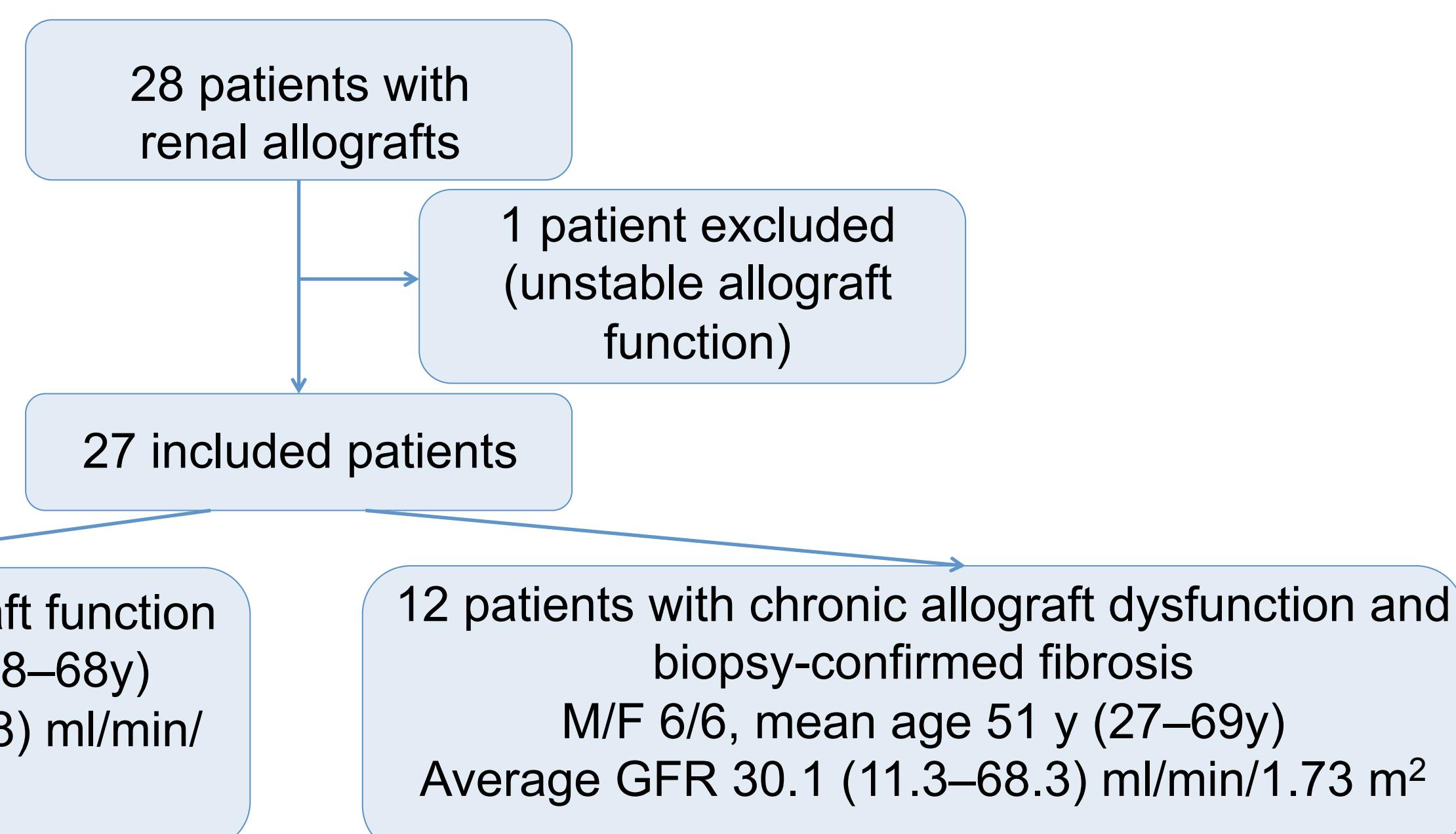
- Renal fibrosis, associated with the deposition of collagen in the cortical interstitial space, is considered an important predictor for allograft prognosis and can be used to adapt treatment.
- T_{1ρ} mapping, which is sensitive to the interactions between water molecules and macromolecules including collagen, may be a suitable MRI technique for noninvasive assessment of renal fibrosis.
- While T_{1ρ} has shown to be sensitive to the degree of fibrosis in the liver^{1,2}, there are no reports in which T_{1ρ} is assessed as potential biomarker for prediction of fibrosis in the kidney.

Objective:

To investigate the utility of T_{1ρ} MRI for the assessment of fibrosis in renal allografts.

METHODS

- Prospective IRB-approved single center study



- T_{1ρ} 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 T_{1ρ} measurement, as determined by coefficient of variation (CV) measurements, was tested in 4 patients (time between scans 17-45 days)
- Average T_{1ρ} 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 T_{1ρ} between stable and fibrotic allografts
 - ROC analysis to determine diagnostic performance of T_{1ρ} for differentiation between functional and fibrotic allografts
 - Spearman correlation analysis to determine association of T_{1ρ} with estimated glomerular filtration rate (eGFR) and histopathological collagen measurement

RESULTS

- T_{1ρ} measurements were more repeatable in the cortex than in the medulla (mean CV T_{1ρ} cortex 7.4%, medulla 13.3%).
- While T_{1ρ} values in the medulla were not significantly different between functional and fibrotic allografts, significant differences were observed in the cortex (**Fig. 1**).
- Representative T_{1ρ} maps and Masson's trichrome images and segmentations of functional and fibrotic allografts are shown in **Fig. 2**.
- Cortical T_{1ρ} measurements were significantly negatively associated with eGFR (**Fig. 3A**) and significantly positively associated with Masson's trichrome stained fractions (**Fig. 3B**).

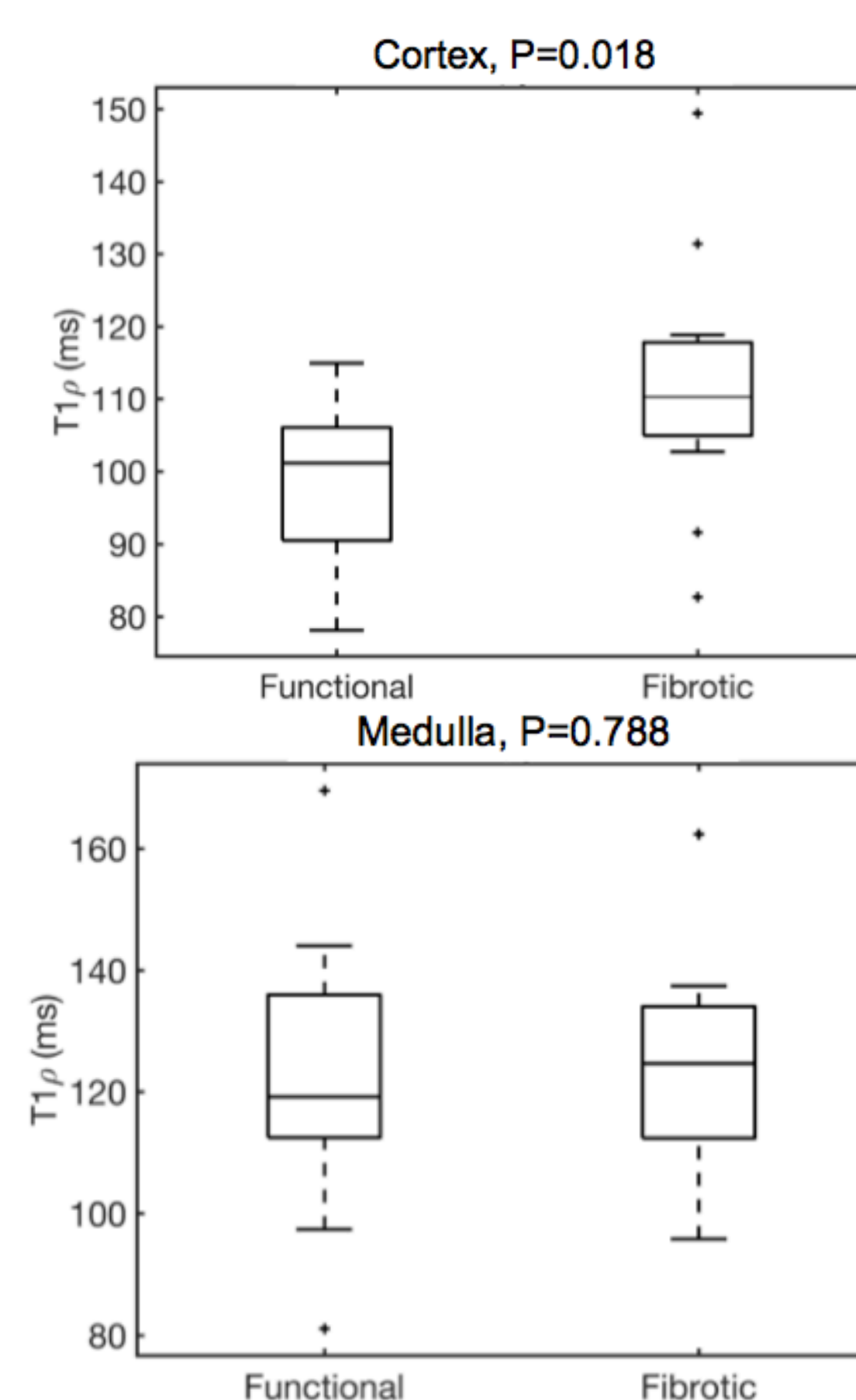


Figure 1. Boxplots of T_{1ρ} values in the renal cortex (top) and medulla (bottom) of functional (n=15) and fibrotic (n=12) allografts.

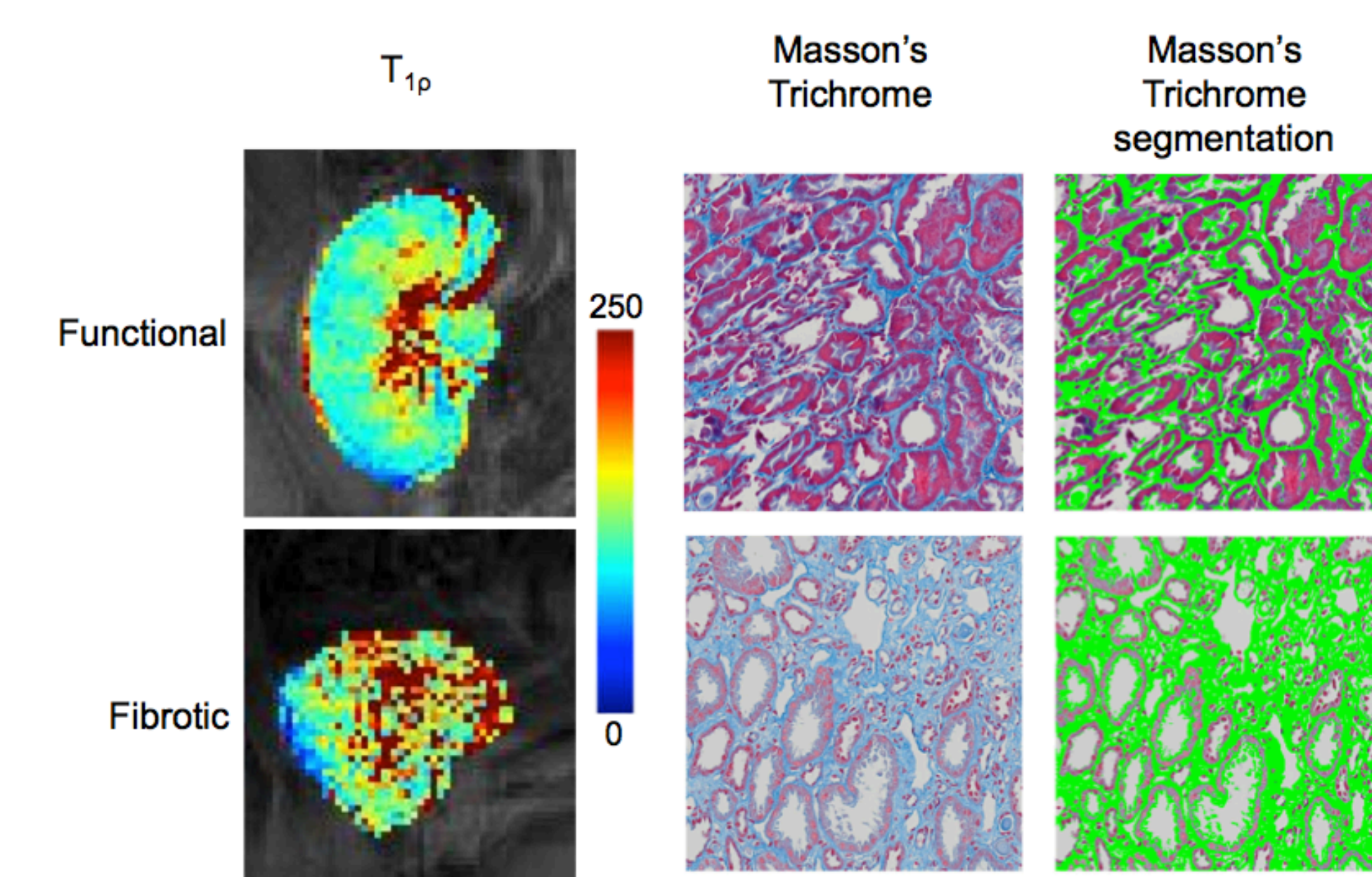


Figure 2. T_{1ρ} maps in the kidney and Masson's trichrome processing. *Top* 55 year-old female patient with functional kidney allograft (eGFR=87.4 ml/min/1.73 m²). Cortical and medullary T_{1ρ} values were 101 and 120 ms, respectively. The stained fraction derived from the Masson's trichrome stained section was 0.48. *Bottom* 59 year-old female with fibrotic renal allograft (eGFR=29.8 ml/min/1.73 m²). Cortical and medullary T_{1ρ} values were 131 and 132 ms, respectively. The stained fraction derived from the Masson's trichrome stained section was 0.66.

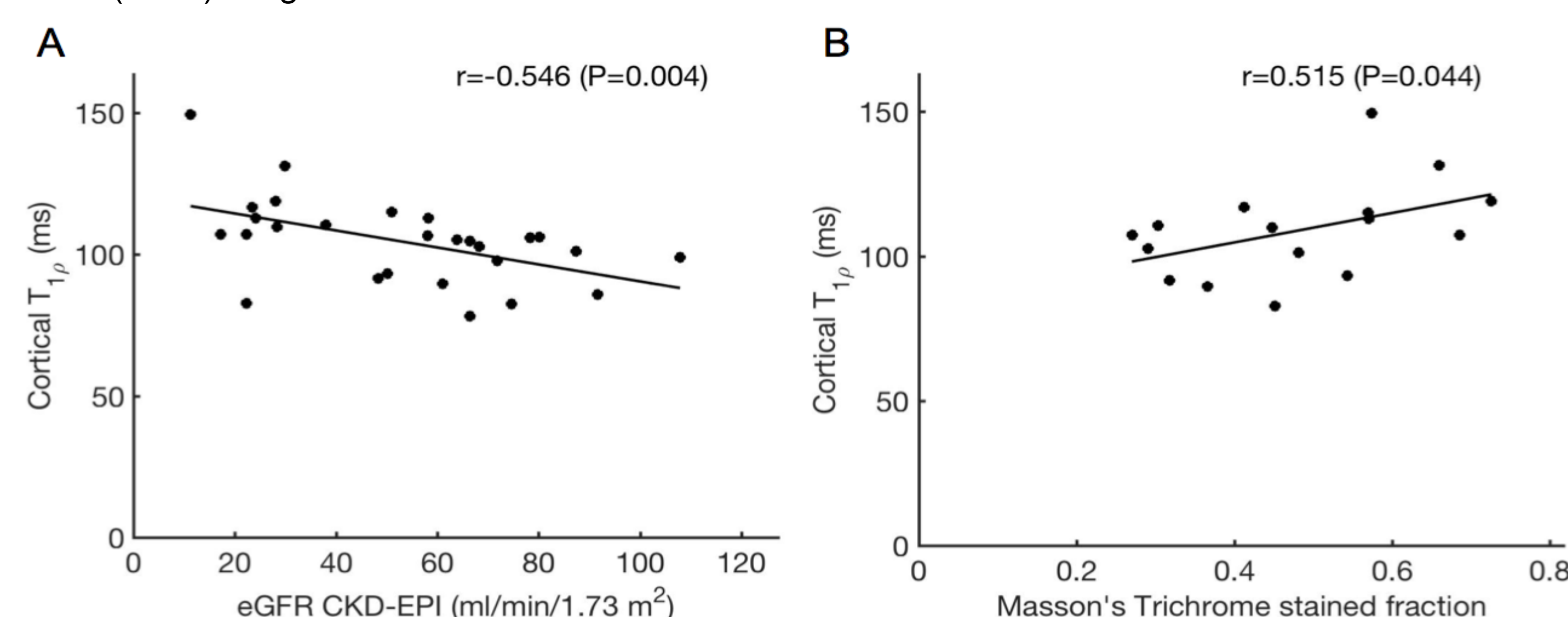


Figure 3. Correlation plots of cortical T_{1ρ} with CKD-EPI eGFR measurements (n=27) and Masson's Trichrome stained fractions (n=16).

CONCLUSIONS

- In this preliminary study, we observed significant elevation of cortical T_{1ρ} in fibrotic renal transplants.
- The significant correlation between cortical T_{1ρ} and Masson's trichrome stained fraction suggests a direct association of cortical T_{1ρ} with collagen content.

REFERENCES

- Allkemper et al. Radiology 2014;271(2):408-415
- Wang et al. Radiology 2011;259(3):712-719