# Magnetic resonance elastography vs. point shear wave ultrasound elastography for the assessment of renal transplant fibrosis

Icahn School of Medicine at Mount Sinai — *Translational and Molecular Imaging Institute*

Paul Kennedy[1,2], Octavia Bane[1,2], Sonja Gordic[1,2], Stefanie Hectors[1,2], Mark Berger[1,2], Jeff Zhang[3], Veronica Delaney[4], Madhav Menon[4], Fadi El Salem[5], Sara Lewis[1,2], Bachir Taouli[1,2]

[1]TMII, [2]Radiology, [4]RMTI; Icahn School of Medicine at Mount Sinai. [3]Radiology, University of Utah

## INTRODUCTION

- Renal transplant is treatment of choice for end stage renal disease, however a high proportion of transplant recipients experience at least one episode of transplant dysfunction[1]
- Monitoring of transplant recipients may provide early indications of dysfunction – biopsy is not a practical surveillance tool due to sampling variability and risks
- MR elastography (MRE) and ultrasound point shear wave elastography (pSWE) allow noninvasive assessment of tissue mechanical properties and have been shown to be feasible in measuring renal transplant fibrosis [2-4]

**Objective**

- Investigate whether MRE and pSWE can differentiate between stable functioning and chronically dysfunctional allografts
- Assess association between MRE and pSWE and histopathological scores, DCE-MRI derived parameters, and clinical outcomes

## METHODS

- 24 kidney Tx patients prospectively enrolled – 15 stable function (M/F 9/6, eGFR 65.9±12.6 ml/min/1.73m$^2$) and 9 with chronic dysfunction (M/F 4/5, eGFR 29.4±16.3 ml/min/1.73m$^2$)
- 1.5T MRE and pSWE performed on same day. DCE-MRI acquired in 12 patients with eGFR>30 ml/min/1.73m$^2$
- Biopsy obtained in 13 patients (4 stable, 9 dysfunction) within 1 year of imaging
- MRE data reconstructed inline by a commercially available inversion algorithm[5]. ROIs corresponded to areas of reliable stiffness in cortex and medulla. pSWE data obtained in cortex
- Reliability criteria of interquartile range ≤30% of median value for pSWE and MRE enforced. pSWE also considered unreliable if ratio of valid measurements to total measurements ≤60%
- DCE data were analyzed using a 3 compartment model[6] which output mean transit time (MTT) over the vascular, tubular and loop of Henle compartments, as well as providing renal plasma flow (RPF) and GFR

## RESULTS

- MRE successful in all patients, pSWE unsuccessful in 1 patient
- MRE and pSWE stiffness measurements are shown in **Table 1**
- Example MRE and pSWE acquisitions are shown in **Figure 1**
- No significant difference between groups when analyzing all data. Reliable MRE measures showed significant difference in groups (p=0.038). No difference was found in in pSWE reliable measures (**Figure 2**)
- MRE correlated with GFR (r=-0.477, p=0.034; **Figure 3**) and time since transplant (r=0.464, p=0.040)
- MRE negatively correlated with DCE-MRI measured MTT in the vascular compartment (r=-0.745, p=0.008; **Figure 3**)
- MRE correlated with Banff inflammation in areas of interstitial fibrosis and tubular atrophy (i-IFTA) and arteriolar hyalanosis (ah) scores, pSWE correlated with Banff cv (r=0.797, p=0.018)

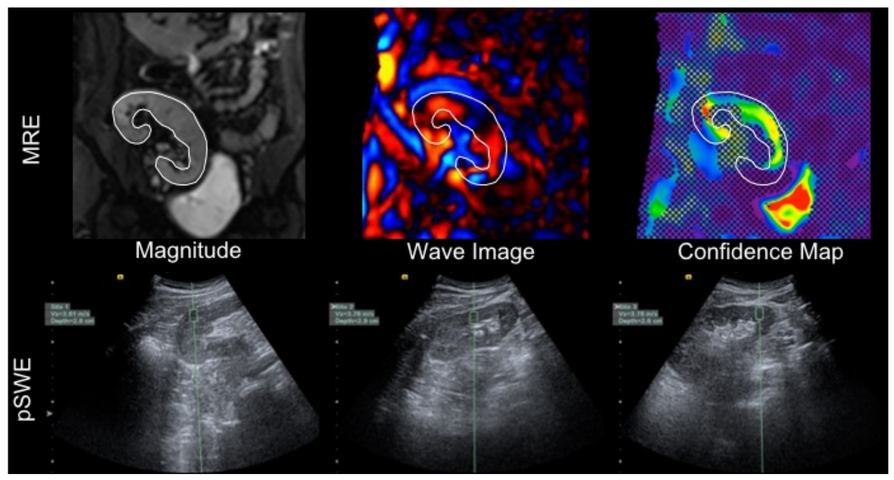


**Figure 1:** Example images of MR elastography (top) and pSWE (bottom). MR elastography images depict magnitude, wave image propagation and stiffness map with overlaid confidence map signifying areas of reliable measurement. pSWE measurements were performed in upper, middle and lower poles.

| Modality | N | Stable (kPa) | Dysfunction (kPa) | *p* |
|---|---|---|---|---|
| MRE - all | 24 | 5.54±1.47 | 7.15±2.37 | 0.069 |
| pSWE - all | 23 | 13.21±4.64 | 13.78±2.46 | 0.516 |
| MRE - reliable | 20 | 5.22±0.83 | 7.15±2.37 | **0.038** |
| pSWE - reliable | 11 | 13.19±2.64 | 14.92±2.82 | 0.201 |

**Table 1**. MRE and pSWE stiffness (mean±SD) of stable and chronically dysfunctional patients. Results from all measurements and only reliable measurements are presented.

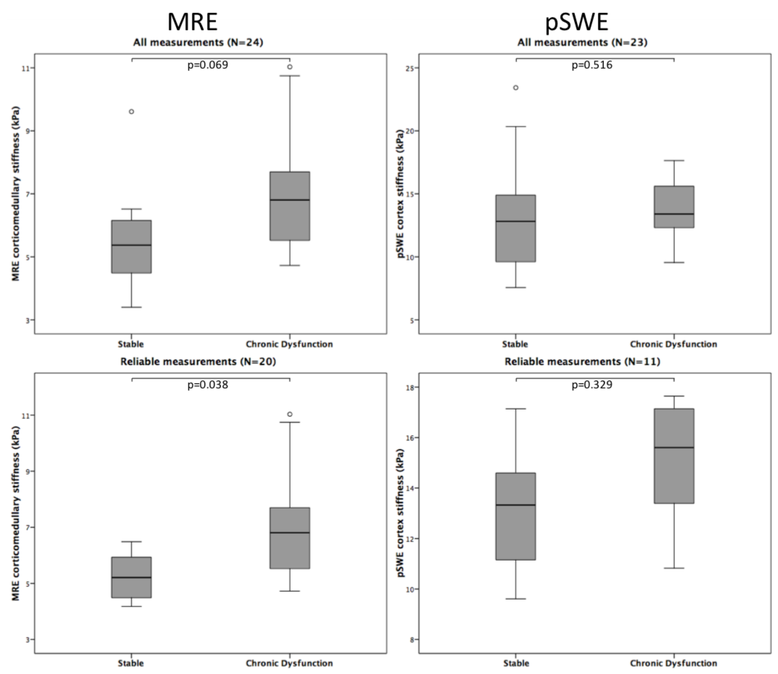


**Figure 2**. Boxplots displaying MRE (left) and pSWE (right) allograft stiffness when including all measurements (top) and only reliable

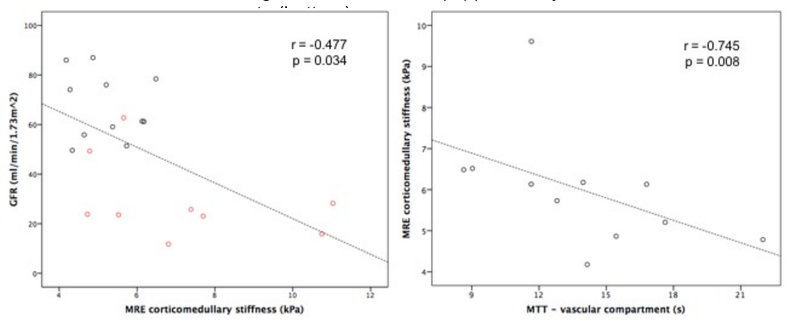


**Figure 3**. Plots displaying correlation between MRE corticomedullary stiffness and GFR (left) and MTT in the vascular compartment (right)

## CONCLUSIONS

- Reliable MRE measures show a significant stiffness increase in chronically dysfunctional allografts compared to stable
- pSWE produces a high proportion of unreliable measures
- Increasing stiffness in dysfunctional allografts previously reported[7], though conflicting results also published[8]. Perfusion[9] and renal anisotropy may affect elastography measurements
- MRE correlated with DCE-MRI measured MTT in the vascular compartment suggesting a relation between stiffness and kidney perfusion
- MRE appears to be sensitive to fibrotic changes in dysfunctional kidneys and may be a potential tool for non-invasive assessment of kidney health

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