Prediction of Renal Allograft Acute Rejection Using Shear-Wave Dispersion Imaging

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Currently, US elastography models adopt a simple linear elastic model that only quantifies the tissue elasticity, and viscosity has been neglected. Shear-wave dispersion imaging is known to indirectly reflect tissue viscosity. The shear-wave dispersion slope showed correlation with the degree of necroinflammatory activity in the allograft liver. This technique has a potential to be applied to the kidney as well.

However, there are some obstacles to apply shear-wave imaging to the kidney. First, kidney is a retroperitoneal organ and skin-to-organ distance is usually long. According to the consensus statement of ultrasound liver elastography, shear-wave push pulse is attenuated by 6 to 7 cm. Second, the kidneys have heterogeneous parenchyma, unlike the livers. Measurements of renal cortex shear elasticity and viscosity in animal models showed inhomogeneous, anisotropic nature of renal cortex. Third, pathophysiology of renal parenchymal disease is complex and might be hard to correlate with shear-wave elasticity or viscosity.

Here, we would like to share the preliminary results of using shear-wave dipersion imaging for evaluating renal allograft dysfunction. We retrospectively reviewed 126 kidney transplant recipients who underwent both shear-wave elastography and kidney biopsy for allograft evaluation. We evaluated parenchymal stiffness and dispersion slope in renal cortex and renal sinus fat, and correlated with clinico-pathologic findings. The median cortex-to-sinus stiffness ratio (SR) did not differ between the patients with acute rejection and without rejection (1.21 vs. 1.20, $P=0.47$), while median cortex-to-sinus dispersion slope ratio (DSR) was higher in patients with acute rejection than in those without rejection (1.4 vs. 1.21, $P<0.01$). Grade of interstitial fibrosis and tubular atrophy (IFTA) was the determinant factor for both SR (coefficient, 0.13 per grade; $P<0.01$) and DSR (coefficient, 0.10 per grade, $P=0.01$). In multivariate analysis, mean resistive index (OR 1.06, 95% CI 1.02-1.15, $P<0.01$) and DSR (OR 18.3, 95% CI 3.3-101.6, $P<0.001$) were independent factors for predicting acute rejection. Using the DSR at a cutoff of 1.36, we could obtain AUC of 0.675, a sensitivity of 58.1%, and specificity of 77.9% for identifying acute rejection. This results show shear-wave dispersion slope may be helpful for identifying renal allograft dysfunction.