

EVALUATION OF RENAL CORTICAL THICKNESS BY NONCONTRAST-ENHANCED MR IMAGING, WITH SPATIALLY SELECTIVE IR PULSES: COMPARISON BETWEEN CIRRHOTIC AND NONCIRRHOTIC PATIENTS

Purpose: Serum creatinine is universally used to assess renal function in clinical practice. However, several problems exist with the current techniques for assessing renal function based on serum creatinine in cirrhotic patients as these patients have underlying conditions that result in falsely low serum creatinine levels, even in the presence of moderate-to-severe renal impairment. Such underlying conditions include decreased creatinine production secondary to decreased hepatic creatine synthesis, increased tubular creatinine secretion, and decreased skeletal muscle mass. Meanwhile, renal cortical volumes and cortical thicknesses have been found to correlate with renal function. Our preliminary study showed that noncontrast-enhanced steady-state free precession (SSFP) MR imaging, with spatially selective inversion recovery (IR) pulses can improve the visualization of renal corticomedullary differentiation, facilitating the measurement of renal cortical thicknesses. In the clinical practice, we have sometime encountered cirrhotic patients with thin renal cortex even though the serum creatinine level was almost normal, suggesting the masked renal dysfunction in cirrhotic patients. Herein, this study aimed to compare the renal cortical thicknesses between cirrhotic and noncirrhotic patients with normal renal functions based on serum creatinine by using noncontrast-enhanced SSFP MR imaging with spatially selective IR pulse.

Methods: This study included 21 cirrhotic patients (mean age, 70 years; range, 39–86 years) and 22 noncirrhotic patients (mean age, 65 years; range, 42–86 years), who had normal renal function and underwent abdominal noncontrast-enhanced SSFP imaging, with spatially selective IR pulses. None of them had a history of renal or vascular diseases. The imaging parameters of the SSFP sequence were as follows: repetition time/echo time = 4.2/2.1 msec, slice thickness = 7 mm, field of view = 400 mm², acquisition matrix = 256 × 256, flip angle = 90°, and receiver bandwidth, 977 Hz/pixel. For the spatially selective IR pulse examination, a spatially selective inversion labeling pulse was placed on both kidneys. Topographically identical SSFP sequences, with spatially selective IR pulses, were performed to observe the signal changes in the labeled renal cortex and medulla, using various TIs of 700–1500 msec in increments of 100 msec. The signal intensities (SIs) of the renal cortex and medulla were measured using region-of-interest (ROI) analysis. The corticomedullary contrast ratio (SI cortex/SI medulla) was calculated to determine the optimal TI for the visualization of the renal corticomedullary junction. Maximal transverse renal width and renal cortical thickness were measured to calculate the renal cortical width ratio (cortical thickness/maximal renal width). The renal cortical thickness and renal cortical width ratio were compared between cirrhotic and noncirrhotic patients. Patients' medical records were reviewed to compare serum creatinine levels and estimated glomerular filtration rates (eGFRs) between cirrhotic and noncirrhotic patients. Mann-Whitney tests were used for statistical analyses.

Results: The renal corticomedullary junction was clearly depicted by noncontrast-enhanced SSFP MR imaging with spatially selective IR pulses in all patients. The mean renal cortical thickness (Fig. 1) in the cirrhotic group (3.6 ± 0.9 mm) was significantly lower ($p < 0.0001$) than in the noncirrhotic group (5.0 ± 0.8 mm). The mean renal cortical width ratio in the cirrhotic group (0.07 ± 0.01) was significantly lower ($p < 0.0001$) than in the noncirrhotic group (0.10 ± 0.02). The mean serum creatinine did not show a significant difference between the cirrhotic and the noncirrhotic group (0.65 ± 0.17 mg/dl vs 0.67 ± 0.18 mg/dl). The mean eGFR did not show a significant difference between the cirrhotic and the noncirrhotic group (84.2 ± 23.1 mL/(min · 1.73 m²) vs 77.7 ± 16.8 mL/(min · 1.73 m²)).

Conclusions: Noncontrast-enhanced SSFP MR imaging with spatially selective IR pulses can be used to measure renal cortical thicknesses and renal cortical width ratios. In this study, the serum creatinine levels and eGFRs did not significantly differ between the cirrhotic and noncirrhotic patients. Conversely, the mean renal cortical thickness and renal cortical width ratio in the cirrhotic group were significantly lower than that in the noncirrhotic group. This suggests that the masked renal dysfunction might be present in cirrhotic patients even though the renal function based on serum creatinine level was normal, and that the measurement of renal cortical thicknesses and renal cortical width ratios by noncontrast-enhanced SSFP MR imaging with spatially selective IR pulses would help evaluate the "true" renal function of cirrhotic patients.

Coronal SSFP images with spatially selective IR pulses in a (a) 62-year-old man with cirrhosis and a (b) 64-year-old woman without liver disease demonstrate lesser renal cortical thickness in the cirrhotic patient than in the noncirrhotic patient. The serum creatinine level and eGFR were 0.72 mg/dL and 85 mL/(min · 1.73 m²), respectively, for the cirrhotic patient, and 0.63 mg/dL and 72 mL/(min · 1.73 m²), respectively, for the noncirrhotic patient.

