

MR GFR measures vs MDRD estimates of renal function in cirrhotics

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Target audience: Clinicians interested in accurately assessing renal function in patients with cirrhosis.

Purpose: Renal failure is an important and severe complication of cirrhosis. Clinical decisions impacted by renal function include medication choices and doses, fluid management, and liver transplant [1]. The most common blood test of renal function is the serum creatinine (Scr). Glomerular filtration rate (GFR) describes renal function, but is not directly measured in clinical practice. Rather GFR is estimated by an equations, such as the MDRD (Modification of Diet in Renal Disease) [2], based on Scr and other factors including age, gender and race. Scr and MDRD measures of renal function may be unreliable in cirrhotics [1]. Our laboratory has shown previously that dynamic low-dose Gd-enhanced MR renography (Gd-MRR) may provide reliable and accurate estimates of GFR (MR_GFR) in cirrhotics and can be obtained during routine liver MR imaging (Figure 1) [3]. Here we report the accuracy of MR_GFR in a large population with a wide range of renal and hepatic function and to compare to the commonly used MDRD estimate.

Methods: Patients with documented liver disease and referred for a clinical liver MRI, were recruited, following an IRB-approved protocol. Demographics and laboratory features used in the MDRD calculation were collected. We followed a published protocol for Gd-MRR [3]. To demonstrate the accuracy of the MR_GFR value reference GFR was measured by the urinary clearance of ^{99m}Tc-DTPA (Nucs_GFR). Descriptive analysis and pairwise correlations were performed. The frequency when the MR_GFR and the MDRD provide a value that is more than 30% different than the Nucs_GFR, a threshold which meets National Kidney Foundation Guidelines for accuracy [4] was calculated. Means are compared using a Student's t-test.

Results: A total of 63 subjects with a wide range of liver disease as estimated by model for endstage liver disease (MELD) scores between 6-27 and the following demographics (mean(range)) were examined: Age: 54(20-72); Scr: 0.9 mg/dL (0.4-2.8); MDRD: 92 mL/min/1.73m²(25-169). Correlations between Scr, MDRD, MR_GFR and Nucs_GFR were all highly significant ($\rho > 0.44$; $p < 0.001$), supporting the evidence that all methods measure renal function. In 9/51(18%) observations where both the MR_GFR and the Nucs_GFR were available, the difference between the two values exceeded 30%. In 20/54(37%) observations where both the MR_GFR and the MDRD were available, the difference between the two values exceeded 30%. In 18/60(30%) observations where both the MDRD and Nucs_GFR were available, the difference between the two values exceeded 30%. MR_GFR and Nucs_GFR were not statistically significant, however both MR_GFR and MDRD, and MDRD and Nucs_GFR were statistically significantly different (Table 1).

Discussion: MR_GFR appears to be a reliable measure of GFR in cirrhotics, providing comparable results to our reference method, urinary clearance of ^{99m}Tc-DTPA. However, the MR_GFR is significantly different from the GFR estimates provided by MDRD estimators, supporting previous reports that MDRD estimates renal function in cirrhotics poorly. For example, one study of 1,447 pre-liver transplant subjects with relatively preserved renal function, found that MDRD showed reasonable correlation ($r = 0.70$) with reference values, but 34% of estimated GFR values were outside $\pm 30\%$ error range [5]. Another study in a population of cirrhotics with impaired renal function (mean GFR = 35.3 mL/min/1.73m² \pm 3.0 by inulin) found a lower correlation between MDRD and reference ($r = 0.52$), where only 6.8% of the 44 measured MDRD-GFR values fell within 30% of reference values [6]. Accuracy in patients with low GFR is particularly important for cirrhotic patients undergoing screening for hepatocellular carcinoma with clinical MRI because of concerns of Nephrogenic Systemic Fibrosis.

Conclusion: MR_GFR appears to measure renal function well in cirrhotics, and may perform better than the MDRD calculation.

References: [1] Caregaro L et al. Limitations of serum creatinine level and creatinine clearance as filtration markers in cirrhosis. *Arch Intern Med* 1994;154(2):201-5. [2] Levey AS et al; CKD Epidemiology Collaboration. *Ann Intern Med*. 2006;145(4):247-54. [3] Vivier PH et al. Kidney function: glomerular filtration rate measurement with MR renography in patients with cirrhosis. *Radiology*. 2011 May;259(2):462-70. [4] National Kidney Foundation. K/DOQI clinical practice guidelines for chronic kidney disease: evaluation, classification, and stratification. *Am J Kidney Dis* 2002;39(2 Suppl 1):S1-266. [5] Gonwa TA, et al. Estimation of glomerular filtration rates before and after orthotopic liver transplantation: evaluation of current equations. *Liver Transpl* 2004;10(2):301-9. [6] Poge U et al. Calculation of glomerular filtration rate based on cystatin C in cirrhotic patients. *Nephrol Dial Transplant* 2006;21(3):660-4.

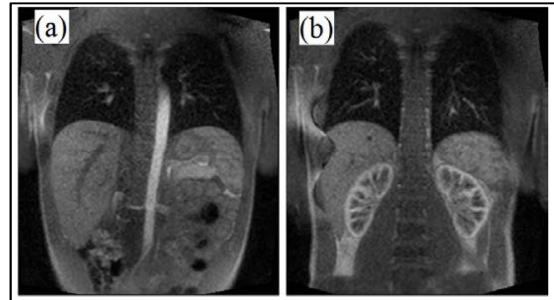


Figure 1: MR renography with 3ml contrast. SR-turbo-FLASH images. a) Abdominal aorta; b) kidneys. Acquisition time 0.5 sec/slice.

Table 1: Comparison of GFR estimation methods

	Mean (N)	95% CI	p
Test 1: Nucs vs MR			
Nucs_GFR	80.7 (60)	72.8-88.5	0.1565
MR_GFR	73.2 (62)	66.3-80.1	
Test 2: MDRD vs MR			
MDRD	91.8 (63)	84.6-99.0	0.0003
MR_GFR	73.2 (62)	66.3-80.1	
Test 3: MDRD vs Nucs			
MDRD	91.8 (63)	84.6-99.0	0.0388
Nucs_GFR	80.7 (60)	72.8-88.5	
GFR units = mL/min/1.73m ²			