

Renovascular Disease: Comprehensive Morphological and Functional Assessment Using a Hybrid MR Technique with contrast-enhanced 3D MRA and Extraslice Spin Tagging Perfusion MRI (ESTpMRI)

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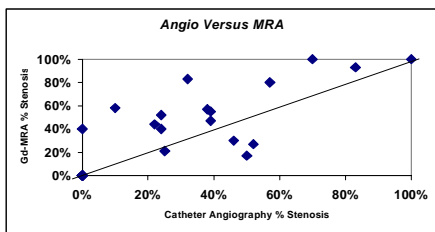
PURPOSE: To determine if the addition of Extraslice Spin Tagging perfusion weighted magnetic resonance imaging (ESTpMRI) can increase the accuracy of contrast-enhanced magnetic resonance angiography (ceMRA) to detect significant obstructions of renal flow.

Materials and Methods: Ten patients with renovascular disease due to atherosclerosis or fibromuscular dysplasia disease (FMD) and six healthy volunteers were imaged at 1.5T. ESTpMRI was performed in all patients and volunteers and the signal intensities were measured in 32 kidneys. Double dose ceMRA of the renal arteries was performed in all patients. Source images as well as MPR and MIP reconstructions were evaluated for presence of renal artery stenosis (RAS). Contrast renal arteriography (CA) was used as the gold standard to which the MR findings were compared.

Results: ceMRA tends to overestimate the degree of stenosis in the majority of cases (Fig1). Compared to CA, ceMRA had a sensitivity and specificity for the presence of renal artery stenosis $\geq 50\%$ of 67% and 72% (Tab1). For stenosis $\geq 70\%$ these values were 100% and 86% respectively (Tab2). The renal parenchyma signal intensity measured by ESTpMRI correlated with the presence or absence of significant RAS determined by arteriography. The cortex of kidneys without stenosis had a signal/noise ratio (SNR) of 58.8 ± 30.6 compared to that of kidneys with renal artery stenosis with $SNR=32.5 \pm 19.5$. This difference was significant ($P=0.012$) (Tab3). The combination of ESTpMRI and ceMRA for stenosis $\geq 50\%$ increased both sensitivity and specificity to 83% and 89%, respectively (Tab 4). The sensitivity for lesions $\geq 70\%$ was unchanged; specificity was slightly decreased to 82% (Tab5). In patients with bilateral stenosis or equivocal findings on ceMRA, ESTpMRI perfusion imaging helped to lateralize the more significant side (Fig 2).

Conclusion: ESTpMRI allows assessing renal perfusion without the need for externally administered contrast agents. Used as an adjunct to ceMRA, it has the potential to improve its accuracy especially in the setting of equivocal findings.

Fig 1. CeMRA tends to overestimate the degree of stenosis in the majority of cases.



Tab 1. Accuracy of ceMRA compared to catheter angiography for stenosis $\geq 50\%$ diameter reduction

	catheter angiography		total
	+	-	
ceMRA +	4	5	9
ceMRA -	2	13	15
	6	18	24
Sensitivity	4/6 = 67%		
Specificity	13/18 = 72%		

Tab 2. Accuracy of ceMRA compared to catheter angiography for stenosis $\geq 70\%$ diameter reduction

	catheter angiography		total
	+	-	
ceMRA +	2	3	5
ceMRA -	0	19	19
	2	22	24
Sensitivity	2/2 = 100%		
Specificity	19/22 = 86%		

Tab 3. SNR of the renal cortex and ratios of kidney signal intensities are presented for ESTpMRI

	Cortex SNR		Cortex Ratio	
	Normal Kidney	Abnormal Kidney	Healthy Volunteer (Left/Right)	Patient Volunteer (Abnormal/Normal)
Mean	58.8	32.5	1.12	0.418
Std. Dev.	30.6	19.5	0.295	0.195

Tab 4. Accuracy of Hybrid MRI (ceMRA and ESTpMRI combined) compared to catheter angiography for stenosis $\geq 50\%$ diameter reduction

	Catheter angiography		total
	+	-	
Hybrid MRI +	5	2	7
Hybrid MRI -	1	16	17
	6	18	24
Sensitivity	5/6 = 83%		
Specificity	16/18 = 89%		

Tab 5. Accuracy of Hybrid MRI (ceMRA and ESTpMRI combined) compared to catheter angiography for stenosis $\geq 70\%$ diameter reduction

	Catheter angiography		total
	+	-	
Hybrid MRI +	2	4	6
Hybrid MRI -	0	18	18
	2	22	24
Sensitivity	2/2 = 100%		
Specificity	19/22 = 82%		

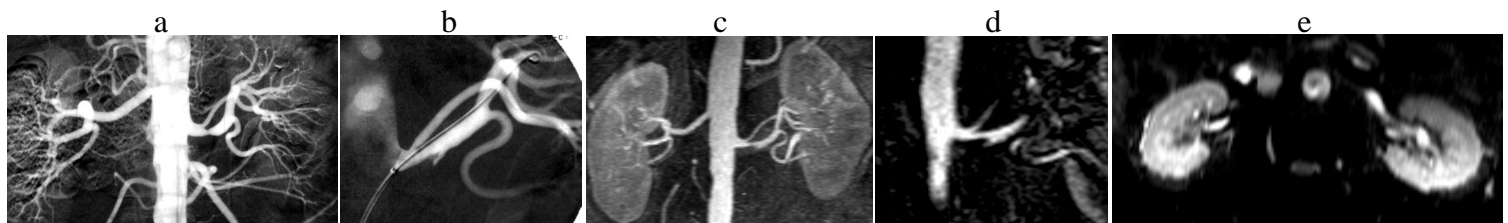


Fig 2. Abdominal aortogram (a) shows right renal artery without stenosis. The left renal artery has a high-grade stenosis. Selective left renal arteriogram immediately post PTA (b) shows a focal dissection with a residual stenosis of 38%, but there was no gradient across the lesion. CeMRA performed the day after the PTA (MIP and oblique MPR) shows residual left RAS of 57% (c, d). ESTpMRI (e) shows normal signal intensity of both kidneys thus reclassifying the false positive ceMRA findings.