Does digital subtraction aid in MRI differentiation of renal cell carcinoma from complex cysts? Comparison of dynamic gadolinium enhancement, digital subtraction, and enhancement threshold methods.

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Introduction: Recent studies on the detection of renal carcinoma by gadolinium-enhanced MR have shown that qualitative review using digitally subtracted post contrast images has nearly equal sensitivity and specificity as quantitative measurement of lesion enhancement [1,2] It remains unclear, however, whether the use of subtracted images adds diagnostic value compared with review of nonsubtracted, dynamic-enhanced MR images of renal masses. We performed this study to evaluate whether digital subtraction of contrast enhanced MR images improves differentiation of renal cell carcinomas from complex cysts compared with dynamic gadolinium-enhanced MR, and then compared these techniques with quantitative measurement of lesion enhancement levels.

Materials and Methods: MRI logs were reviewed to identify all renal mass MRI studies performed between 5/1/96 and 12/31/01. Inclusion criteria were renal lesions <4 cm diameter with either solid appearance or complex cystic appearance (containing septations or nodules, or internal signal not matching water on T1W or T2W series). Also required was pathologic proof of malignancy, or at least 12-month stability on imaging follow-up for benign lesions. The study cohort consisted of 30 malignant lesions in 30 patients and 20 complex cysts in 12 patients. None of the lesions in the cohort were oncocytomas.

Dynamic gadolinium-enhanced coronal sequences were performed with either 2D-FSPGR with flip/TR/TE = 60-90^0/100-130/1.8-3.9 or fat suppressed 3D-FSPGR (12-15^0/5-8/1.8). Slice thickness was 5-7 mm, matrix 256 x 192 and FOV 32-40 cm. Precontrast, 20 sec., and 90 sec. post contrast phases had been acquired.

Dynamic enhanced images and subtracted postcontrast images through the renal lesions were reviewed in random order by two body imaging fellowship-trained radiologists reading independently, blinded to patient information. For the subjective review, they assigned a malignancy score for each lesion using a 1–4 scale (1=Definitely Benign, 2=Probably Benign, 3=Probably Malignant, 4=Definitely Malignant). Criteria for malignancy in the subjective review were: enhancement greater than subcutaneous fat; wall thickness or septal thickness >1mm; nodularity of walls. Dynamic and subtracted images were reviewed separately, then in combination 6 weeks later. ROI measurements of the most obviously enhancing portion of the mass were also made on soft-copy images by a third radiologist blinded to patient information.

Results: Using a threshold score of >=3 as a positive sign of malignancy, for readers A and B, sensitivity for the dynamic enhanced method alone was 83 and 67 % and specificity was 85 and 80%. Sensitivity for the combined dynamic+subtracted method for the two readers improved to 97 and 97% (p= 0.22 and 0.01) while specificity was not significantly changed at 80 and 85% (p= 1.0 and 1.0). Interobserver variability measured with weighted kappa scores improved from moderate to very good, at 0.55 and 0.89 for dynamic and combined dynamic+subtracted image review. Sensitivity for the subtracted method alone for Readers A and B was 97 and 97%, while specificity was 70 and 80%. Measurement of ROI enhancement values using a malignancy threshold of 36% had 100% sensitivity and 90% specificity.

Conclusions: When interpreting dynamic enhanced MRI of renal masses or complex cysts, reviewing subtracted images in combination with the dynamic enhanced images adds sensitivity for detection of malignancy without significant change of specificity. Measurement of enhancement levels using a malignancy threshold of >=36% yielded slightly improved sensitivity with similar specificity.

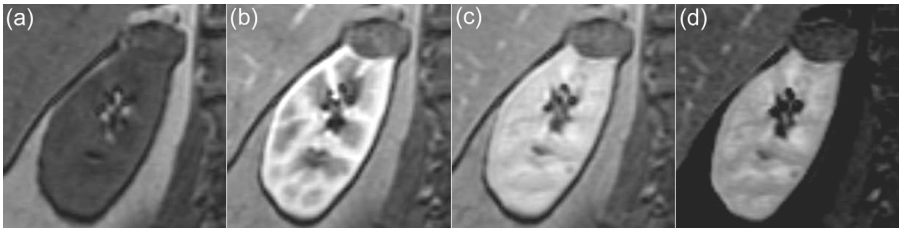

Figure 1. Comparison of a) precontrast, b) corticomedullary and c) nephrographic phases from T1W dynamic enhanced 2D FSPGR MRI of right upper pole renal lesion with d) subtracted [nephrographic – precontrast] images. Subtracted image more clearly shows enhancement of mass greater than perirenal fat. Surgical pathology revealed mixed papillary and clear cell renal carcinoma. ROI measurements revealed 63.7% lesion enhancement.

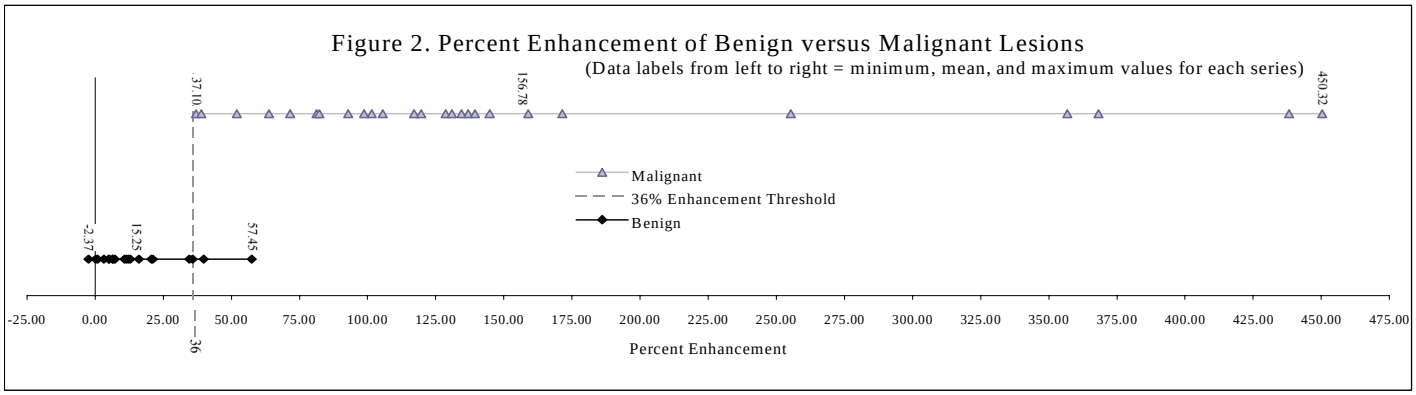

Table 1. Comparison of results for readers A and B using different thresholds for positive tests. Methods compared are dynamic-enhanced images ("Dynamic") and dynamic-enhanced images in combination with digitally subtracted post-contrast images ("Combined")

Criteria for Positive Test	Reader	-----Sensitivity-----			-----Specificity-----		
		Dynamic	Combined	P	Dynamic	Combined	P
>=2	A	100% (30/ 30)	100% (30/ 30)	1	15% (3/ 20)	50% (10/ 20)	0.04
	B	100% (30/ 30)	97% (29/ 30)	1	0% (0/ 20)	60% (12/ 20)	0.001
>=3	A	83% (25/ 30)	97% (29/ 30)	0.22	85% (17/ 20)	80% (16/ 20)	1
	B	67% (20/ 30)	97% (29/ 30)	0.01	80% (16/ 20)	85% (17/ 20)	1
4	A	30% (9/ 30)	70% (21/ 30)	<.001	100% (20/ 20)	90% (18/ 20)	0.5
	B	27% (8/ 30)	90% (27/ 30)	<.001	100% (20/ 20)	85% (17/ 20)	0.25

References:

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2. Ho VB, Allen SF, Hood MN, Choyke PL. Renal masses: quantitative assessment of enhancement with dynamic MR imaging. *Radiology* 2002;224:695-700.