MR Feature Analysis and Classification of Renal Masses with Pathologic Correlation

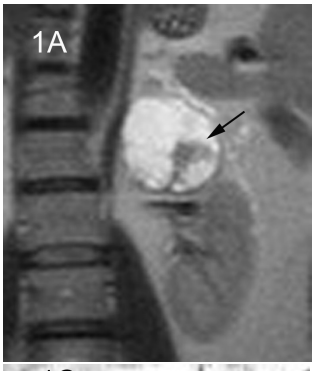
I. Pedrosa[1], M. Chou[2], L. Ngo[3], R. H. Baroni[4], E. Genega[5], W. C. Dewolf[1], and N. M. Rofsky[1]

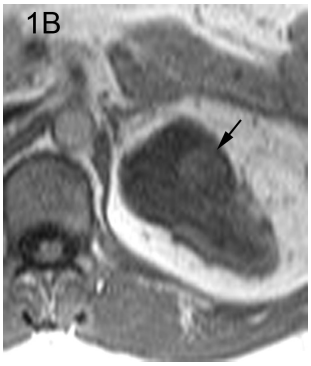
[1]Radiology, BIDMC, Boston, MA, United States, [2]BIDMC, MA, United States, [3]Department of Medicine, BIDMC, Boston, MA, United States, [4]Radiology, Hospital das Clinicas da FMUSP, Sao Paulo, Brazil, [5]Pathology, BIDMC, Boston, MA, United States

Purpose: To retrospectively correlate magnetic resonance imaging (MRI) features of renal masses with their histological type and nuclear grade and report the diagnostic value of a proposed MRI classification of renal masses.

Material and Methods: Between 1999 and 2003 80 patients (54 males and 26 females) underwent precontrast and dynamic gadolinium-enhanced MRI of 83 renal masses. This IRB-approved study was HIPPA compliant. Two radiologists, blinded to all clinical and pathological data, reviewed the MRI for the following imaging features: location of the mass, signal intensity (SI) on T2-weighted images (T2-WI), uniformity of the SI on T2-WI, cystic component, bulk fat, subvoxel fat, hemorrhage, necrosis, type of enhancement, retroperitoneal collaterals, perirenal fat invasion, renal vein thrombosis, and tumor size. Using pathology as the reference standard, a logistic regression analysis was conducted to establish which features were predictive of histologic type and nuclear grade. Each renal mass was also assigned to one of the 8 categories from a proposed MRI classification system. Sensitivity and specificity of the MRI classification was calculated.

Results: Pathologic diagnosis included 34 low-grade clear cell renal cell carcinoma (RCC), 14 high-grade clear cell RCC, 10 low-grade papillary RCC, 5 high-grade papillary RCC, 5 chromophobe RCC, 7 transitional cell carcinoma (TCC), 2 lymphoma, 1 angiomyolipoma, 1 oncocytoma, and other benign (n=2) or malignant (n=2) neoplasms. Tumor size did not correlate with histologic type or nuclear grade. Subvoxel fat on chemical shift imaging correlated to clear cell type ($p<0.05$); sensitivity of 71%, specificity of 97%. Intratumoral necrosis, retroperitoneal vascular collaterals, and renal vein thrombosis predicted high-grade clear cell type ($p<0.05$). Peripheral location, lower intratumoral SI on T2-WI, and low-level enhancement predicted papillary type ($p<0.05$). Sensitivity, specificity and confidence intervals of the MRI classification system for diagnosing low grade clear cell, high-grade clear cell, all clear cell, all papillary, and TCC were 50% (34%-66%) and 94% (84%-95%); 93% (69%-99%), and 74% (63%-83%); 92% (81%-97%) and 80% (64%-90%), 99% (65%-100%) and 99% (93%-100%); and 80% (55%-93%) and 93% (84%-97%), respectively.





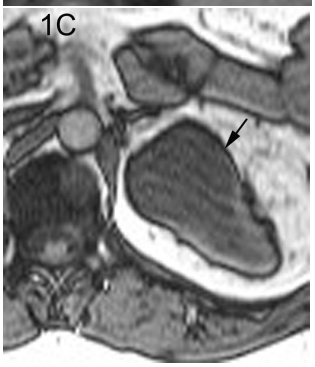
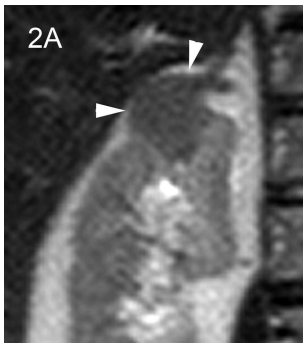


Figure 1. Cystic mass in the left kidney shows nodule (arrow) on SSFSE image (1A). The nodule shows drop SI on the T1-OP phase image (1C) compared to T1-IP image (1B), consitent with intravoxel fat. Pathology confirmed low-grade clear cell RCC.

Discussion: The natural history and growth rates of small incidentally detected renal masses are both variable (1) and do not provide a clear direction for treating patients with such lesions. Tumor size does not correlate with histology type or nuclear grade, nor does it predict biological behavior in small renal tumors (2). Application of imaging features for tumor characterization may help guide management options for patients with incidentally discovered renal masses in a more objective manner. Insights into the histologic type and nuclear grade of a renal mass based on MRI features can suggest potential tumor aggressiveness and metastatic potential.

Conclusion: The MRI feature analysis and proposed classification system helps predict the histological type and nuclear grade of renal masses.



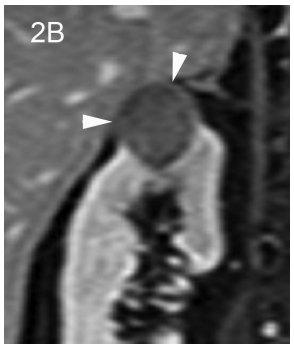


Figure 2. SSFSE (2A) image shows a mass (arrowheads) of homogeneous low SI. Gd-enhanced image (2B) during the nephrographic phase confirmed homogeneous low-level enhancement compared to precontrast (not shown). Pathology after partial nephrectomy revealed low-grade papillary RCC

References:

1. Volpe A, Panzarella T, Rendon RA, Haider MA, Kondylis FI, Jewett MA. The natural history of incidentally detected small renal masses. Cancer 2004; 100:738-745.
2. Leibovich BC, Pantuck AJ, Bui MH, et al. Current staging of renal cell carcinoma. Urol Clin North Am 2003; 30:481-497.