

MRI Subtraction

Subtraction Imaging Technique

- * Unenhanced T1-weighted sequence is digitally subtracted from the identical sequence post gadolinium enhancement
- * Any native T1 signal is removed
- * Remaining Signal on the “subtracted sequence” is due solely to enhancement

Specific Applications

- * In the setting of hemorrhage within an organ
 - * T1 sequence will show increased signal
 - * intracellular and extracellular methemoglobin
 - * Is there an underlying lesion/enhancement
- * Good homogeneous fat suppression
 - * avoiding the limitations of field inhomogeneity

Subtraction Applications

- * Any signal from blood products will be removed
- * Enhancement will be more conspicuous
- * A simple hematoma will appear as a signal void

Subtraction Applications

Specific scenarios

- * Already routinely used in breast mri and in mr angiography
- * RCC(hemorrhagic cysts), equivocal history of trauma-
to characterize complex splenic mass
- * Postop hematoma vs. residual tumor, or post
RFA/CRYO

Applications

- * Cirrhosis

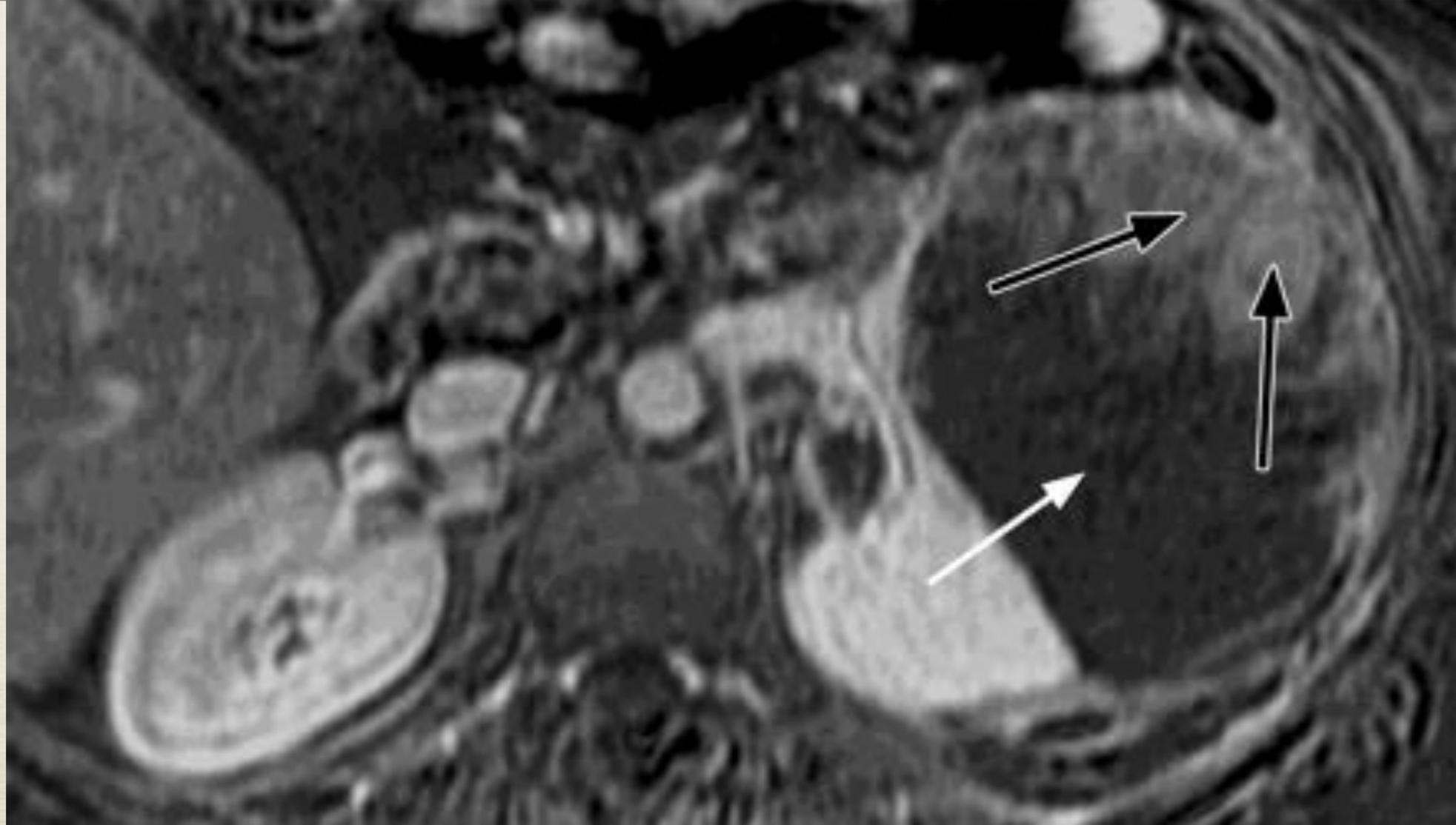
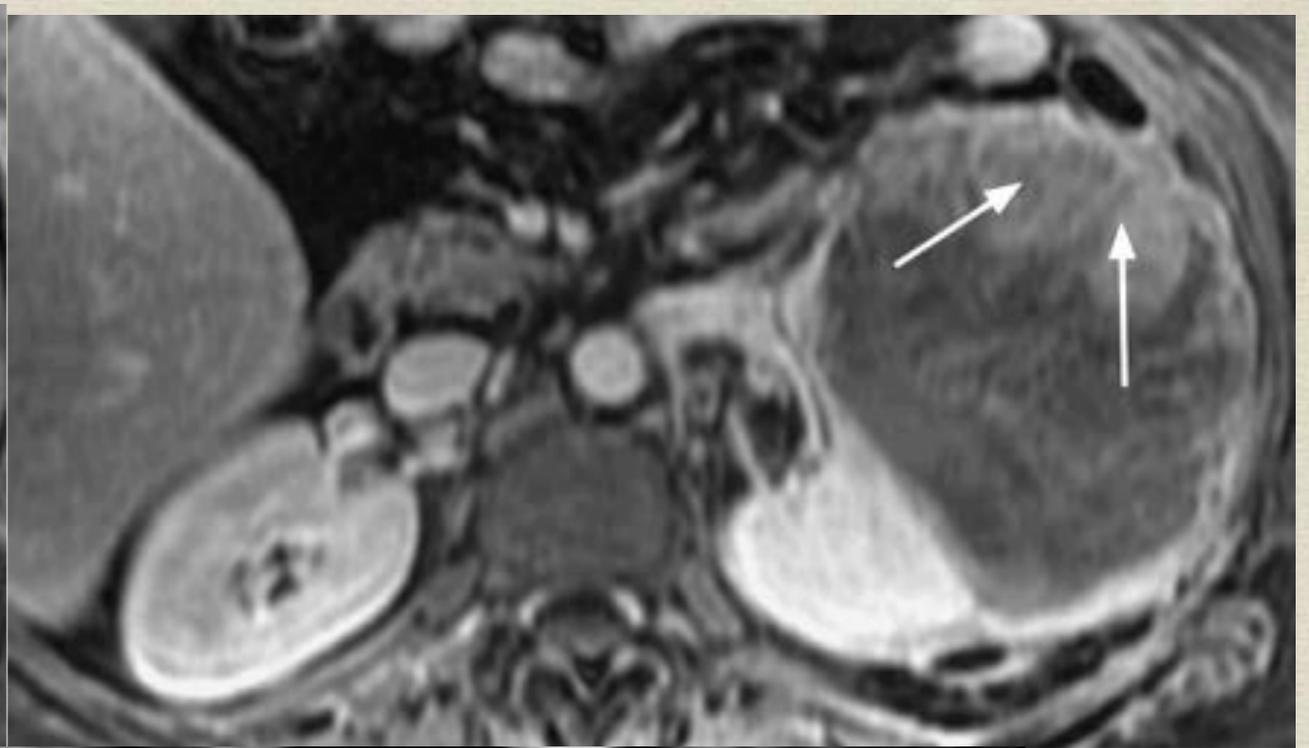
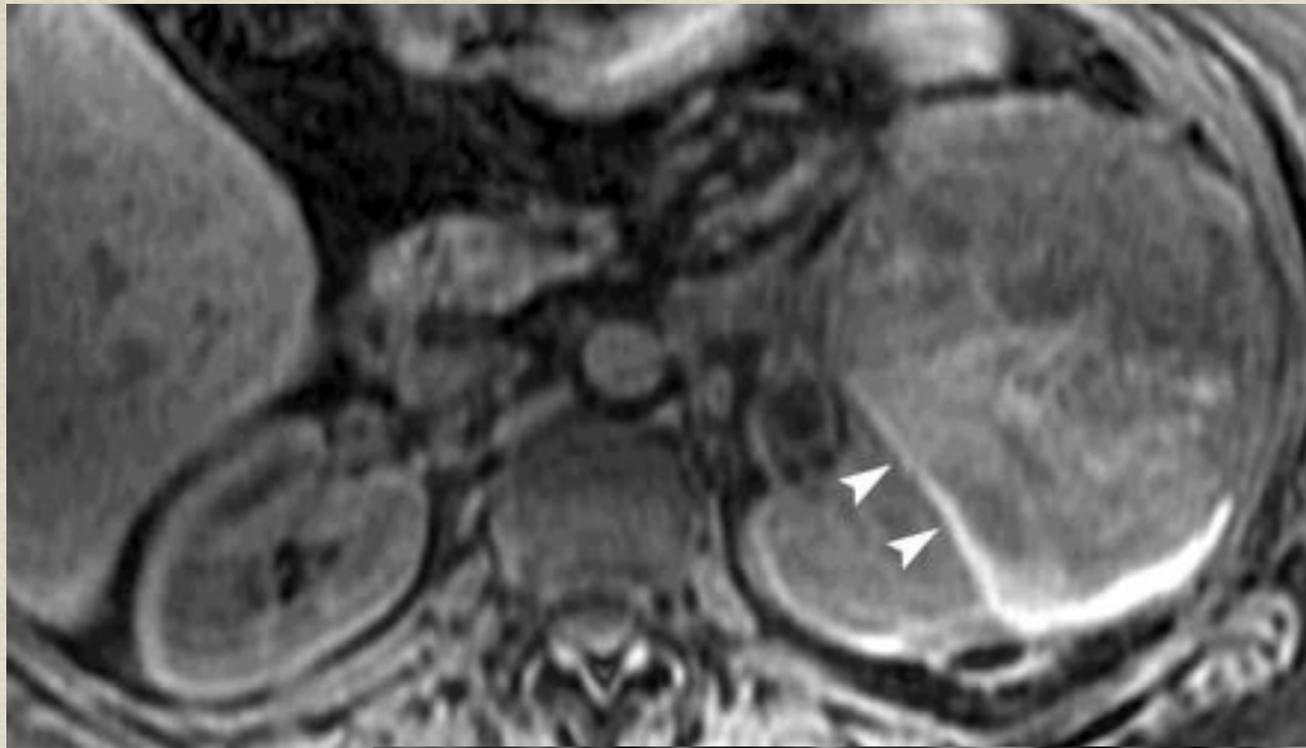
- * nodules often have regenerative and dysplastic nodules will appear increased in signal on T1

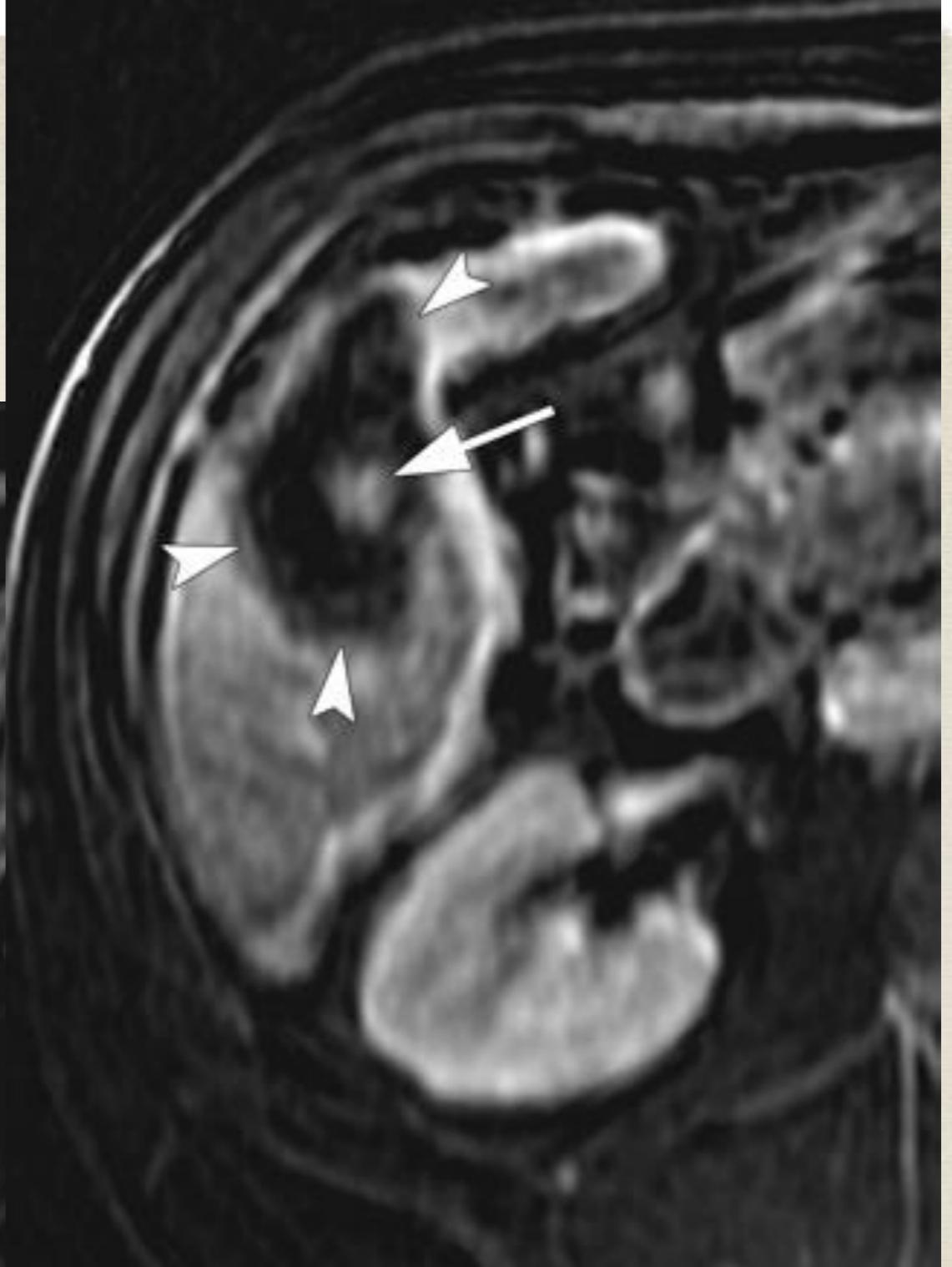
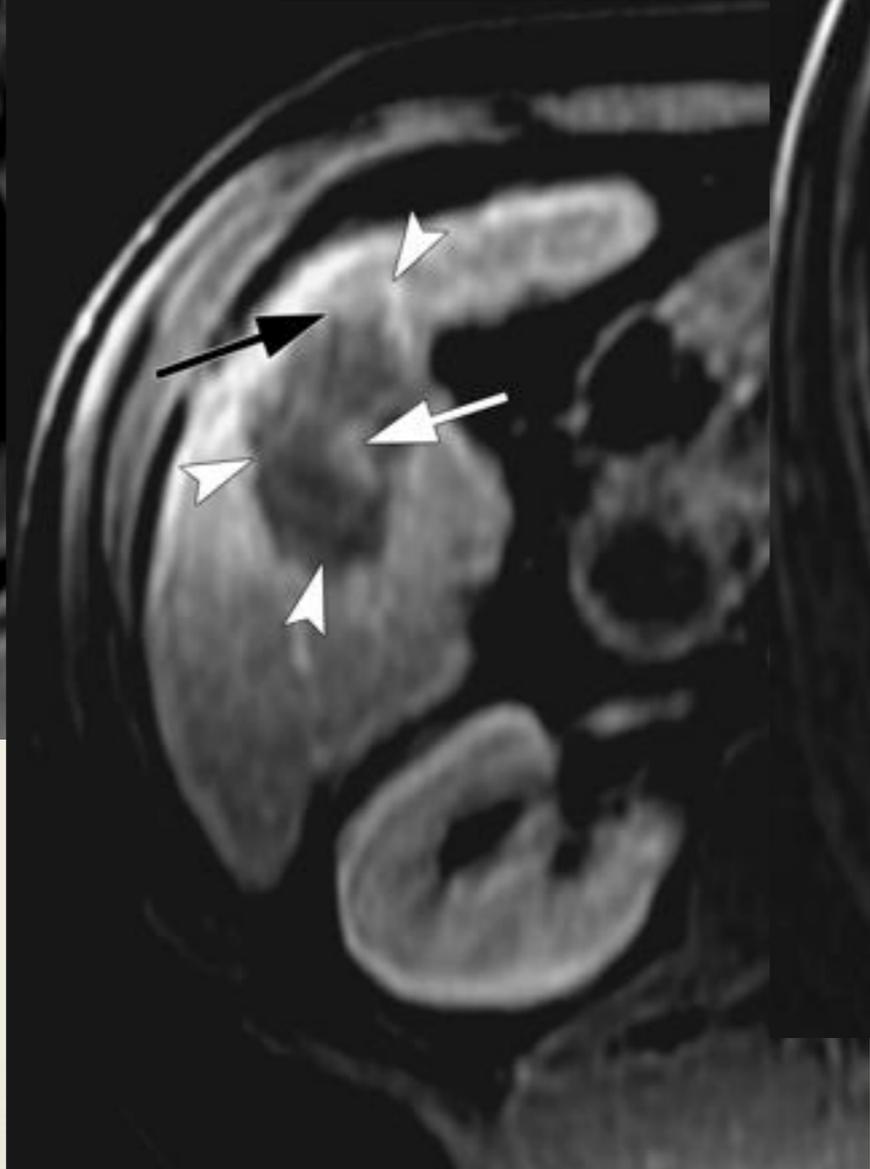
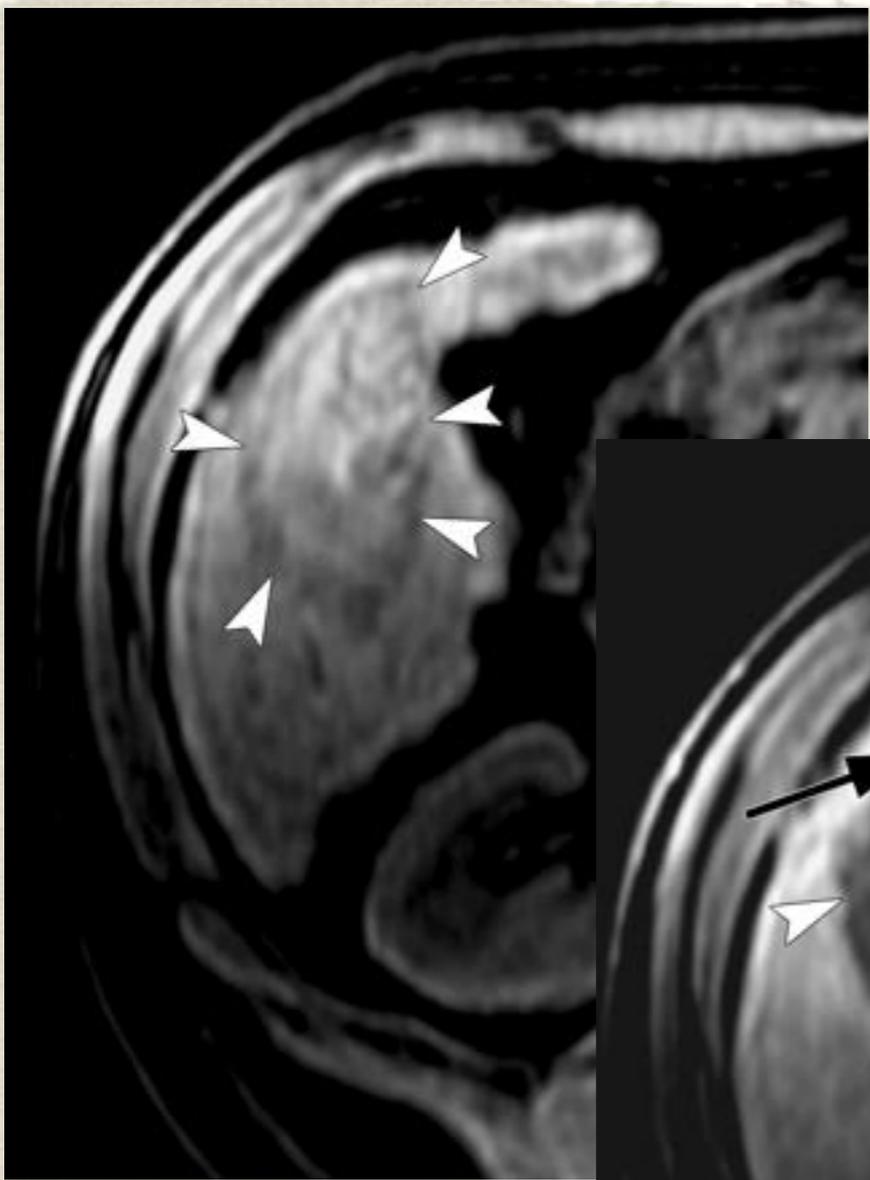
- * CRYO/RF ablation

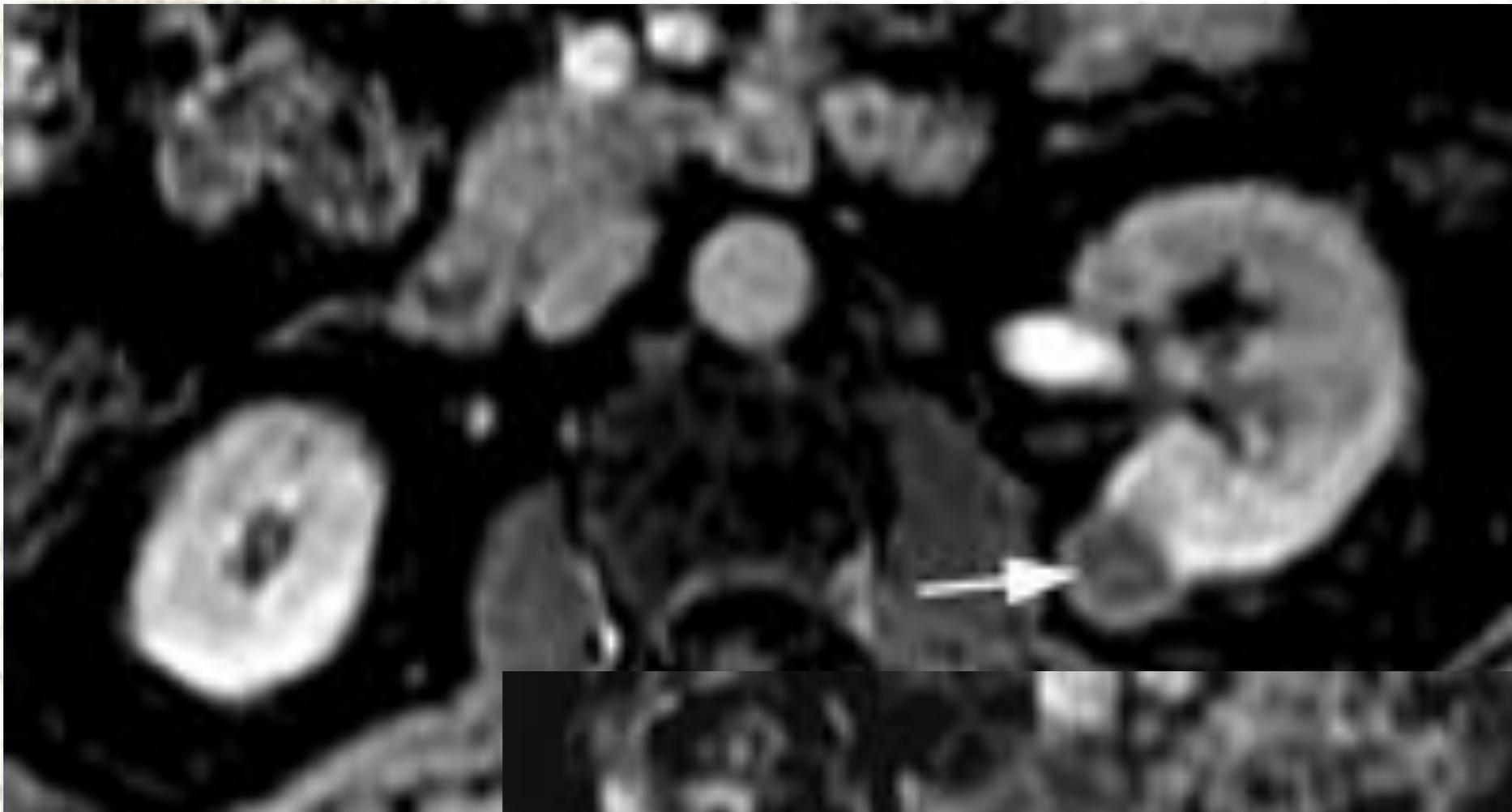
- * ideally suited for such a role
- * subtle enhancement within a tumor more conspicuous (hemorrhage often coag necrosis)

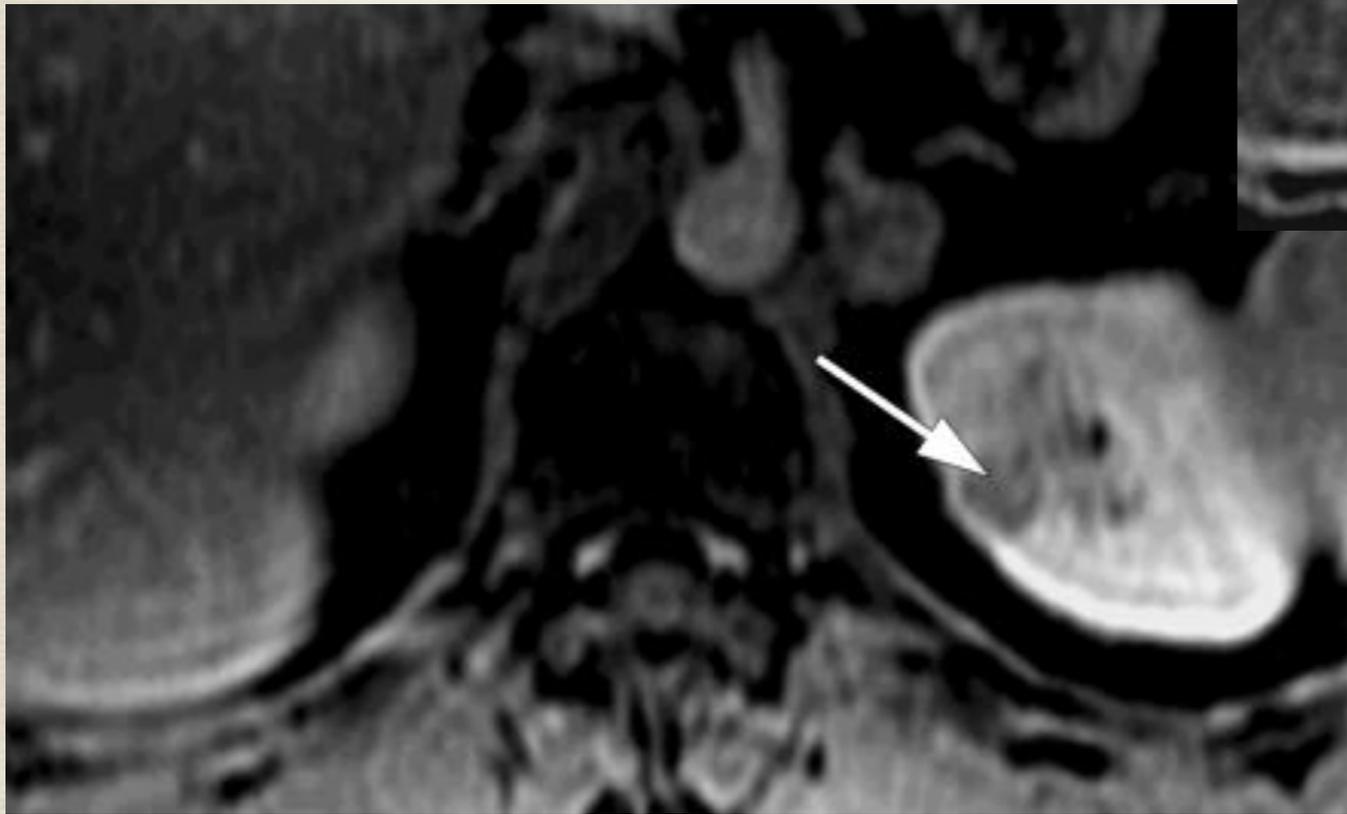
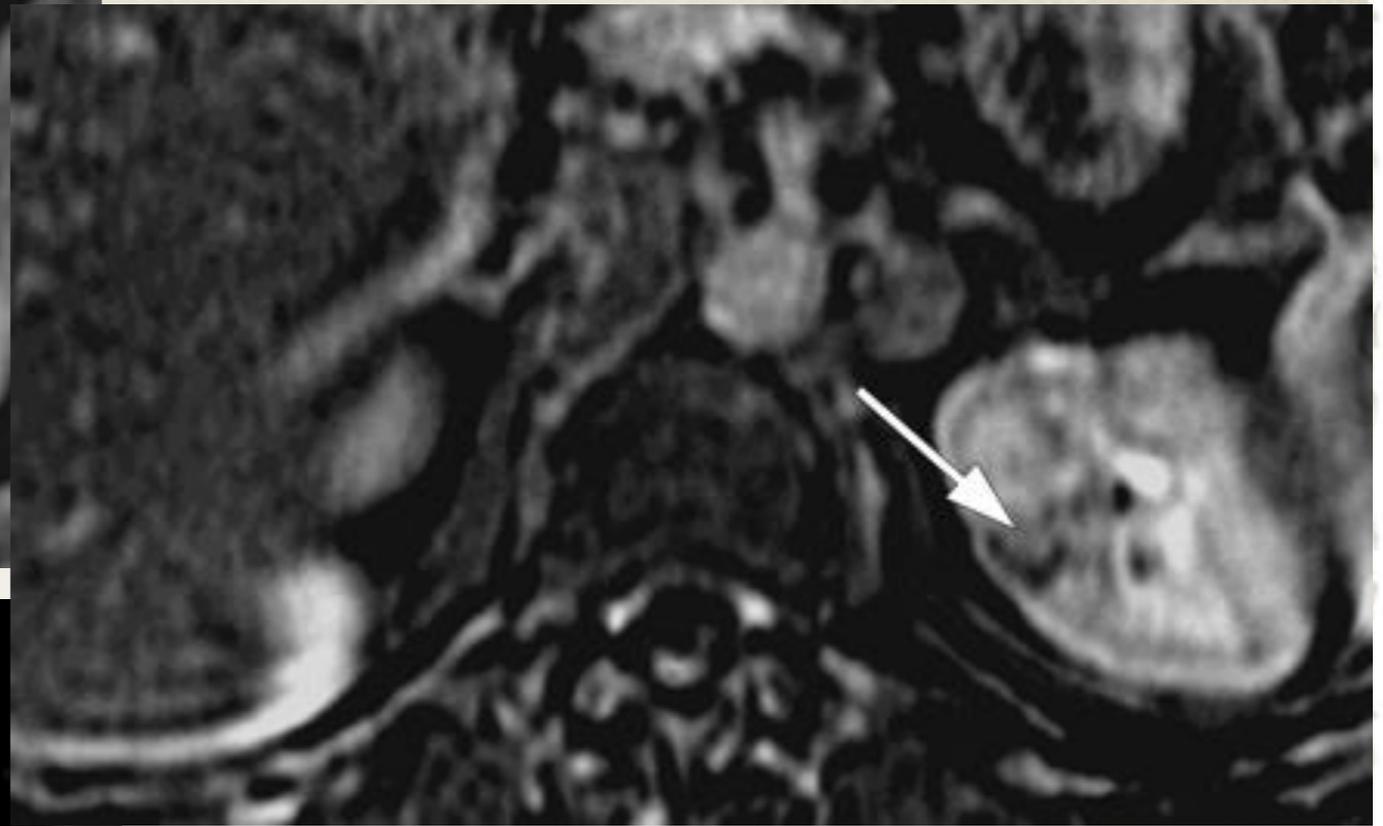
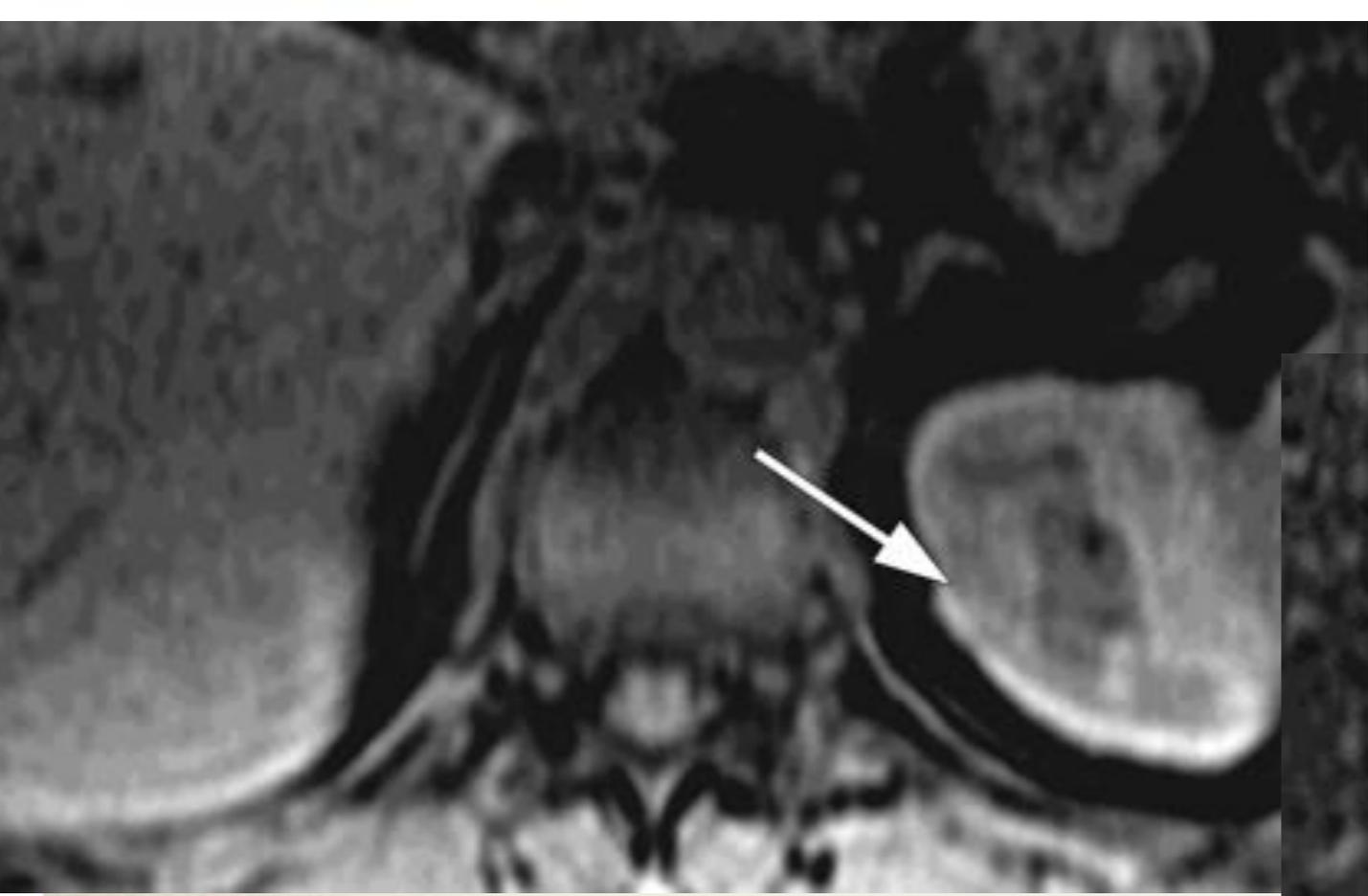
Pitfalls

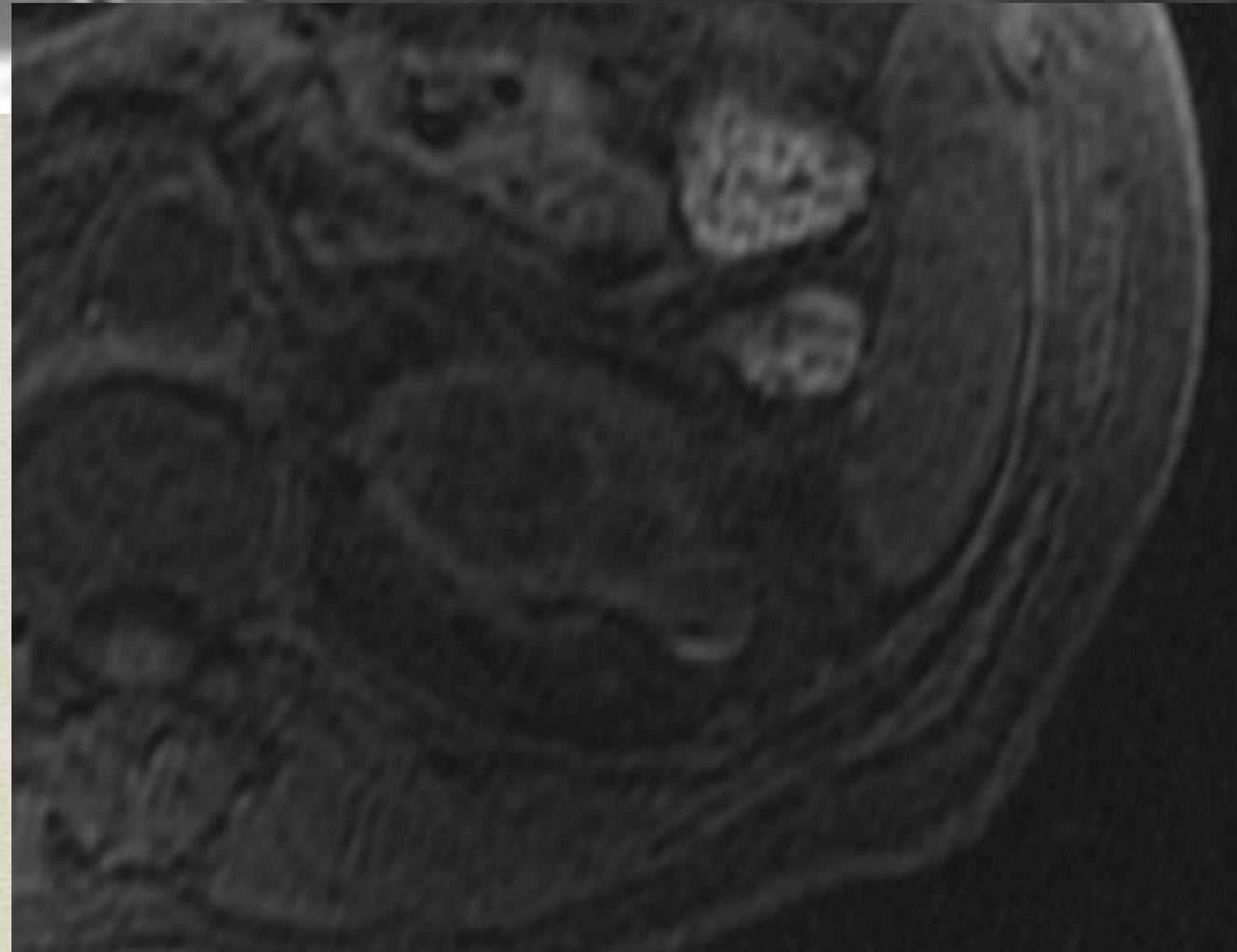
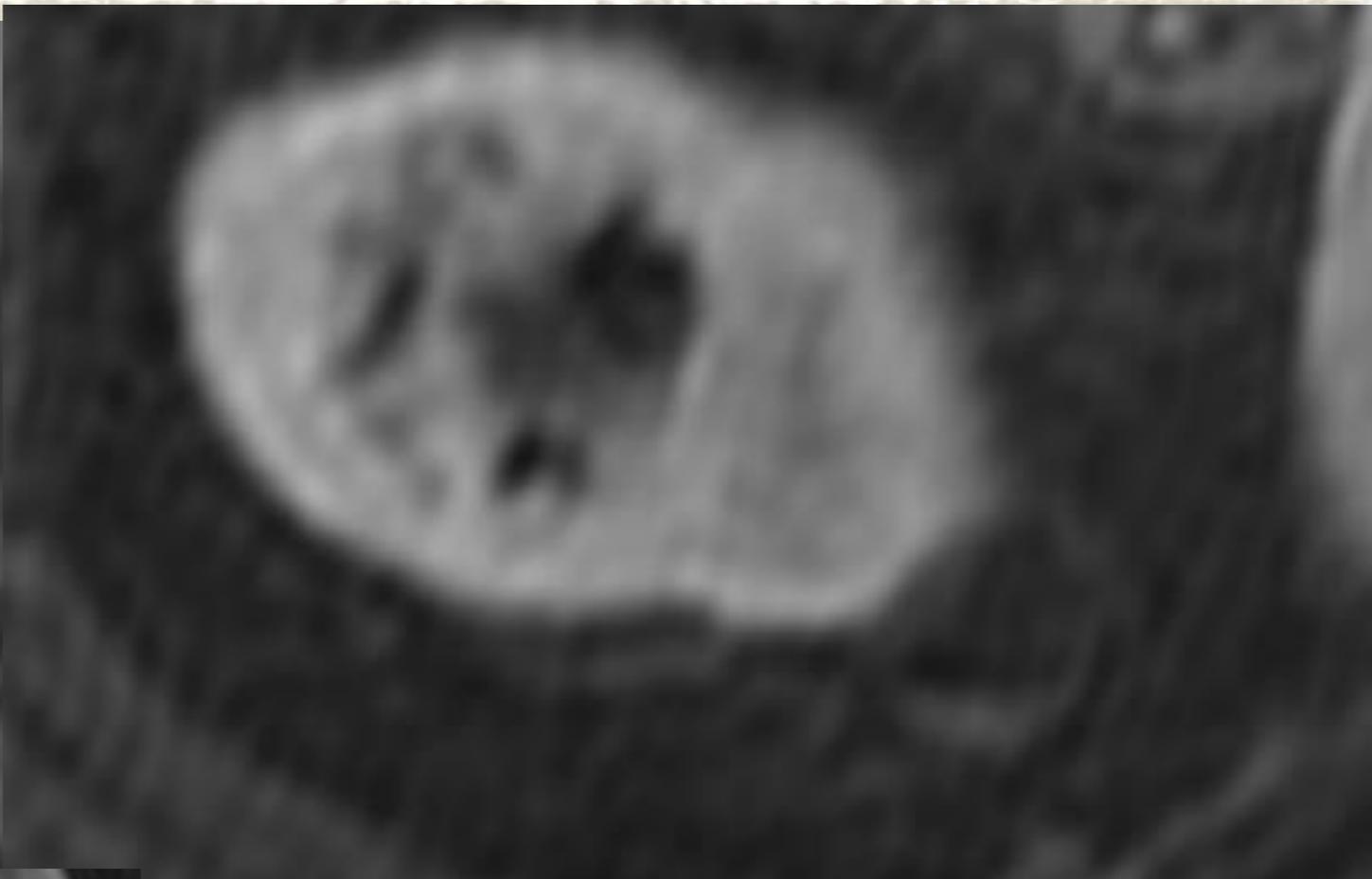
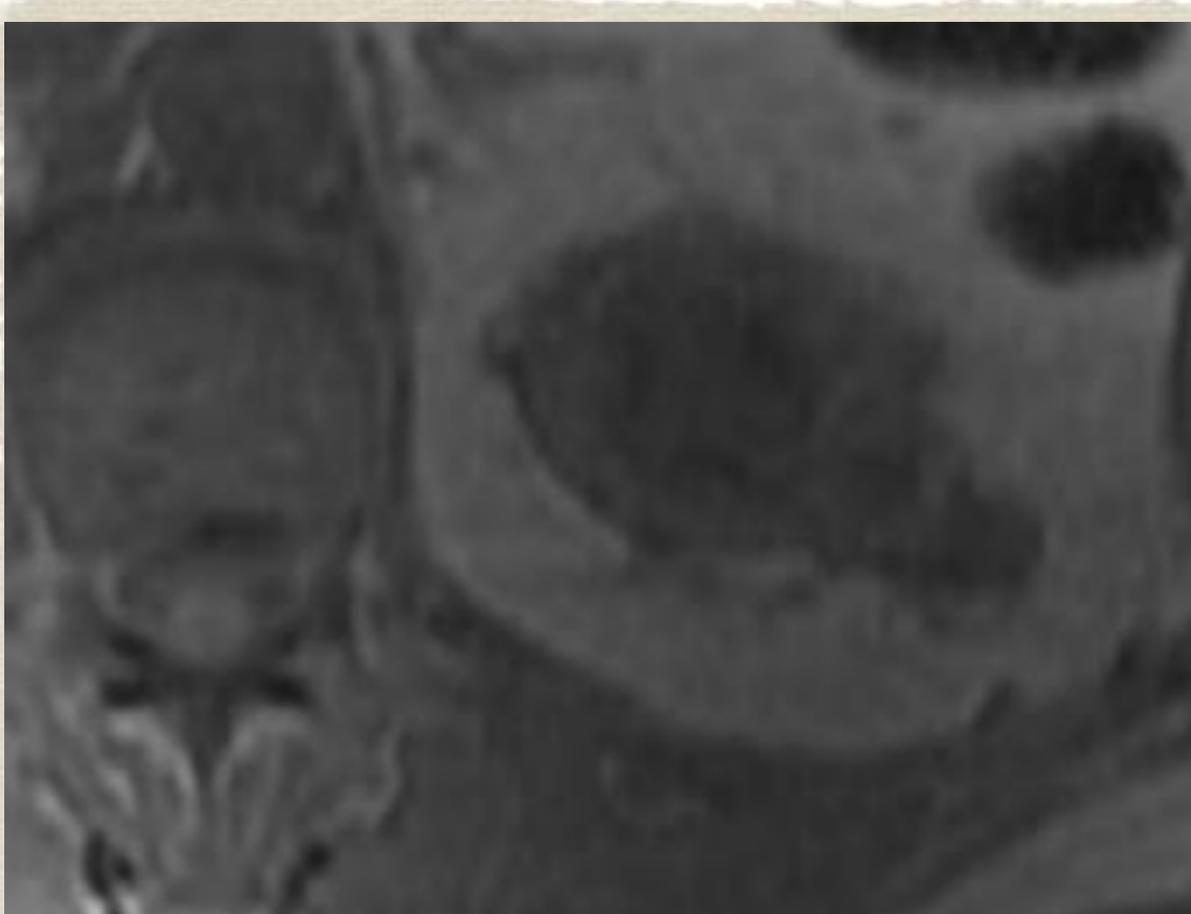
- * Imperative to keep all technical parameters constant
 - * from unenhanced to the enhanced sequences
 - * TR/TE/flip angle/slice thickness/matrix/zero interpolation factor
- * Avoid Patient movement
 - * reproducible breathhold
 - * misregistration artifact

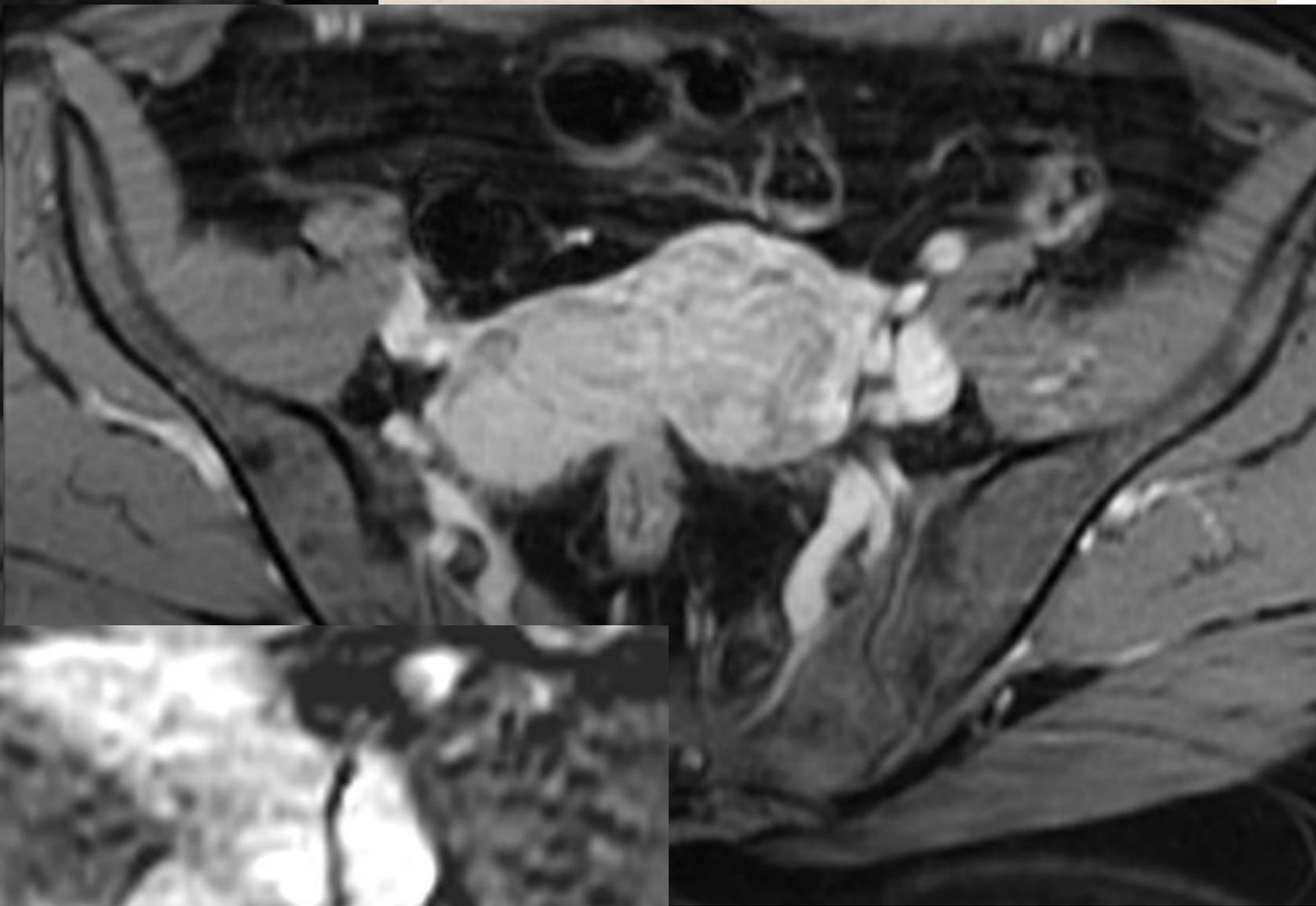
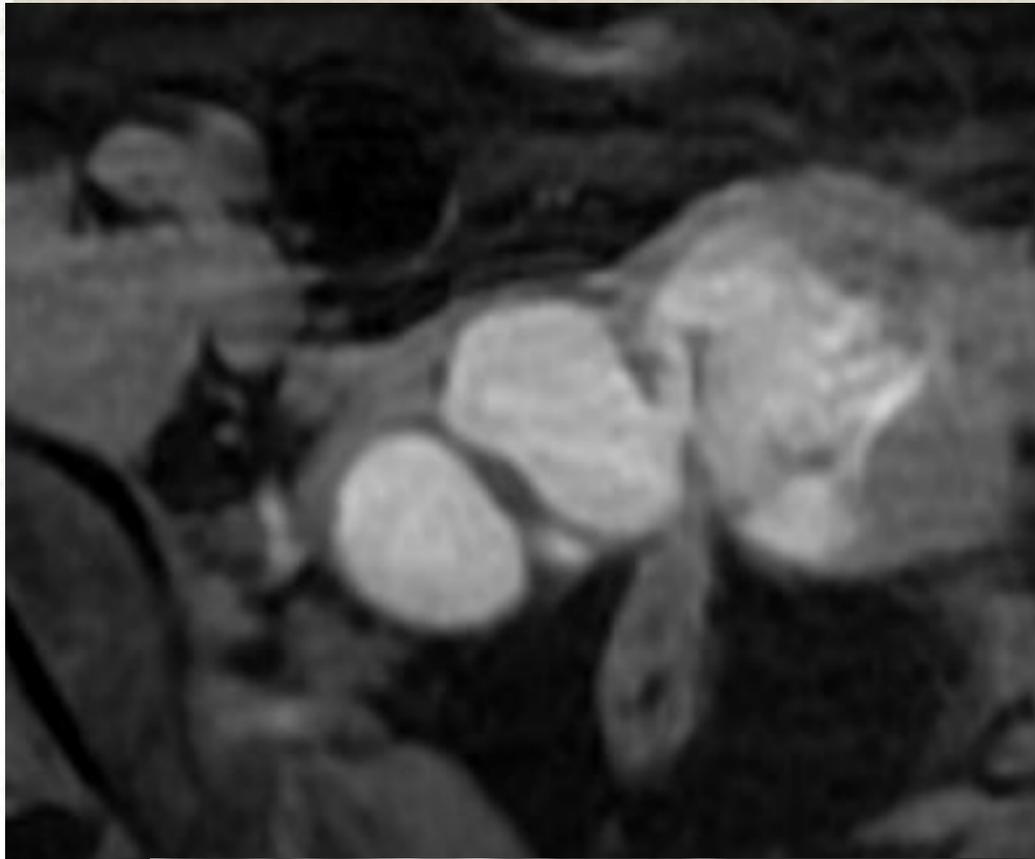












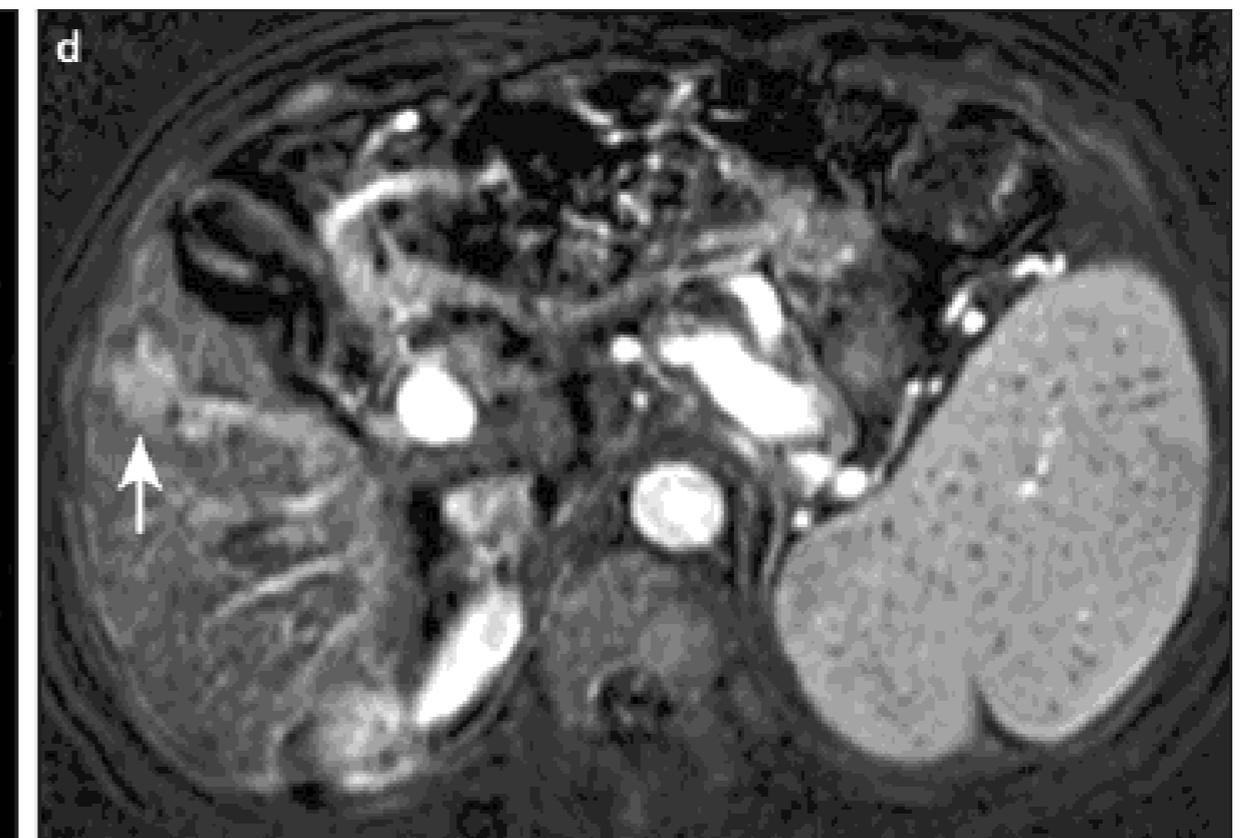


Figure 1. a–d. A 51-year-old man with cirrhosis. Axial T2-weighted MR image (a) shows heterogeneous parenchyma with multiple nodules and a hyperintense lesion in the posterior sector (*arrow*). Axial pre-contrast T1-weighted MR image (b) shows multiple hyperintense nodular lesions (*arrows*). On post-contrast axial T1-weighted MR image (c), the hyperintense lesions became isointense with the parenchyma except for the hepatocellular carcinoma (HCC) lesion in the posterior sector (*arrow*). Subtracted MR image (d) demonstrates a lesion in a different location (*arrow*) from the other nodular lesions, which was proven to be an HCC.

The role of dynamic subtraction MRI in detection of hepatocellular carcinoma

Table 1. Patient-based analysis by both methods for detection of hepatocellular carcinoma

	Patients (n)	
	Standard protocol	Standard protocol + subtraction
True positive	9	12
False positive (overdiagnosis)	5	3
False negative (underdiagnosis)	4	2
True negative	15	15

Table 2. Statistical results of methods for detection of hepatocellular carcinoma

	Standard protocol	Standard protocol + subtraction
Sensitivity	61.5%	85.7%
Specificity	78.9%	83.3%
Positive predictive value	66.6%	80.0%
Negative predictive value	75.0%	88.2%
Accuracy	71.8%	84.3%

Summary

- * Broadly applicable postprocessing technique
- * Quick and efficient
- * Improving the sensity and specificity of interpretation

References

- Lee VS, Flyer MA, Weinreb JC, Krinsky GA, Rofsky NM. Image **subtraction** in gadolinium-enhanced MR imaging. *AJR* 1996; 167:1427 -1432 [[Abstract/Free Full Text](#)]
- 1. Krinsky GA, Lee VS, Theise ND, et al. Hepatocellular carcinoma and dysplastic nodules in patients with cirrhosis: prospective diagnosis with MR imaging and explantation correlation. *Radiology* 2001; 219:445 -454 [[Abstract/Free Full Text](#)]
- 2. Yu JS, Rofsky NM. Dynamic **subtraction** MR imaging of the liver: advantages and pitfalls. *AJR* 2003; 180 : 1351-1357 [[Free Full Text](#)]
- 3. Amit Newatia¹, Gaurav Khatri, Barak Friedman and John Hines. **Subtraction** Imaging: Applications for Nonvascular Abdominal **MRI**