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 with in an organ
  * T1 sequence will sow increased signal
  * Intracellular and extracellular methemoglobin
  * Is there an underlying lesion/enhancement
  * Good homogenous 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 breathold
  - 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

<table>
<thead>
<tr>
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<th>Patients (n)</th>
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<tbody>
<tr>
<td></td>
<td>Standard protocol</td>
</tr>
<tr>
<td>True positive</td>
<td>9</td>
</tr>
<tr>
<td>False positive (overdiagnosis)</td>
<td>5</td>
</tr>
<tr>
<td>False negative (underdiagnosis)</td>
<td>4</td>
</tr>
<tr>
<td>True negative</td>
<td>15</td>
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Table 2. Statistical results of methods for detection of hepatocellular carcinoma

<table>
<thead>
<tr>
<th></th>
<th>Standard protocol</th>
<th>Standard protocol + subtraction</th>
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<tbody>
<tr>
<td>Sensitivity</td>
<td>61.5%</td>
<td>85.7%</td>
</tr>
<tr>
<td>Specificity</td>
<td>78.9%</td>
<td>83.3%</td>
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<tr>
<td>Positive predictive value</td>
<td>66.6%</td>
<td>80.0%</td>
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<tr>
<td>Negative predictive value</td>
<td>75.0%</td>
<td>88.2%</td>
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<tr>
<td>Accuracy</td>
<td>71.8%</td>
<td>84.3%</td>
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Summary

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


3. Amit Newatia¹, Gaurav Khatri, Barak Friedman and John Hines. Subtraction Imaging: Applications for Nonvascular Abdominal MRI