Evaluation of 3D T2-weighted Imaging In Breast MRI
• T2 contrast

• 2D versus 3D T2-weighted MRI

• T2-weighted imaging in breast MRI

• Pilot study in breast MRI
• T2 contrast

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T2-weighted Contrast

- Signal changes by two mechanisms

**T1 relaxation:**
- Spin-lattice relaxation
- Return of spins to their initial orientation

**T2 relaxation:**
- Spin-spin relaxation
- Interaction of nuclei with local environment
T2-weighted Contrast

- $T2 < T1$
- Short $T2$s darker, longer $T2$s brighter
- Fluids bright on $T2$, more structured or solid dark on $T2$
T2-weighted Contrast

• T2 < T1

• Short T2s darker, longer T2s brighter

• Fluids bright on T2, more structured or solid dark on T2
  • Cyst
  • Fluid-filled
  • Hyperintense T2-signal
T2-weighted Contrast

- T2 < T1
- Short T2s darker, longer T2s brighter
- Fluids bright on T2, more structured or solid dark on T2
  - Invasive Ductal Carcinoma (IDC)
  - High-cellularity
  - Isointense T2-signal
T2-weighted Contrast

- T2 < T1
- Short T2s darker, longer T2s brighter
- Fluids bright on T2, more structured or solid dark on T2
  - Mucinous carcinoma
  - High mucin component
  - Hyperintense T2-signal
• T2 contrast

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2D T2-weighted MRI

- Fast Spin Echo Acquisition
- Necessity for long TR, short signal duration

\[ T_2 < 200 \text{ ms} \]
\[ T_1 = 200-3000 \text{ ms} \]
2D T2-weighted MRI

- Inefficient scan
- Long scan times for high resolution
2D T2-weighted MRI

- Inefficient scan
- Long scan times for high resolution
- Acquired in 2D with low through-plane resolution
- Obscure lesion morphology
- Difficult to align findings
3D T2-weighted MRI

RF

Signal
3D T2-weighted MRI

• Variable flip angle, extended echo train T2-weighted
3D T2-weighted MRI

- More efficient scan
- Higher resolution in all planes, reasonable scan times
3D T2-weighted MRI

- More efficient scan
- Higher resolution in all planes, reasonable scan times
3D T2-weighted MRI

- More efficient scan
- **Higher resolution** in all planes, reasonable scan times
3D T2-weighted MRI: Trade-offs

- T1 signal contamination
- Blurring due to extended echo train
- Tissue dependent
• T2 contrast

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• T2 contrast

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Clinical Breast MRI Protocol

T1-weighted Pre contrast

T1-weighted Post contrast

T2-weighted
Clinical Breast MRI Protocol

- T1-weighted Pre contrast
- T1-weighted Post contrast
- T2-weighted
T2-weighted Imaging in Breast MRI

- Identification of cysts
- Lesion characterization (contrast/morphology)
- Alignment with DCE images
- Small lesions
T2-weighted Imaging in Breast MRI

- Recent studies continue to show the potential contribution of T2-weighted Imaging to Breast MRI

**Original Article**

Nonmass Lesions in Magnetic Resonance Imaging of the Breast: Additional T2-Weighted Images Improve Diagnostic Accuracy

*Pascal A.T. Baltzer, MD, Matthias Dietzel, MD, and Werner A. Kaiser, MD, MS*

**Objective:** In magnetic resonance imaging (MRI) of the breast, contrast enhancements present as mass or nonmass (NM) lesions. This study aimed to test the usefulness of currently accepted T1-weighted Breast Imaging Reporting and Data System predictors and to determine the incremental value of new T2-weighted predictors for differentiation of benign from malignant NM lesions.

**Methods:** Comparative studies of T1, T2, and T1 fat-attenuated T2 images. The BI-RADS lexicon differentiates between space-occupying mass and non-space-occupying nonmass lesions. The advantage of this approach is that different biological tumor growth conditions are taken into account. Furthermore, radiological lesion descriptors applicable on the one group might show limited use in the other, that is, lesion margins. In comparison to mass lesions, the knowledge of nonmass lesions is rather limited. The
T2-weighted Imaging in Breast MRI

• While others point to the lingering questions of T2-weighted Imaging in breast MRI
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In the T2-weighted images water-containing lesions or edematous lesions have an intense signal, and in this sequence small cysts and myxoid fibroadenomas are very well identified. In most cases cancer does not yield a high signal on T2-weighted images; thus, these sequences can be useful in the differentiation between benign and malignant lesions. However, as most of these lesions can also be identified on T1-weighted images, there is no evidence as yet of added value of T2-weighted sequences in breast MRI [14, 15].
T2-weighted Imaging in Breast MRI

• While others point to the lingering questions of T2-weighted Imaging in breast MRI
• T2 contrast

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• T2-weighted imaging in breast MRI

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• T2-weighted imaging in breast MRI

• Pilot study in breast MRI
• Routine part of Protocol
• Routine part of Protocol

• Role remains vague
• Routine part of Protocol
  • Role remains vague
    • Alignment of finding, small lesions
• Routine part of Protocol
  • Role remains vague
    • Alignment of finding, small lesions
      • 3D T2-weighted Imaging
• Routine part of Protocol

• Role remains vague
  • Alignment of finding, small lesions
    • 3D T2-weighted Imaging
      • Improved resolution
• Routine part of Protocol

• Role remains vague
  • Alignment of finding, small lesions
    • 3D T2-weighted Imaging
      • Improved resolution
        • Improved T2-weighted data
Evaluation of 3D T2-weighted Imaging In Breast MRI
2D vs. 3D T2-weighted Imaging in Breast MRI

Subjects:

- 25 patients
- Clinically indicated breast MRI
- 2D-FSE and 3D-FSE-Cube
- 3D-FSE-Cube added on to clinical protocol
- Informed consent
2D vs. 3D T2-weighted Imaging in Breast MRI

Scans:

- 3T (GE Discovery MR 750)
- 8-channel GE HD Breast Coil
- Axial plane
## 2D vs. 3D T2-weighted Imaging in Breast MRI

### Imaging parameters:

<table>
<thead>
<tr>
<th></th>
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<th>3D-FSE-Cube</th>
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<tbody>
<tr>
<td><strong>Resolution</strong></td>
<td>1.25 mm x 1.0 mm</td>
<td>1.25 mm x 1.0 mm</td>
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<tr>
<td><strong>Slice Thickness</strong></td>
<td>4 mm</td>
<td>2 mm</td>
</tr>
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<td><strong>ETL</strong></td>
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<td>64</td>
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In 2/3 scan time 3D-FSE-Cube provided 50% reduction in voxel size
Analysis

• Identification of lesions

• Pathology

• Stability from prior imaging studies
Analysis

- Contrast
- Lesion morphology
- Diagnostic significance
Analysis: Contrast

- Lesion-to-fibroglandular tissue signal ratio ($S_L/S_F$)
- Lesion signal intensity ($S_L$)
- Fibroglandular signal intensity ($S_F$)
Analysis: Lesion Morphology

• Blinded paired review

• Three radiologists with breast imaging expertise

• Only lesion with high T2-signal

• Lesion magnified and indicated with an arrow
Analysis: Lesion Morphology

- Clearer depiction of morphology
- Or if depiction of morphology was equivalent
- Statistical significance
Analysis: Diagnostic Significance

- Fourth radiologist with breast MRI expertise

- Unblinded review

- Instances where 3D-FSE-Cube affected diagnostic information were noted

- Images analyzed in acquisition plane as well as in reformatted sagittal and coronal orientations
Results

• 17 lesions identified

• 7 malignant and 10 benign
  • 7 invasive ductal carcinomas
  • 5 fibroadenomas
  • 3 cysts
  • 1 papilloma
  • 1 cyst/hematoma
2D FSE vs. 3D-FSE-Cube Lesion-to-Fibroglanular Tissue Contrast ($S_L / S_F$)

$R^2 = 0.93$
Equivalent Contrast

Contrast-Enhanced T1-weighted

IDC

Fibroadenoma

2D-FSE

3D-FSE-Cube
Depiction of Lesion Morphology: 2D FSE versus 3D-FSE-Cube

Statistically significant: $p \leq 0.02$, $p \leq 0.01$, $p \leq 0.03$
Depiction of Lesion Morphology
Depiction of Lesion Morphology

2D-FSE

3D-FSE-Cube

✓ ✓ ✓
Depiction of Lesion Morphology
Depiction of Lesion Morphology

2D-FSE  =  3D-FSE-Cube
Potential Diagnostic Contribution

Contrast-Enhanced T1-weighted

2D-FSE

3D-FSE-Cube
Conclusions

• Comparable contrast

• Improves the depiction of lesion morphology

• Contribution to differential diagnosis
Clinical Utilization, Future Work

• 3D-FSE-Cube now routine in breast MRI at Stanford
• Alignment of findings
• Larger database of patients
• Focus on specific T2-features of breast lesions
Acknowledgements

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