Comparison of steady-state and spin-echo DWI based on morphological assessment of breast lesions

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Target Audience: Breast radiologists and engineers interested in steady-state DWI

Introduction
Steady-state diffusion weighted sequences, such as DESS [1,2], use a Cartesian acquisition to acquire images with less distortion and less blurring than with single-shot spin-echo EPI DWI. The DESS sequence has primarily been used for knee imaging, but has the potential to greatly improve diffusion-weighted breast imaging [3,4], where single-shot EPI DWI has limited image quality. To evaluate the potential of using DESS for diffusion-weighted breast imaging, we surveyed radiologists and compared image quality and diagnostic value (relative to pathology) based on assessment of lesion morphology.

Methods & Results
The DESS sequence was added to our 3T clinical protocol allowing us to compare DESS to conventional DWI and post-contrast DCE images (gold-standard). Patients were scanned between November 2009 and May 2013 following an IRB-approved protocol. Only lesions with pathology results were included. An experienced radiologist identified lesions on DCE, DESS, and DWI images using all available diagnostic information, including findings from MRI, mammography, ultrasound, manual exams, and pathology. Four other experienced breast radiologists evaluated image sharpness and diagnostic value of the images. The radiologists were shown a single image at a time in random order and blinded to the sequence type.

Image quality
The image quality rating includes the effects of image resolution, distortion, blurring, and motion artifact. As expected, both the DCE images were rated as sharper than DESS images (DCE>DESS) and the DESS images were rated as sharper than DWI images (DESS>DWI). The differences in image quality are significant at the p=0.001 level for all but one comparison (Radiologist 1, DESS vs. DWI).

<table>
<thead>
<tr>
<th>Prescribed resolution</th>
<th>Scan time [min.sec]</th>
<th>Rating</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DCE 0.11 x 0.11 x 1.2</td>
<td>18:08*</td>
<td>1</td>
<td>Very blurry</td>
</tr>
<tr>
<td>DESS 0.09 x 0.13 x 2.5</td>
<td>3:35</td>
<td>2</td>
<td>Blurry</td>
</tr>
<tr>
<td>DWI 0.21 x 0.21 x 5.0</td>
<td>2:50</td>
<td>3</td>
<td>Average</td>
</tr>
</tbody>
</table>
* hi-res pre, 14 dynamic (13s), & 4 hi-res post frames

Breast Imaging Reporting and Data System (BI-RADS) score
Pathology results were used as the gold standard for determining malignancy. Sensitivity and specificity were calculated using each BI-RADS score as a threshold to generate ROC curves. The area under the curve (AUC) was calculated using trapezoid approximation, and AUC confidence intervals were calculated using multi-reader multi-case analysis software from University of Iowa [5].

The only significant difference in AUC was for the comparison of DCE and DWI (p=0.002). However, there is a trend in the AUC and confidence intervals: the AUC is greatest and the confidence interval is tightest for DCE and the AUC is smallest and the confidence interval is the widest for DWI. The lower endpoint of the DESS confidence interval is greater than 0.5 (corresponding to a random chance test).

Discussion & Conclusion
Our patient population included only subjects with lesions, so further study is needed to evaluate the performance in a general screening population. The DESS images were rated as being significantly sharper than DWI images, and the ROC curves of DESS had larger AUCs than those of DWI. Further study is warranted to determine the value of using quantitative information, such as ADC values, and using multiple images, e.g., DESS and DCE together, to improve diagnosis of breast lesions.

In conclusion, we have demonstrated that the DESS images have significantly higher image quality than conventional DWI images for the patients in our study. The higher image quality may facilitate diagnosis by improving the morphologic depiction of breast lesions.

References
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