

Clinical evaluation of 3D diffusion-weighted breast imaging with dual echo steady state (DESS)

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Introduction

The DESS sequence has been shown to provide 3D high-resolution diffusion-weighted images with low distortion (Figure 1), which may improve the specificity of breast MRI [1,2,3]. In this study, we compare the ability of DESS with the abilities of T1-weighted dynamic contrast-enhanced (DCE) and spin-echo diffusion-weighted imaging (DWI) to detect and characterize potentially malignant breast lesions.

Methods

All data were acquired on a 3T GE MR750 scanner (GE Healthcare, Waukesha, WI) using an 8-channel breast coil (GE Healthcare, Milwaukee, WI). Patients that had been scanned with this protocol were scanned with informed consent and IRB approval. The DESS images were compared to DCE and DWI images. Typical acquisition parameters were:

DCE: 4:00 min, TE/TR=2.4/5.3ms, 1.4x0.6x1.2mm³ voxels, 13°;

DWI: 2:20 min, TE/TR=8/20ms, 1x1x2.5mm³ voxels, 90°, b~600s/mm²;

DESS: 2:20 min, TE₁/TE₂/TR=8/32/20ms, 1.3x0.9x2.5mm³ voxels, 35°, b~300s/mm²

A radiologist identified biopsy- and mastectomy-proven lesions in the 20 patients that have been scanned with this protocol. Three different radiologists rated the images in terms of lesion visibility (not visible, very faint, barely seen, definite, brighter than glandular tissue), image sharpness (very blurry, somewhat blurry, average, sharp, very sharp), margin (smooth, lobulated, microlobulated, spiculated), rim signal (no high rim signal, possible, likely, definite, very bright rim signal), and septa (no internal septa, possible, likely, definite, very clear septa). Radiologists viewed a single sequence at a time and in random order.

Results and Discussion

Visibility – Fifteen benign and nineteen malignant lesions were found among the 20 cases (Table 1). DESS images showed 21 lesions as brighter than normal glandular tissue, whereas DWI only showed 17 lesions. DESS only failed to identify malignant lesions that were isointense on DCE, some invasive ductal carcinomas, and when fat suppression failed and obscured the lesion (Figure 2).

Sharpness – In general, DESS produces sharper images than DWI (Figures 1,3). Of the 6 cases for which at least one radiologist rated the DESS image as blurrier than the DWI image, 4 images had poor fat suppression and 2 images had visible motion artifact. Therefore, better fat suppression and motion correction may further improve DESS image quality.

Spiculations – Due to the higher resolution of the DESS acquisitions, it is generally much easier to see the spiculations on DESS than DWI (Figure 1). There was only one lesion that was identified to have spiculations on DWI, but not DESS (Figure 3). However, for that case the DESS image was rated as much sharper than the DWI image, so the lesion was more clearly depicted.

High rim signal – Of the 15 lesions with rim enhancement visible on DCE, 6 had high rim signal on both DESS and DWI, 2 had high rim signal on DESS but not DWI, and 3 had high rim signal on DWI, but not DESS. These differences in rim signal may be due to difference in contrast mechanisms (perfusion vs. diffusion) and differences in the resolution of the images.

Septa – There were no septa identified in the DCE images. Of the septa identified on the DWI and DESS images, the low signal in many cases is due to Gibb's ringing or lesion heterogeneity. Further study of benign lesions is necessary to assess the ability of DESS to depict septa.

Conclusion

DESS is a promising method for imaging breast cancer without the need for IV contrast and even shows lesions that are surrounded by fibroglandular tissue (Figure 3). Furthermore, DESS generates images with T2 weighting, and T2 and ADC maps can be calculated from multiple DESS acquisitions [4]. With improved fat suppression (currently achieved with a spatial-spectral excitation) and correction for the motion artifact (Figure 4, arrow), DESS may replace spin-echo DWI because DESS can provide better morphological information due to higher resolution and lower distortion. Future potential as a contrast-agent-free method warrants additional investigation.

References [1] ISMRM 2010, #366. [2] Eur Rad 2010, 20: 1101. [3] ISMRM 2011, #380. [4] ISMRM 2011, #500.

	Pathology	DCE	DWI	DESS
Benign	15	11	9	10
Malignant	19	19	8	11

Table 1 Number of lesions identified by pathology and identified as bright on each sequence by all three radiologists.

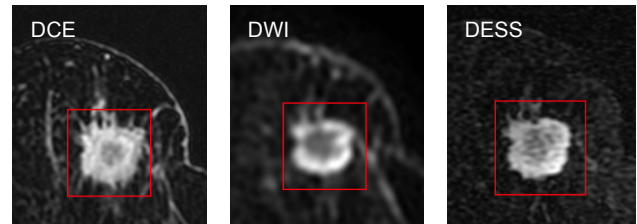


Figure 1 – 2.4cm Grade 2 IDC. High rim signal is clearly visible on all images.

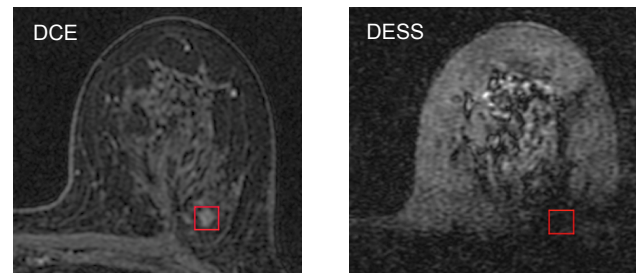


Figure 2 – 0.6cm Grade 1 IDC. The fat suppression failed in the DESS image, which resulted in water suppression and therefore obscured the lesion.

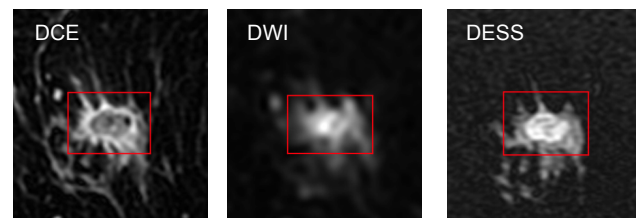


Figure 3 – 1.9cm Grade 2 IDC. The higher resolution of the DESS image compared to DWI better depicts the margin.

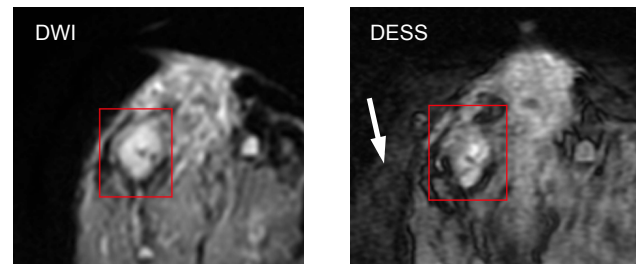


Figure 4 – 1.8cm Galactocoele. The higher resolution and lower distortion of the DESS image make the septa easier to see. (Arrow shows motion artifact.)

Acknowledgements R01-EB009055 R21-EB012591 P41-RR009784