Specialty Area: **Advanced Diffusion Acquisition: Targeted Methods**

Lecture Title: **Breast**

Speaker Name: **Savannah C. Partridge, PhD; scp3@uw.edu**
University of Washington, Seattle, WA USA

Target Audience: Radiologists, Medical Physicists, MR Technologists

OBJECTIVES:
- Review challenges of breast DWI
- Optimization of breast DWI protocols
- Factors affecting breast ADC measures

PURPOSE: There has been growing interest in the use of diffusion weighted MRI (DWI) for breast imaging. This technique has shown promise for improving the specificity of breast MRI [1], early detection of treatment response, and as a non-contrast MRI alternative for breast screening. However, there are challenges to obtaining good quality breast DWI images. Technical considerations for obtaining high quality breast DW images are presented with examples and general protocol recommendations.

METHODS: The techniques used to acquire DW images of the breast, including the choice of b-values, vary considerably across studies in the literature. There is also wide variation in image quality of breast DWI due to the particular challenges of off-isocenter imaging, air-tissue interfaces, and significant fat content in the breast. Furthermore, differences in data analysis approaches including post-processing, ADC calculation, and region-of-interest methods result in considerable differences in the reported ADC values of similar breast pathologies. This lack of standardization makes it difficult to define interpretation recommendations for breast DWI and reliably assess the clinical utility of the technique.

RESULTS: To reduce EPI-related artifacts in the breast, good shimming and bilateral suppression of lipid signal is essential. Advanced RF coil design, parallel imaging, and higher order shimming techniques help to overcome some of the technical limitations to achieving high quality breast DW images, particularly at higher field strengths. Protocols also must be optimized for adequate signal-to-noise ratio (SNR) by minimizing TE and balancing spatial resolution and appropriate b-values [2]. For lesion conspicuity and detection purposes, a high b-value ($\geq$800 s/mm^2) may be preferred, while for differentiation between benign and malignant lesions, choice of b-value may be less important [3]. Further, multiple b-value acquisitions in the breast have not been shown to improve diagnostic performance over standard two b-value acquisitions, and the advantage of a nonzero minimum b-value ($\geq$50 s/mm^2) has not been proven in breast [3]. Low spatial resolution remains a primary limitation of DWI that can preclude detection and characterization of small or diffuse disease. Higher spatial resolution may be achievable in breast DWI at higher magnetic field strength or through alternative acquisition strategies [4]. Image registration prior to ADC mapping is useful to correct misalignments between gradient DW images due to motion and/or eddy currents. Normalized ADC values (tumor/normal tissue) may further improve diagnostic performance by accounting for inter- and intra-subject variations in breast density and water content [5].

DISCUSSION/CONCLUSION:
Recommendations for high quality breast DWI at 1.5T or 3T include using an EPI-based sequence with parallel imaging, SPAIR (at 3T) or other effective fat suppression, and higher order image-based shim methods (particularly at higher field strengths) for bilateral imaging. Given the time constraints of clinical practice, ADC calculation using two b-values (i.e. b = 0, 800 s/mm^2) is acceptable. A growing number of imaging centers are incorporating DWI into the clinical breast MR examination. However, it is essential to standardize breast DWI acquisition and interpretation approaches before widespread clinical implementation is warranted.

REFERENCES:

1. Partridge SC, DeMartini WB, Kurland BF, et al. AJR 2009;193:1716-1722.
2. Bogner W, Gruber S, Pinker K, et al. Radiology 2009 Nov;253(2):341-51.
3. Peters NH, Vincken KL, van den Bosch MA, et al. J Magn Reson Imaging. 2010 May;31(5):1100-5.
4. Singer L, Wilmes LJ, Saritas EU, et al. Acad Radiol 2012; 19(5):526-34.
5. El Khouli RH, Jacobs MA, Mezban SD, et al. Radiology 2010; 256(1):64-73.