

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

**Lecture Title:** Abdomen and Pelvis

**Speaker Name:** Thomas L. Chenevert, Ph.D.; [tlchenev@umich.edu](mailto:tlchenev@umich.edu)  
University of Michigan, Ann Arbor, MI USA

**Target Audience:** Body Radiologists and MR Scientists

**Objectives:**

- Identify biophysical targets of DWI for abdomen/pelvis applications
- Technical challenges and current remedies
- Common protocols

**PURPOSE:** Despite widespread use of abdominal/pelvic DWI, robust acquisition methods are not uniformly available across system platforms and protocols are not standardized. Technical variation stems from multiple approaches to deal with challenges presented by respiratory/cardiac motion, fat signal, and need for high shim quality over a large FOV in presence of susceptibility gradients. Current issues, their remedy and recommended protocols will be presented.

**METHODS:** Biophysical targets available to abdominal/pelvic DWI include depiction of disease by way of diffusion patterns that alter cell density and perfusion, as well as their change due treatment. Relative sensitivity of DWI to true thermal-driven water mobility versus macroscopic motion and flow is primarily driven by choice of b-value and direction of the motion-encoding gradient. Perfusion effects are most apparent in the low b-value regime ( $<150\text{s/mm}^2$ ), with diffusion dominant at higher b-values ( $>500\text{s/mm}^2$ ). The high degree of anisotropic diffusion observed in neural tissue is not seen in abdominal and pelvis tissue, therefore DTI is not common in the abdomen/pelvis. Nevertheless, potential directional bias is removed by DWI measurement along three orthogonal directions so that the rotationally-invariant mean diffusivity or ADC value can be derived. Important secondary considerations in DWI acquisition include method of fat suppression (STIR-based, or chemical shift selective-based), bulk motion control (single-shot vs multi-shot; cardiac/respiratory synchronization; high averaging), and use of parallel imaging to reduce spatial distortion, reduce TE (increase SNR), and increase spatial resolution.

**RESULTS:** Single-shot DW EPI remains the mainstay for torso DWI. Spatial distortion is effectively controlled by parallel imaging (factor 2-3 or greater if coil properties allow). Respiratory motion control by gated acquisition or diaphragm navigation/tracking increase scantime but improve spatial alignment of DW images and ADC quantification; although, asynchronous cardiac pulsation still confound ADC measurement in the left lobe of the liver. Contrast, thus detection of cellular dense lesions is enhanced at high b-values, although ADC calculation may be biased by low SNR, particularly for moderate-high ADC tissue. The issue of "detection" vs "quantification" should be considered for each application. Perfusion-sensitive DWI that focusses on signal vs b-value in the low b-value regime are an active area of interest, especially for vascular rich tissues such as in the kidney.

**DISCUSSION / CONCLUSION:** Recommendations for organ- and application-specific protocols are available (1-5) and serve as a starting point to standardization DWI acquisition. Protocol harmonization is essential for multi-center trials, and lack of standardization in the most fundamental parameter, b-value, has contributed to variance in ADC due to variable degree of perfusion influence on measurements.

**REFERENCES:**

1. Chandarana H, Taouli B. Diffusion and perfusion imaging of the liver. *Eur J Radiol.* 2010;76(3):348-58.
2. Koh DM, Collins DJ. Diffusion-weighted MRI in the body: applications and challenges in oncology. *AJR Am J Roentgenol.* 2007;188(6):1622-35.
3. Koh DM, Takahara T, Imai Y, Collins DJ. Practical aspects of assessing tumors using clinical diffusion-weighted imaging in the body. *Magn Reson Med Sci.* 2007;6(4):211-24.
4. Padhani AR, Liu G, Koh DM, Chenevert TL, Thoeny HC, Takahara T, et al. Diffusion-weighted magnetic resonance imaging as a cancer biomarker: consensus and recommendations. *Neoplasia.* 2009;11(2):102-25. PMID: 2631136.
5. Thoeny HC, Forstner R, De Keyzer F. Genitourinary applications of diffusion-weighted MR imaging in the pelvis. *Radiology.* 2012;263(2):326-42.