

## Evaluation of Focal Liver Lesions with Diffusion Weighted MRI and ADC maps

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**Introduction:** Diffusion weighted MR imaging (DWI) detects thermally induced brownian movement of water molecules in biologic tissues under the influence of gradients. Viable tumors with high cellularity and intact cell membranes restrict the mobility of water molecules causing a relatively low apparent diffusion coefficient (ADC) value (restricted diffusion). Conversely, cellular necrosis and cystic lesions cause increased membranous permeability, allowing water molecules to move freely, causing a relative increase in the ADC value (non restricted diffusion). Thus, DWI and ADC values can provide insight into tumor microstructure.

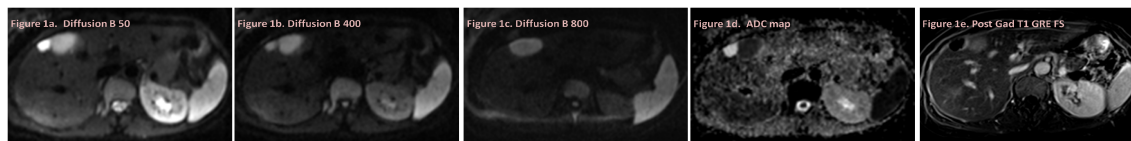
There is lack of utilization of DWI in body imaging. DWI is excellent in neuro-imaging in diagnosis of acute infarcts and characterizing brain lesions, but has not been effectively utilized in other areas such as characterizing liver lesions. Currently liver lesions are characterized with pre and post contrast and multiple phase imaging via CT or MR based on size, density/ signal intensity and enhancement pattern. DW MR imaging can enable qualitative and quantitative assessment of tissue diffusivity without the use of intravenous gadolinium contrast, which makes it a highly attractive technique.

DWI takes advantage of diagnosis and differentiating between benign and malignant liver lesions with additional functional information. It is also a helpful tool in following up treated lesions. Liver lesions can be analyzed with DWI without the use of IV contrast and can contribute to planning whether it is related to making a decision to resect the mass, biopsy or other interventions. DWI can also detect early 'micrometastasis' that can affect staging. DWI can also assist in the planning of invasive procedures and help in deciding which lesions to biopsy in cases with multiple liver lesions which may contain a mix of benign and malignant lesions.

DWI offers the additional functional information over contrast imaging with quantitative analysis as well as qualitative (visual analysis) without the administration of IV contrast. Advantages of DWI are numerous compared to routine imaging in the realm of oncology. DWI has a similar functional component of imaging such as Positron Emission Tomography (PET), but with better anatomy, reduced background artifact and higher resolution.

**Methods:** Respiratory-gated DWI sequence is used in our clinical setting. Patients are scanned on a 1.5T ESPREE MR scanner (Siemens, Erlangen, Germany). Patients lie supine and an 8 channel torso coil was placed on the abdomen with liver positioned in the centre of the coil. Fat suppression enabled DW-EPI sequence supplied by the vendor was used for the respiratory-gated DWI. A single-shot EPI readout was preceded by a diffusion sensitizing block consisting of two 180° radiofrequency pulses and four motion-probing gradient pulses. Three b-values: 50, 400 and 800 s/mm<sup>2</sup> was used. For respiratory triggering, PACE (prospective acquisition correction) technique was used. The imaging parameters used for the gated DW scans were as follows: TR = 5000 ms, TE = 82 ms, number of averages = 2, BW = 1630 Hz/px, data matrix = 192 × 192, FOV = 35 × 35 cm<sup>2</sup>, number of slices = 24 (for each b-value), slice thickness = 6 mm and slice gap = 2 mm. Total imaging time was ~ 6- 10 min depending on each individual's breathing cycle.

**Results and Discussion:** Figure shows DWI acquired at different b-values and the computed ADC map and post contrast imaging demonstrating two hepatic lesions in a case of colon cancer with benign and malignant characteristics. Figures 1 a-e demonstrates two focal lesions in the anterior right hepatic lobe. Figures 1a-c are DWI images at increasing b-values 50, 400, 800 s/mm<sup>2</sup> demonstrating the smaller, more lateral cystic lesion showing drop out compatible with benign cyst. The more medial, larger solid lesion is compatible with metastatic lesion as it doesn't drop out with increasing B values (Figure 1c.) This is further confirmed on ADC image (Figure 1d) which shows the larger solid metastatic lesion showing restricted diffusion with hypo-intense signal on ADC images. Figures 1a-d differentiates the benign and malignant lesion subjectively. The corresponding PET image (not listed in this abstract) demonstrates increased metabolic activity in the region of the metastatic lesion, but the poor resolution and increased noise makes it difficult to appreciate the anatomy and the adjacent benign cyst. Based on our quantitative analysis, we also confirmed the characterization with ADC values. The solid lesion had an ADC value of 1.06 (malignant), and the smaller, more lateral cystic lesion had an ADC value of 2.88 (benign). Figure 1e, post contrast T1-GRE fat saturated image demonstrates the enhancing malignant lesion and the non enhancing benign cystic lesion.



**MRI with DWI, ADC map and post contrast T1 FS images demonstrating two hepatic lesions in a case of colon cancer with benign and malignant characteristics.**

The presented cases demonstrate how DWI can help detect some focal lesions better than other routine or dedicated oncological imaging, differentiating between malignant and benign lesions, and following treated lesions. The cases easily demonstrate how DWI characterizes the lesions subjectively. The malignant lesions restrict diffusion (appear hyper-intense on diffusion imaging and hypo-intense on ADC images). However, in our current study based on our extensive data set, it was determined that these lesions can be characterized quantitatively using ADC values. Based on our preliminary data set trend, it is proposed that lesions with ADC values less than 1.4 were malignant, lesions with values > 1.5 were benign and lesions with ADC values between 1.4 and 1.5 were indeterminate.

**Conclusion:** DWI can be highly beneficial in diagnosis and differentiating benign from malignant liver lesions with additional functional information. DW MR imaging along with corresponding ADC values can enable qualitative and quantitative assessment of tissue diffusivity without the use of intravenous gadolinium contrast enabling a more noninvasive insight into tumor microstructure.

