**PRINCIPLES OF DWI**

- Diffusion Weighted Imaging (DWI) provides tissue contrast by measuring the diffusion of water molecules within tissues. Molecules move in Brownian motion, or molecular diffusion, which is the concept that any molecule in a fluid will be randomly displaced due to agitation by thermal energy.
- Diffusion of water molecules can occur via random diffusion due to heat, Brownian motion, and turbulence within tissues. This random movement causes the signal to decrease with increased b-values, where the b-value is the strength of the diffusion-weighting.
- In biological tissues, diffusion is also affected by the biophysical properties of tissue cells, such as intactness of cell membranes, the diffusion rate of molecules, and cell density.
- Pathological processes which change the volume ratio or physical nature of intra- and extra-cellular spaces affect the diffusion of water within cells, which is decreased in intact cells and increased in disrupted cells.
- DWI imaging provides information that reflects tissue integrity and the integrity of cellular membranes.

**LIVER DWI UTILITY/ADVANTAGES**

- Diffusion weighted imaging (DWI) has demonstrated promise in the evaluation of liver malignancy, particularly in detecting tumors with low cellularity or disrupted cell membranes, which is encountered in tissues with low cellularity or tissues with disrupted cellular membranes, i.e., abscesses.
- Reduced ADC values have been reported in most malignant lesions, likely related to cellular membrane integrity or the mobility of water molecules.
- ADC values may reflect the differentiation of liver lesions, and ADC values are also promising in determining which lesions are high ADC values than malignant lesions. Further characterization of lesions may be achieved by comparing lesions, and their components have been shown to demonstrate suppression or enhancement.

**TREATMENT RESPONSE**

- The dynamic evolution of tumor tissue is expected in response to treatment on theoretical grounds. Increased in tumor ADC has been observed in several studies with different treatments and HCC.
- ADC changes are observed earlier than morphologic alteration and may be as early as 24-48 hours after treatment.
- An increase in ADC has been observed in responders to both systemic and local therapies.
- ADC change may be observed even by less-invasive, non-contrast-enhanced imaging modalities.

**PITFALLS/LIMITATIONS OF DWI**

- Single shot echo planar DWI (SS-EPI DWI) is the gold standard in abdominal DWI technique. It has a limited image quality, arising from poor signal-to-noise ratio (SNR), spatial resolution, and echo-planar imaging-related artifacts.
- Inherent to the technique, the sequence is limited to spatial resolution and low SNR. However, EPI can be used to image specific regions of interest.
- ADC changes are observed earlier than morphologic alteration and may be as early as 24-48 hours after treatment.
- Optimization of DWI can be achieved by combining parallel imaging, decreased echo-spacing encoding points, and small diffusion gradients to achieve image quality and SNR similar to those of T2-weighted imaging.

**ADC MAPPING**

- ADC mapping is a reproducible and accurate imaging modality to assess tissue characteristics for different DWI sequences and b-values.
- ADC changes are observed earlier than morphologic alteration and may be as early as 24-48 hours after treatment.
- ADC values are useful in differentiating between benign and malignant lesions that have been reported in various studies.

**DWBART/FACTS (cont.)**

- Sensitivity and specificity of DWI in assessing hepatic lesions are high, with high accuracy compared to conventional imaging. DWI can demonstrate suppression or enhancement of lesions.
- Diffusion imaging can be used to identify hypervascular lesions, such as hepatocellular carcinoma (HCC) and focal nodular hyperplasia (FNH).
- DWI is demonstrated to have higher sensitivity, better image quality and fewer artifacts than conventional imaging techniques.

**CASE 1: Giant Cavernous Hemangioma**

Hepatic hemangiomas (also known as hepatic cavernous malformations) are benign vascular malformations of the liver. They are also referred to as cavernous hemangiomas or angiomatous lesions. They are most common in women and usually occur in the right lobe of the liver.

**CASE 2: Hepatic Cyst**

Simple hepatic cysts may be isolated or multiple and may vary from a few millimeters to several centimeters or diameters. Simple hepatic cysts are benign developmental lesions that do not communicate with the biliary tree. The current theory regarding the origin of simple hepatic cysts is that they originate from the embryonic ductal plate which become lined by epithelium and then stop developing.

**CASE 3: Carcinoid Tumor with Liver Metastasis**

Neuroendocrine tumors arise from various neuroendocrine cells whose normal function is to secrete various hormones into the bloodstream. Neuroendocrine tumors are present not only in endocrine glands throughout the body that produce hormones, but also found in nearly all solid tissues. Carcinoid tumors and related neuroendocrine tumors (NETs) are small, slow-growing tumors that are more commonly found in young women. They are frequently asymptomatic and typically discovered during imaging tests for other conditions.

**CASE 4: Focal Nodular Hyperplasia**

Focal nodular hyperplasia (FNH) is the second most common form of benign liver tumor after hemangiomas. They are more commonly found in young women. They are asymptomatic and generally discovered during imaging tests for other conditions.

**REFERENCES**

- Andrew Marshall, MD; Krystle Barhaghi, MD; Jeremy B. Nguyen, MD, MS; Scott L. Beech, MD; Cynthia W. Haneman, MD; Mandy Weidenhaft, MD; James Vu, BS.

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