Incorporating Diffusion Techniques into Whole body MRI

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Purpose:

Diffusion weighted MRI sequences have been shown to aid in lesion detection and characterization by providing unique information regarding the mean free path of water movement within cells and in their adjacent extracellular environment. This sequence has the ability to aid in discrimination between benign and malignant lesions, and coupled with co-localized conventional sequences has the ability to assess both form and function, thus maximizing spatial and contrast resolution. Optimizing acquisition of these sequences for scanning the whole body provides high diagnostic yield. This presentation will review the theory behind diffusion, and outline pearls and pitfalls in free breathing techniques for whole body diffusion coupled with co-localized conventional sequences from a facility that has performed over 1000 body diffusion cases.

Outline of Content:

Diffusion weighted imaging (DWI) is a sequence which, like many functional imaging techniques, is able to provide maximal contrast resolution of a lesion to background tissue almost irrespective of lesion size. This is accomplished by utilizing gradient based b-values with fat suppression. Using at least two different b-values, the machine independent, quantifiable apparent diffusion coefficient (ADC) value of tissue can be calculated. The lower the b-value, the more signal is provided from both normal, and hypercellular tissue. However b-values below 100, result in dominant flow effects from solid organs skewing the linear component of the calculated ADC value, thus resulting in inaccurate ADC measurements. For lesion detection in body diffusion sequences, depending on the degree of native tissue cellular density, b-values of 500 and 800 are preferred. These b-values result in minimized scan time, with an optimal degree of lesion to background signal, thus providing the ability to correct for free breathing versus breathold misregistration, particularly near the diaphragm, and where cardiac pulsation artifact is also present. Whole body diffusion sequences are typically viewed inverse (black on white background) to improve conspicuity(see figure 1). At our facility multi b-value DWI sequences are 3 space DICOM registered with conventional breathold sequences. This allows triangulation of DWI detected lesions easily with conventional high spatial resolution sequences, thus maximizing diagnostic information.

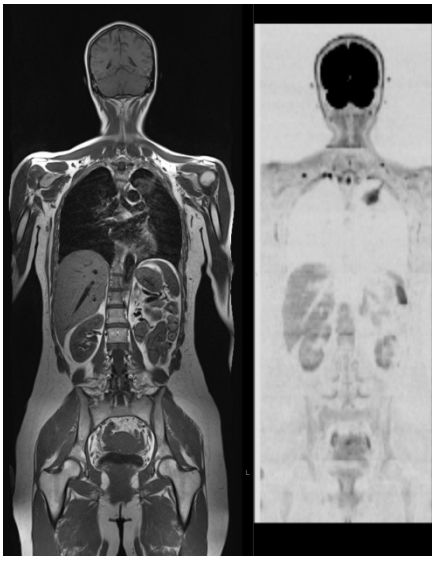

Figure 1 Stage 1 Lung Cancer. DWI sequence conspicuity is not affected by breathing, or pulsation

Conventional sequences rely on morphology of fat and/or water signal for qualitative tissue assessment, with gadolinium contrast being administered to assess for tissue vascularity. Increased tissue vascularity is often considered a harbinger of malignancy, which is commonly accompanied by hypermetabolism, and hypercellularity. DWI sequences, based on the Stokes equation and echo-planar based acquisition, have the capability to characterize lesions associated with not only increased cellularity, but also with decreased viscosity, and hemorrhagic components.

Summary:

Incorporation of DWI sequences into routine clinical body imaging is easily achievable on modern MRI scanners, and this functional sequence has the ability to improve lesion detection and characterization as well as provide a quantifiable parameter of free water motion in the cellular microenvironment.