Whole Body DWI

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Key points:

1. Whole body DWI (WB-DWI) is increasingly used for disease detection, disease staging and the assessment of treatment response in patients with cancer.

2. Knowledge of technical optimization and interpretative pitfalls is critical to ensure good diagnostic performance.

3. WB-DWI shows substantial promise for the evaluation of bone metastases and bone marrow infiltration (e.g. multiple myeloma), for which conventional imaging techniques are limited in defining disease extent and response to treatment.

Target Audience:

Radiologists, technologists and allied scientists interested in cancer staging and WB-DWI.

Outcomes/ Objectives:

1. Understand the rationale, technical implementation and interpretative pitfalls of WB-DWI in oncology.

2. Learn the use WB-DWI for the evaluation of cancers, including metastatic bone disease and bone marrow infiltration.

Introduction:

Diffusion-weighted MRI (DWI) is now widely used as a standard MR sequence for body imaging. The technique results in high signal contrast between cellular tissue (e.g. tumors) and normal tissue. On DWI, the impeded motion of water protons in tumors returns relatively high signal intensity, compared with the normal background tissue, which is relatively signal suppressed. The degree of water mobility can be quantified by the apparent diffusion coefficient (ADC).

On newer MR imaging platforms, the use of surface coils and parallel imaging techniques, allow DWI to be sequentially performed across multiple anatomical stations in a relatively short time. These images are stacked together to create whole body displays for review and interpretation. By using radial maximum intensity post-processing technique, whole body projection images are created that superficially resemble PET imaging. Such images can be appraised quickly by radiologists "at-a-glance" in clinical deployment.

Technical Consideration and Image interpretation:

WB-DWI should be acquired with meticulous technique to maximize image signal-to-noise and to reduce artifacts. In particularly, ghosting artifacts resulting from poor fat suppression can adversely affect the quality of the maximum intensity projection images. At 1.5T, spinal misalignment may be avoided or minimize by applying the frequency offset from the tune-up or generalized shim to all the imaging stations. However, this is usually less successful at 3T and manual post-processing may be required.

When interpreting images, the DWI b-value images should always be read alongside morphological T1/T2-weighted images and the ADC maps to avoid mistakes. The radiologists should be familiar with the known causes of false positives and false negatives. For example, false positive may result from benign cellular processes and T2-shine through effects; while false negative may result from cystic or mucinous disease, lesion hemorrhage, lesion calcifications and image artifacts.

Disease evaluation

WB-DWI has been applied for cancer staging and evaluation in multiple myeloma, malignant melanoma, lung, breast and prostate cancers. In particular, the technique has shown enhanced diagnostic performance for the detection of bone disease compared with radionuclide bone scan and CT. Furthermore, studies have shown that with successful treatment, tumor ADC values in bones significantly increase in responders to treatment. This has implications for the development and deployment of therapeutic regimes for malignant bone disease, as there are currently no reliable or widely accepted criteria for the evaluation of bone metastases. However, as the diffusion signal intensity in bones vary with the proportion of yellow versus red marrow, and the presence of bone sclerosis/calcification and fibrosis, more work is needed to understand the complex relationship between the diffusion signal and ADC value with alterations in the composite elements in bones.