Added value of DWI for assessing bones

Prof. Anwar R Padhani. Mount Vernon Cancer Centre, London, England

anwar.padhani@stricklandscanner.org.uk

Metastatic bone disease is a common manifestation of advanced cancers with a very high prevalence in breast, prostate and lung cancers. Accurate assessments of skeletal disease burden and response evaluations of patients with bone metastases are notoriously difficult to do particularly in breast and prostate cancer patients where bone only disease is a common occurrence. The inability to accurately determine bone metastases status results in the poor performance of conventional trial endpoints such as progression free survival; the latter cannot be used as a surrogate of overall survival (1). Current methods of assessing tumor response at skeletal sites do not always enable the positive assessment of therapeutic benefit to be made but instead provide an evaluation of progression, which then guides therapy decisions in the clinic.

Whole body DW imaging (WB-DWI) has emerged as a promising bone marrow assessment tool for detection and therapy monitoring of bone metastases (2-4). On WB-DWI, lytic skeletal metastases appear as focal or diffuse areas of high-signal intensity on high b-values on a background of lower signal intensity of the normal bone marrow. Metastasis detection with DWI should be done with anatomical MRI (4); a recent meta-analysis demonstrated high sensitivity of WB-DWI to detect metastases at the expense of specificity (2). Causes for false-positive findings on WB-DWI include bone marrow edema caused by fractures, osteoarthritis, infection, bone infarcts, vertebral hemangiomas, isolated bone marrow islands and bone marrow hyperplasia. False-negative findings occur when there are low levels of bone marrow infiltration or when background bone marrow hyperplasia obscures metastases. Detection of skeletal metastases may be impaired in areas of body movement and the visibility of skull vault and base infiltrations are impaired because of the adjacent high signal of the brain. False-negative findings also include treated malignant disease and sclerotic deposits.

WB-DWI when combined emerging “wet” biomarkers can improve the classification of therapy response in patients with metastatic bone disease. Both high b-value image signal intensity and ADC value changes are needed for therapeutic assessments. A range of imaging findings can be seen depending on the type of therapy and duration of treatment (3, 5). Diffusion MRI therapy response criteria need to be developed and tested in prospective studies in order to address current, unmet clinical and pharmaceutical needs for reliable measures of tumor response in metastatic bone disease (6).

1. Huang X, et al. Challenges to improved therapeutics for metastatic castrate resistant prostate cancer: from recent successes and failures. J Hematol Oncol 2012; 5:35-42.
2. Wu LM, et al. Diagnostic value of whole-body magnetic resonance imaging for bone metastases: a systematic review and meta-analysis. J Magn Reson Imaging. 2011; 34:128-135.
3. Padhani AR, Gogbashian A. Bony metastases: assessing response to therapy with whole-body diffusion MRI. Cancer Imaging 2011; 11:S129-145.
4. Lecouvet FE, et al. Can whole-body magnetic resonance imaging with diffusion-weighted imaging replace Tc 99m bone scanning and computed tomography for single-step detection of metastases in patients with high-risk prostate cancer? Eur Urol 2012; 62:68-75.
5. Padhani AR, et al. Therapy monitoring of skeletal metastases with whole body diffusion MRI. J Magn Reson Imaging 2013; In press.
6. Padhani AR, Koh DM, Collins DJ. Whole-Body Diffusion-weighted MR Imaging in Cancer: Current Status and Research Directions. Radiology 2011; 261:700-71