

Whole-body diffusion-weighted MRI with apparent diffusion coefficient mapping for monitoring multiple myeloma

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Introduction: Multiple myeloma (MM) is a typical bone marrow neoplasia of the elderly. Whole-body MRI has been demonstrated to be superior to skeletal survey and CT, which could display the diffuse marrow infiltration and focal bone lesions before osseous destructions occur. Apparent diffusion coefficient (ADC) value could semi-quantitatively discriminate the active and stationary lesions in MM patients.

Purpose: This study analyses the diagnostic potential of diffusion-weighted imaging with background suppression (DWIBS) in the detection and discrimination of focal bone marrow lesions from multiple myeloma. The bone marrow signal characteristics of active and stationary periods are also evaluated.

Methods: A prospective analysis including 25 MM patients (16 males and 9 females, aged 42-78 years) undergoing whole-body DWI was performed. 12 newly diagnosed MM patients with high serum concentration of the M-component were divided in active group. 13 MM patients who had accepted standard therapy (range 6-42 months) with stable hematologic parameters were divided in stationary group. All examinations were performed on a 3.0 T MRI scanner (Skyra, Siemens Healthcare) using a dedicated 18-channel coil array system. Axial DWI was acquired using a STIR-EPI sequence covering from the head to the pelvis with parameters: TR = 7000 ms, TE = 57 ms, b = 0 and 800 s/mm², STIR with fat suppression with TI = 180 ms, matrix size = 192×96, slice thickness = 5 mm, FoV = 150×96 cm². Coronal T1-weighted TSE and coronal T2 weighted STIR were also performed. The overall examination time was about 1 hour according to the patient height. All data were acquired during free breathing. No contrast agent was applied. The mean ADC value was evaluated in all foci lesions > 1 cm. The following regions of bone marrow: the 8th thoracic vertebrae, the 4th lumbar vertebrae, ilium, head of humerus, head of femur were calculated. These parameters were correlated with clinical and laboratory criteria.

Results: The mean ADC value of active lesions (n=114) was (880.04±212.31)μm²/S, which is significantly lower than that of inactive lesions (n= 80) (1784.29±419.17)μm²/S. There is statistical significance (P < 0.01). In 12 newly diagnosed MM patients, 4 cases show diffuse marrow infiltration and 8 cases with only focal myeloma infiltration. The mean ADC value of diffusely infiltrated marrow is (632.91±43.52)μm²/S, higher than those of stationary period bone marrow(286.18±25.17) μm²/S and only focal myeloma bone marrow(420.25±31.11) μm²/S. There is statistical significance between either two groups. Correlation of ADC values with hematologic parameters is moderate.

Discussion: Typical values of the ADC in normal bone marrow are in the range of 0.2–0.5×10⁻³mm²/s^[1]. Molecular diffusion of water is substantially increased in bone marrow with only focal myeloma may because of bone-marrow edema and the disruption of the trabecular structure. In diffuse marrow infiltration patient, diffusion is partially restricted due to displacement of adiposity and the high cellularity of myeloma tissue.

Conclusion: The ADC value allows differentiation between active and stationary myeloma lesions, normal bone marrow and tumors of myeloma. Whole body DWI could provide complementary information for MM diagnosis, treatment and prognosis.

Reference

[1] Dietrich O, Biffar A, Reiser MF, et al. Diffusion-weighted imaging of bone marrow. *Semin Musculoskelet Radiol.* 2009;13(2):134–44.

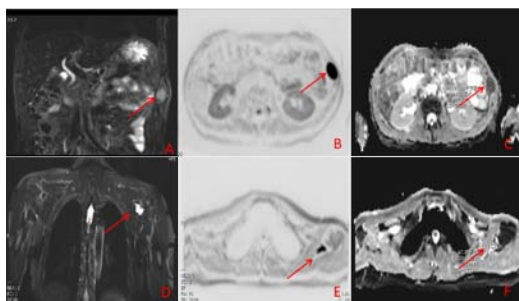


Fig1. Images of MM lesions. ABC: active lesion of rib; DEF: scapular inactive lesion. A,D: coronal STIR; B,E: axial DWI; C,F: ADC map.

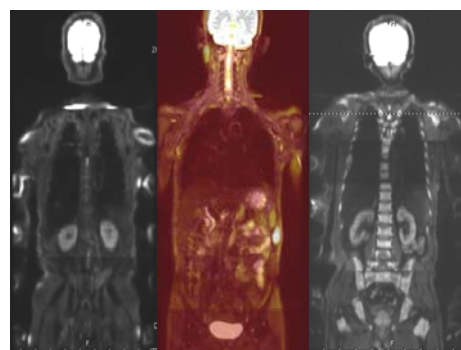


Fig 2. Images show bone marrow signal characteristics of MM. A: stationary period bone marrow; B: only focal myeloma lesions; C: diffusely infiltrated marrow.