Diffusion-weighted MRI and ADC measurement of tumoral bone marrow

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Introduction
In lumbar spine, images obtained with low-strength diffusion-weighted technique have been used to study compression fractures (Baur A. et al.) and in the detection of vertebral metastases (Castillo M. et al.). A new heavily diffusion-weighted single-shot fast spin-echo sequence (DWSSFSE) is available on 1.5 T Signa unit (GE Medical systems). Our purpose was to evaluate the apparent diffusion coefficients (ADCs) measured by this sequence in tumoral and normal lumbar bone marrow.

Methods
We studied prospectively with MRI of the lumbar spine 19 patients aged 50 to 87 (mean, 66 years) with a proven diagnosis of monoclonal gammapathy (n=2), multiple myeloma (n=8), or metastases (n=9). T1-weighted spin-echo (SE), short inversion time inversion-recovery (STIR), and fat-suppressed gadolinium-enhanced T1- weighted MR images were available in these 19 patients. A control group of 70 patients with back or radicular pain was also studied. T1- weighted spin-echo (SE) and STIR images were available in these 70 patients. Abnormal-appearing tumoral lumbar bone marrow was defined as nodular or diffuse lesions with low-signal intensity on SE T1- weighted images, and high-signal intensity on STIR and fat-suppressed gadolinium-enhanced T1- weighted MR images.

All patients underwent a standardized DWSSFSE sequence in three orthogonal directions using the following parameters: a single sagittal section (7mm-thickness), TR 5000 ms, TE 119 ms, B value 600 s/mm2. Bone marrow regions of interest (ROIs) were selected and drawn on diffusion-weighted images for the five lumbar bodies in each patient. The ADC was calculated for each ROI using dedicated software (Basser PJ et al.).

Results
In 6 of the 89 patients (one with myeloma and five controls), the measurement of the ADC was impossible, due to a lack of signal. These patients were excluded from further analysis. In the control group, 56 patients had degenerative disc disease, while 9 had a normal lumbar MRI. The mean ADC in the control group was 0.354 x 10-5 cm2/s (ranging from 0.185 x 10-5 cm2/s to 0.674 x 10-5 cm2/s). In 95% of the 65 patients with normal bone marrow, the ADC value was < 0.500 x 10-5 cm2/s.

Four patients with monoclonal gammapathy or myeloma had normal-appearing bone marrow on MR images. These vertebral bodies had a mean ADC of 0.400 x 10-5 mm2/s, ranging from 0.279 x 10-5 to 0.624 x 10-5 mm2/s. Fourteen patients with myeloma or metastases had abnormal-appearing bone marrow on MR images. In these patients, vertebral bodies with abnormal bone marrow had higher values of ADC, ranging from 0.600 to 1.200 x 10-5 cm2/s. In the same patients, normal-appearing vertebral bodies had lower values of ADC, comparable to the control group.

Discussion
The DWSSFSE sequence allows a rapid quantification of the ADC of bone marrow. The value of the ADC is partially correlated with the degree of cellular infiltration of bone marrow. Higher values of ADC are observed when bone marrow has an abnormal tumoral appearance on SE T1 and STIR images (focal or multiple disease). Study Limitation: Measurement of the ADC was performed with one ROI located on a single 7mm-thick sagittal slice. This could explain low values of the ADC in vertebral bodies only partially infiltrated by tumoral tissue.

References
