Diffusion Weighted MRI for assessing treatment response in myeloma bone disease

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Introduction
There is growing interest in diffusion weighted (DW) MRI as a biomarker of treatment response in metastatic and myeloma bone disease. The predominance of fat requires consideration when interpreting DW MRI of normal adult bone marrow because return of normal fatty marrow following treatment leads to a fall in ADC. In contrast response with necrosis will result in an ADC rise. The study aims therefore were 1. To compare ADC values in normal adult marrow with ADC values from marrow with myeloma involvement 2. To investigate the feasibility of segmentation techniques based on ADC differences of normal and pathological marrow in order to determine feasibility of using a threshold value of ADC for identifying marrow involvement with myeloma.

Methods
DW MRI of lumbar spine and pelvis of 23 healthy volunteers was performed: Siemens Avanto 1.5T, axial plane, slice thickness 5mm, TR 3600ms, TE 70ms, 7 averages, 3 orthogonal directions and b values of 0, 50, 250, 750, 1300, 1400 smm⁻² with SPAIR. Corresponding T1W imaging was also performed to guide ROI placement. Monoexponential ADC maps were generated using system software. 2.3cm² ROIs were drawn on ADC maps avoiding areas of artefact in L5, right and left iliac bones. 8 patients with myeloma also underwent DWI lumbar spine and pelvis and ROIs (up to 6 per patient) were drawn around lesions or whole bone if disease was diffuse. ROC analysis was performed (SPSS vs 15). Thresholds derived from the ROC analysis were used to segment whole vertebral body data from a further patient with diffuse myeloma disease before and after treatment into normal and pathological marrow (Diffusion View).

Results
66 regions of interest were drawn on ADC maps of healthy volunteers (mean age 48.0 years) and 42 on ADC maps of patients with myeloma (mean age 67.1 years). The mean ADC of normal marrow was 543.7 mm²s⁻¹x 10⁻⁶ and the mean ADC of myeloma marrow disease was 1234.7 mm²s⁻¹x 10⁻⁶.

Discussion and Conclusion
Contrast between normal adult marrow and myeloma marrow disease on DW MRI allows disease to be segmented from normal marrow with a high sensitivity and specificity. Interrogation of the relationship between fat/water fraction derived from 2 point Dixon MRI and ADC and measurement of changes in fat using segmented ADC maps is warranted to establish utility of DW MR as a response biomarker in bone marrow.

References