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Noninvasive and quantitative evaluation of bone marrow infiltration and bone marrow microcirculation in patients with monoclonal plasma cell disease by means of diffusion weighted imaging

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With its unique technique of measuring diffusion of water molecule, DWI has come as a new promise in the diagnosis and staging of plasma cell diseases using functional imaging. Currently, invasive bone marrow biopsy is a standard hematological procedure for the diagnosis and follow-up investigation in plasma cell diseases. The response to treatment is evaluated mostly on the basis of hematologic parameters. This study was performed to investigate whether DWI parameters correlate with parameters of histology, so that DWI could be further investigated as a possible non-invasive diagnostic and therapy monitoring tool for monoclonal plasma cell diseases.

On the basis of hypothesis that ADC parameter acquired by DWI corresponds to the cellularity, which is higher in malignant tissue, IVIM imaging of pelvis region and additionally of the lumbar spine of 31 patients with monoclonal plasma cell diseases of all stages was performed. Bone marrow biopsies from pelvis of all patients were obtained. DWI parameters of the same pelvis region were determined from where biopsy was obtained.

A significant correlation between DWI parameters (apparent diffusion coefficient and diffusion coefficient) and plasma cell percentage in bone marrow histology ($p = 0.009$ and $p = 0.008$ respectively) was found. Furthermore, these DWI parameters also significantly correlated with other factors of disease activity, e.g., monoclonal protein ($p = 0.009$ and $p = 0.008$ respectively), hemoglobin ($p = 0.01$ and $p = 0.02$ respectively), β2-microglobulin ($p = 0.05$ and $p = 0.043$ respectively) and immunoparesis ($p = 0.007$ and $p = 0.008$ respectively). A borderline positive correlation between diffusion coefficient and micro vessel density ($p = 0.05$) was found. A significant positive correlation was found between all three corresponding DWI parameters of lumbar vertebrae and pelvis: ADC ($p = 0.001$), D ($p < 0.0001$) and D ($p < 0.0001$).

The result of this prospective study clearly shows that bone marrow infiltration by plasma cells and bone marrow microcirculation can be measured and monitored non-invasively by DWI. Thus, using a highly sensitive functional imaging tool like DWI together with clinical parameters and conventional morphological imaging may assist in increasing the confidence of diagnosis and monitoring treatment response in clinical routine. However, a standard optimized guideline must be defined for its wide and proper clinical routine application, which would also boost the scientific research with significantly accurate results for example if the same protocol is used for the investigation of the pelvis by all study groups. To achieve this target, studies on a larger group of patients using a standard but highly sensitive method in consensus according to international working groups is essential and prolific.