Dynamic contrast-enhanced Magnetic Resonance Imaging for assessing the disease activity of multiple myeloma: comparison with histological and clinical markers

MRI has been used for assessing treatment response in MM of the spine. However, it is so far unproven that increased contrast uptake in bone marrow indeed reflects tumor infiltration. Therefore, aim of this study was to examine histologically whether increased contrast enhancement in bone marrow of patients with MM corresponds with local tumor infiltration and increased vessel density.

The spina iliaca superior posterior of 24 patients with MM was examined using a dMRI protocol with a pump-controlled infusion of Gd-DTPA. After dMRI, a biopsy of the spina iliaca superior posterior was taken. Using a two-compartment model, the pharmacokinetic
dMRI parameters amplitude (A) and \( k_{ep} \) in the region of the biopsy were calculated. These pharmacokinetic parameters describe the contrast agent behavior in the bone marrow. A reflects the plasma volume and \( k_{ep} \) is the exchange rate constant, which is influenced by the vessel permeability and/or perfusion. To reduce possible inter-individual fluctuations in contrast agent dose, all A values of the biopsy regions were normalized to the A obtained of a ROI drawn in the iliac artery. Then, \( A_n \) and \( k_{ep} \) were prospectively compared in a point-to-point fashion with histological features of the bone marrow obtained, and additionally with clinical data.

First, we examined whether the existence of tumor involvement in the bone marrow was associated with an increased contrast agent uptake. We found that both dMRI parameters (\( A_n \) and \( k_{ep} \)) were significantly higher in lesions with marked infiltration than with mild or no infiltration \((p<0.05)\). Furthermore, \( A_n \), but not \( k_{ep} \), was higher in lesions with high vessel density at histology \((p=0.01)\) than in specimens with low vessel densities.

When comparing dynamic parameters with clinical data, we found \( A_n \) to be significantly higher in patients with CRP >5mg/dl. Furthermore, \( k_{ep} \) levels were higher in presence of increased tumor burden at the moment of the exploration, as reflected by Ig concentration in serum or urine.

It can be therefore be concluded, that areas of increased contrast uptake in the bone marrow of MM patients very probably reflect tumor involvement. Furthermore, the degree of contrast enhancement is correlated with the degree of both tumor infiltration and vessel density. However, dMRI only becomes abnormal when marked bone marrow infiltration is present but is obviously unsuitable to differentiate minimally infiltrated from unaffected bone marrow. With respect to studies related to therapy monitoring using dMRI, our results justify to use measurements in lesions which are conspicuous due to their contrast enhancement, since these very probably reflect areas involved by tumor.