Introduction: Dynamic contrast-enhanced (DCE) MRI is widely used to study kinetic parameters of human tissues [1, 2]. The quantification of these parameters relies on the deconvolution with the arterial input function (AIF), which can be determined from the signal changes in a major artery. In particular for field strength above 1.5 T RF-field inhomogeneities provoke considerable intensity variations in the abdomen which affect the determination of the AIF (AIF of two comparable arteries diverges significantly). The aim of this work was to investigate the B1 inhomogeneity dependent influence of vessel selection for the AIF determination, the impact on quantification of the pharmacokinetic parameters $K^{trans}$ and $V_c$ in a region of interest (ROI) and the possibility to correct the RF-field inhomogeneities by using the measured flip angle distribution.

Methods: A 3D FLASH sequence was used for DCE-MRI with the following parameters: $T_E=3.34$ ms, $T_R=1.1$ ms, FA = 15°. $N_x \times N_y = 256 \times 256$ matrix size, FOV = FOVz = 300, mm, TH = 4 mm, slices = 20 (no gaps), time points = 40, acquisition time ~ 7 min. The contrast media concentration was determined by a method mentioned by Hittmair [3] using a proton density weighted reference scan (3D FLASH) with $T_E=100$ ms, $T_R=1.1$ ms and FA = 5°. All other parameters were consistent with the DCE scan parameters. The actual flip angle distribution, which is proportional to the active RF-field component $B_1$ was measured with a dedicated STEAM sequence [4]. The parameters of this sequence were: $T_R=1200$, $T_E=14$ ms, FA = 90°. $N_x \times N_y = 52 \times 64$ matrix size, FOVz = 308 mm, FOVy = 250 mm, TH = 5 mm, slices = 19 (10 mm gap), acquisition time ~ 1 min. Using the reference and the DCE images the temporal $T_1$ relaxation can be calculated using equation (1) [3]. $S_{ref}$, $S_{D}(t)$ and $S_{B}(t)$ are the signal intensity of the reference scan, the signal intensity of the dynamic scan at the time point $t$ and the repetition time of the DCE scan respectively. $\alpha_D$ and $\alpha_B$ are either the nominal flip angles or the corrected flip angles of the dynamic and the reference scan respectively. The contrast agent concentration $C(t)$ follows from equation (2) using a relaxivity $r$ ($\text{mmol}^{-1} \cdot \text{s}^{-1}$). The Tofts-model described in formula (3) was used for the estimation of the kinetic parameters $K^{trans}$ and $V_c$. $C(t)$ represents the tracer concentration in the tissue at time $t$ and $C_I(t)$ represents the AIF and is the tracer concentration in arterial whole blood at time $t$. Hct represents the hematocrit, $V_I$ is the volume of extravascular extracellular space per unit volume of tissue and $K^{trans}$ is the volume transfer constant between blood plasma and $V_I$. This model was fitted to the dynamic concentration data to obtain values for $K^{trans}$ and $V_c$. For the analysis of the AIFs the maximum values and the root mean square deviation of the left to the right AIF were calculated. For the analysis of the kinetic parameters the absolute deviation between the values obtained with the left and right AIF were determined. All results were calculated without and with $B_1$ correction and were checked against each other. The measurements were performed for a group of 9 persons using a 3.0 T MRI scanner (Magnetom Tim Trio, Siemens Medical, Germany).

Results: Fig.1 (a) shows a DCE image of the pelvis region including the magenta-marked regions for the left and right AIF and for the ROI used for the calculation of the required kinetic parameters with and without $B_1$ correction. Fig.1 (b) shows the comparison of the left and right AIF obtained with (red, magenta) and without $B_1$ correction (blue, cyan). Fig.1 (c) and (d) show the comparison of the maximum values and the root mean square deviation (RMSD) of the left to the right AIF. The blue and cyan bar represent the values obtained without $B_1$ correction and the red and magenta bar represent the values obtained with $B_1$ correction.

Fig. 2 (a) and (b) show the comparison of $K^{trans}$ and the absolute deviation of $K^{trans}$ for the ROI obtained with the left and right AIF. Fig. 2 (c) and (d) show the comparison of $V_c$ and the absolute deviation of $V_c$ for the ROI obtained with the left and right AIF. The blue and cyan bar represent the values obtained without $B_1$ correction and the red and magenta bar represent the values obtained with $B_1$ correction.

Discussion: Dynamic contrast-enhanced MRI was performed at 3.0 T in combination with a special sequence in order to determine $B_1$ inhomogeneities. AIF and tissue concentrations were calculated and the kinetic parameters $K^{trans}$ and $V_c$ were determined by means of a generalized kinetic model. The absolute deviation of the maximum values of the left and right AIF can be improved by a factor greater than 10 (up to 70) and the root mean square deviation concerning the left to the right AIF can be decreased by factor greater than 5 (up to 30) if $B_1$ inhomogeneities are corrected. Also the deviations of the kinetic parameters $K^{trans}$ and $V_c$ obtained with the left and right AIF are significantly lower if $B_1$ correction is used.

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