Assessment of response to therapy by DCE-MRI and DWI MRI in primary liver cancers

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Introduction: Regional chemotherapy through hepatic arterial infusion (HAI) has been used in primary liver cancers of both hepatocellular carcinoma (HCC) and intrahepatic cholangiocarcinoma (ICC) [1]. Recent clinical trials involve a combination of chemotherapy and antiangiogenic therapy (anti VEGF) in the treatment of primary liver cancers [2]. Therefore, a combination of DCE-MRI and DW-MRI is investigated for the utility of contrast kinetic parameters and diffusion parameters in the assessment of response to therapy in primary liver cancer patients undergoing regional HAI chemotherapy and antiangiogenic therapy. This study seeks a relation between each of these parameters over the course of treatment without a correlation to the treatment outcome.

Materials and Methods: 13 patients (12 ICC, 1 HCC) undergoing regional chemotherapy and antiangiogenic therapy with FUDR and Bevacizumab through HAI were scanned at baseline and at multiple treatment intervals every two months using an MRI (1.5T, GEMS, Waukesha, WI). A bolus of Gd-DTPA (Magnevist, Berlex) was injected at a constant dose (0.1 mmol/kg) for all the patients. DCE-MRI and DW-MRI were acquired using an 8 channel phased array coil. The perfusion images were corrected for respiratory motion and analyzed using a two compartmental model of vascular space (VS) and extra-vascular extra-cellular space (EES) and a model vascular input function (VIF). The parameters, K^{trans} (volume transfer constant between VS and EES, min^{-1}), k_{ep} (rate constant between EES and VS, min^{-1}) and v_e (fractional vascular space) were measured using the imaging data sets [3, 4]. The diffusion weighted echo planar images were acquired with two b values under a breath hold and three ADC (apparent diffusion coefficient, mm^2/s) were constructed from these data sets (0 and 400, 0 and 700 and 0, 400 and 700 s/mm^2). The baseline and multiple treatment scans (43 scans) were analyzed and parameters were estimated through both region of interest (ROI) and voxel (Vx) analysis.

Results: The diffusion parameters (ADC) and contrast kinetic parameters (K^{trans}, k_{ep}, and v_e) for tumors (12 ICC, 1 HCC) from 13 patients and 43 scans are shown in Figure 1.
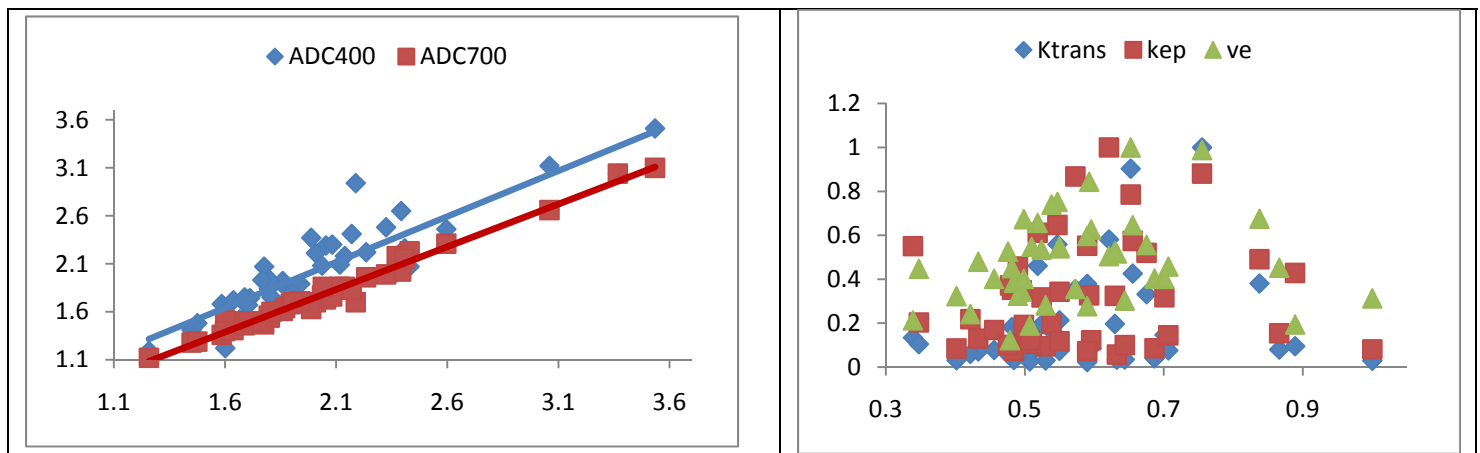

Figure1: Mean ADC (b=400 s/mm^2) and mean ADC (b=700 s/mm^2) vs. mean ADC(b=0, 400 and 700 s/mm^2) (left), normalized K^{trans}, k_{ep} and v_e, vs. mean ADC(b=400 s/mm^2) (right). The units of axes are 10^{-3} mm^2/s for ADC.

The correlation coefficients (cc) between ADC (b=400 s/mm^2), ADC (b=700 s/mm^2) and ADC (b=0, 400, 700 s/mm^2) were 0.84, 0.91 and 0.99; between kinetic parameters (K^{trans}, k_{ep} and v_e) were 0.85, 0.79 and 0.47, respectively. However, the diffusion and kinetic parameters did not correlate with each other (cc of 0.21 and lower) over the course of treatment for these patients. The results show that DCE-MRI and DW-MRI appear to measure different characteristics of tumors over the course of therapy. Further development of imaging methods relevant to changes in diffusion and perfusion of the tumors under treatment may improve the use of DCE-MRI and DW-MRI in therapy response monitoring.

References:
[1] Atiq OT, Kemeny N, Niedzwieki D, Botet J. Cancer 1992; 69:920-924.
[2] Curran SD, Muellner AU, Schwartz LH. Cancer Imaging. 2006 Oct 31;6:S126-30.
[3] Tofts PS, Brix G, Buckley DL et al. J Magn Reson Imaging 1999; 10(3):223-232.
[4] Jarnagin WR, Schwartz LH, Gultekin DH et al. Ann Oncol. 2009; 20(9):1589-95.