Comparison between pre and post chemoradiation therapy DCE-MR and pCT findings: initial observations in locally advanced rectal tumors

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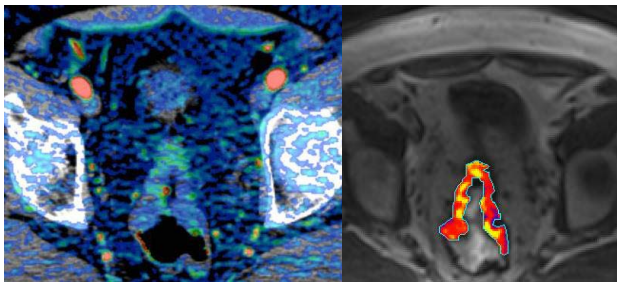
INTRODUCTION: In locally advanced rectal tumors, previous studies have evaluated the capability of dynamic contrast enhanced magnetic resonance (DCE-MR) [1] and perfusion computed tomography (pCT) [2] for monitoring response to neoadjuvant chemoradiation therapy (NACRT) or to predict therapy outcome. As the pharmacokinetic parameters obtained by these methods differ, as do the properties of the contrast agents used, it is not clear whether the metrics obtained are effectively equivalent between the modalities or offer complementary insight into tumor physiology. As yet, the comparison of these functional imaging techniques in the assessment of rectal tumors is limited [3]. The aim of our study was to compare the findings of DCE-MR and pCT at baseline and after NACRT. We report here our preliminary assessment after 13 patients.

METHODS AND MATERIALS: The study was approved by our Institutional Ethics Committee, and written informed consent was obtained from all participants before entry into the study. From March 2009 to August 2010, patients with locally advanced non-mucinous rectal adenocarcinoma (T stage ≥ T3, or N1-2 as staged by MRI) were prospectively enrolled in the study and underwent a multimodality imaging assessment, including DCE-MR and pCT, before and after neoadjuvant chemoradiation therapy. MR exams were performed on a 1.5T scanner (Avanto, Siemens Medical Systems, Erlangen, Germany). DCE-MR used a dynamic T1-weighted sequence performed at 5s intervals for 8 minutes after intravenous injection (0.2mL/kg, 3.5mL/sec) of contrast agent (Magnevist; Schering, Berlin, Germany), followed by a 20mL saline flush. pCT exams were performed with a 16-slice CT scanner (LightSpeed 16; GE Healthcare, Milwaukee, USA) with dynamic CT scans acquired over 2 minutes after intravenous injection of 40mL of non-ionic iodinated contrast material (Iomeron 400; Bracco, Milano, Italy), followed by 40mL of saline solution. Data was analyzed with dedicated software (MRIWorkbench, Royal Marsden Hospital, Sutton, England) for DCE-MR and manufacturer provided software for pCT (CT Perfusion 3, GE Healthcare, Milwaukee, USA). A radiologist defined ROIs for each modality which were applied to the functional maps to extract regional values of the following quantitative parameters: Ktrans, Kep, Ve and IAUC60 (for DCE-MR); blood flow (BF), blood volume (BV), mean transit time (MTT) and permeability-surface area product (PS) for pCT. The correlations between individual quantitative parameters obtained by DCE-MR and pCT inclusive of all groups were calculated.

RESULTS: 13 patients have been enrolled to date (8M, 5F; mean age 56.4 years, age range 42-74 years). Preliminary analysis of pre-treatment values of this small group shows moderate correlation between Kep and BV (R=0.64), a trend to correlation between Ktrans and BV (R=0.56) and between Ve and PS (R= 0.55). At this point, 10 of the 13 patients have undergone post-treatment DCE-MR and pCT, showing correlation between post-treatment Ktrans and PS (R=0.63), Kep and PS (R=0.61) and IAUC and PS (R=0.61). The remaining correlation values were less than 0.33 (see table).

Pre-NACRT						Post-NACRT				
vs	BF	BV	MTT	PS		vs	BF	BV	MTT	PS
Ktrans	0,292	0,563	0,1161	0,022		Ktrans	-0,111	-0,042	0,307	0,632
Kep	0,316	0,639	0,122	-0,176		Kep	-0,060	0,029	0,147	0,616
Ve	0,107	0,072	-0,053	0,551		Ve	0,062	-0,049	0,061	0,041
IAUC60	0,221	0,318	0,014	0,221		IAUC60	0,021	0,100	0,169	0,616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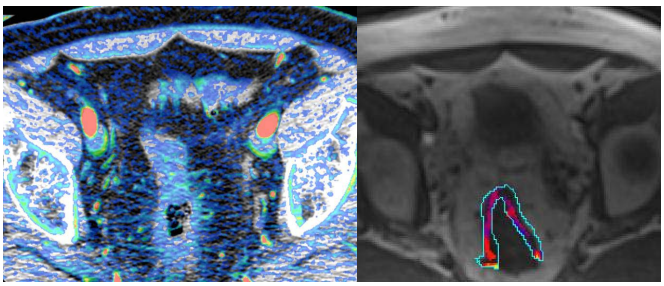
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CONCLUSIONS: Our preliminary results suggest that following therapy, there is a correlation between quantitative parameters Ktrans and Kep, and IAUC60 of DCE-MR with PS of pCT, all of which relate to estimates of capillary permeability. Prior to therapy on the other hand, only Ve from DCE-MRI showed a trend to correlation with PS while Ktrans and Kep correlated with BV, with all three of these relations being entirely lost following therapy. These changes in the relationships following therapy between DCE and pCT parameters relating to capillary permeability and blood volume suggest that either the contrast agents or the models used in calculating the different parameters exhibit different sensitivities to the vascular status possibly relating to the balance between flow and permeability limited conditions for the different contrast agents prior to and following NACRT. The otherwise general lack of correlation between the various parameters suggest that in large part, DCE-MR and pCT indeed provide different, likely complementary views on the endothelial changes caused by therapy.

Figure 1 – Pre-therapy colour maps of BV (1a) and Ktrans (1b). High BV values are indicated by colour shades of green; colour shades of yellow and red indicate high Ktrans.
Figure 2 – Post-therapy colour maps of BV (2a) and Ktrans (2b). Colour shades of blue indicate low BV value after NACRT; colour shades of blue and purple indicate low Ktrans after NACRT

References:
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