Changes in Dynamic Contrast Enhanced MRI Paramters in the First 8 Weeks of Prostate Radiotherapy

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Introduction: MRI is being integrated into the radiotherapy treatment planning process for prostate cancer in the hopes of improved therapeutic ratio. Dynamic contrast enhanced MRI (DCEMRI) performed during radiotherapy has been shown to be predictive of patient outcome for cervix cancer [1]. There has been little publication of the changes in DCEMRI parameters in the prostate during the course of therapy. Knowledge of these changes might provide insight into the optimal timing and endpoints for early assessment of radiation therapy response in prostate cancer allowing for patient specific adaptive therapeutic strategies.

Purpose: To determine changes in prostate DCEMRI parameters during the course of external beam radiation therapy.

Materials and Methods: In this prospective research ethics board approved trial, 12 patients with low or intermediate risk prostate cancer underwent MRI examinations prior and at 2, 4, 6, and 8 weeks during external bean radiotherapy (78Gy, 2Gy per fraction, 5 days per week). Images were obtained using a 1.5T scanner (Excite, GE Healthcare) using the torso phased-array coil. DCE-MRI was performed as follows: 3D FSPGR, TR/TE = 4.2/1.9ms, 256x128 matrix, 6mm slice thickness, 0.65 NEX, FOV = 20cm, flip angle= 20deg, 6s temporal resolution, 55 phases. A modified Tofts model [2] with an assumed arterial input function and T1 [3] was used to calculate K_{trans}, v_e and $IAUCC_{60}$ for the whole prostate (WP), peripheral zone (PZ) and transition zone (TZ). Gluteal muscle was used as a control. The percent change from baseline was used as the response measure. Spearman's Rho correlations with time of therapy were calculated.

Results and Discussion: There was a significant moderate positive correlation between cumulative radiation dose and K_{trans}, v_e, and $IAUCC_{60}$ for WP, PZ and TZ (Table 1). In the control tissue no correlation was found between K_{trans} and $IAUCC_{60}$ and radiation dose but there was a mild-moderate correlation with v_e. The overall pattern which was similar for WP, PZ and TZ consisted of a maximal two week incremental increase occurring in the first 4 weeks during therapy in 10/12 patients but there was a wide range of maximal change values during this early treatment period (Fig 1 and 2). Standard deviations were similar for PZ and TZ for all parameters. K_{trans} and $IAUCC_{60}$ are of particular interest as the exhibited a more marked change than the control tissue. The wide range of response values may be indicative of variable tissue sensitivity to therapy but further investigation would be required. It would be of interest to evaluate cancer foci directly however these could not be consistently visualized in all patients.

Tissue	DCE	CC	p-value
Whole Prostate	K_{trans}	0.53	<0.00002
	v_e	0.69	<0.00001
	$IAUCC_{60}$	0.55	<0.00001
Peripheral Zone	K_{trans}	0.44	<0.0005
	v_e	0.65	<0.00001
	$IAUCC_{60}$	0.49	<0.0001
Transition Zone	K_{trans}	0.53	<0.00002
	v_e	0.64	<0.00001
	$IAUCC_{60}$	0.54	<0.00001
Muscle(Control)	K_{trans}	-0.13	0.33
	v_e	0.46	<0.0003
	$IAUCC_{60}$	-0.10	0.43

Table 1 Correlation (CC) of DCE Endpoints with Cumulative Radiation Dose

Percent Change from Baseline

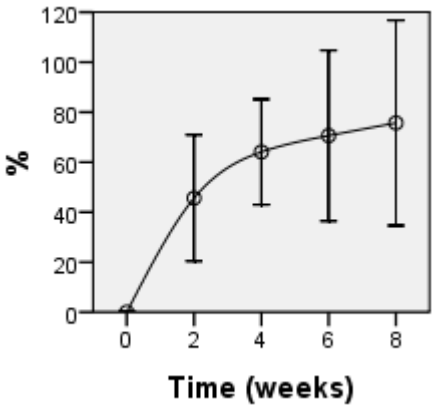

Fig 1 Change in IAUCC60 for the Whole Prostate During the Course of Radiation Therapy

Error bars represent standard deviation

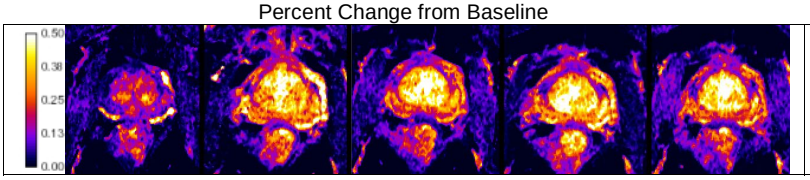

Fig 2 Serial $IAUCC_{60}$ images preformed at baseline, 2, 4, 6, and 8 weeks during radiation therapy showing general increase throughout the prostate. Note some increase in rectal mucosa as well

Conclusions: There is an early increase in K_{trans}, v_e, and $IAUCC_{60}$ during the first 4 weeks of prostate radiation therapy and it is this early time point that may be most beneficial for capturing early predictors of patient outcome, thereby permitting the potential adaptation of therapeutic interventions.

References: [1] Wang, Proceeding RSNA 2007. [2] Tofts. JMRI 1997; 7:91-101. [3] Fritz-Hansen MRM 1996; 36:225-231.