Dynamic contrast enhancement (DCE) MRI of parotid glands after radiotherapy

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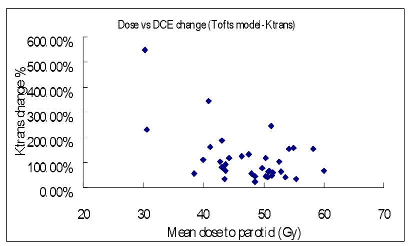
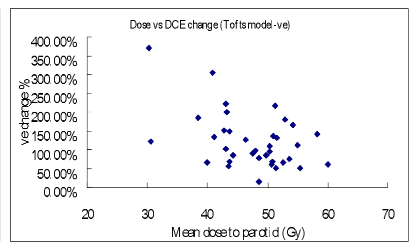
Introduction: Radiation injury occurs in the parotid glands of patients being irradiated for head and neck cancer. Increased contrast enhancement in MRI of parotid glands after radiotherapy has been reported[1] and so to improve the understanding of radiation injury we studied further these changes in contrast enhancement using dynamic contrast enhancement MRI (DCE-MRI).

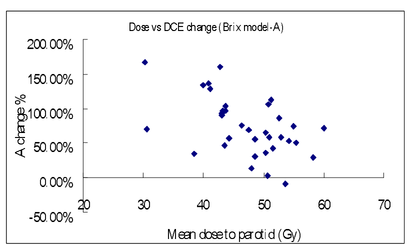
Method: Eighteen nasopharyngeal carcinoma patients underwent DCE-MRI in a 1.5T scanner (Intera, Philips Medical Systems, Best, the Netherlands) before and at 3 months after completion of radiotherapy. The DCE-MRI protocol included gradient echo acquisitions (TR/TE = 2.7/0.9ms, 128 x 128 matrix, 25 slices, slice thickness = 4mm) with different flip angles (2/10/20/30) for T1 determination, dynamic gradient echo images with time resolution of 3.5 sec for 371 sec. Contrast agent (Dotarem, Guerbet, France) was injected into the patients at 20 sec after start of dynamic scan with a power injector at 3ml/sec. These patients received intensity modulated radiotherapy and the mean radiation doses received by parotid glands were recorded. Data were analyzed using two pharmacokinetic models from Tofts[2] and Brix[3] and semi-quantitative analysis. Correlation on the percentage change of parameter means pre- and post-treatment with the mean parotid dose was conducted using two-tailed Pearson test.

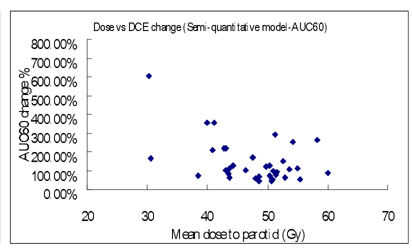
Results: The result of the correlation tests and the plots of the significantly correlated parameters are shown below.

	% change in parameter	p-value	R-square
Tofts	k_{trans}	0.0014**	0.2639
	v_e	0.0053**	0.2069
	v_p	0.4516	0.0017
Brix	A	0.0021**	0.2593
	k_{el}	0.9213	0.0003
	k_{21}	0.3005	0.0335
Semi-quantitative	AUC60	0.0066*	0.1973
	Peak enhancement	0.7172	0.0039
	Time to peak	0.9709	0.0000









* marginally significant ** significant (with Bonferrroni correction)

Discussions & Conclusions: Significant correlation was shown between radiation dose to the parotid and percentage change in the k_{trans}, v_e, A, and AUC60. These four parameters showed an increase after treatment, but the percentage change showed an inverse relationship to the dose. It has been shown in previous reports[4,5] that permeability in tumors is increased at the beginning of radiotherapy, due to the disruption of normal endothelium and inflammation. Ultimately, radiation damages the vessels and reduces permeability and vascular density. No study has yet demonstrated similar time course of events in parotid glands, but the current data suggests that the former effect may be more prominent with exposure in lower radiation dose, while a larger radiation dose may induce a greater and earlier manifestation of the latter effect in this organ. Increase in v_e is probably related to the increase in extra-cellular extra-vascular space (EES) after serous acinar cell loss and edema. A previous report has shown that higher radiation doses induce more atrophy in parotid glands[5], which may reduce the intracellular space within. This may explain the inverse relationship of the change in v_e with radiation dose.

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Reference:

1.Juan CJ, et al. *Eur Radiol.* 2008. 2.Brix G, et al. *J Comput Assist Tomogr* 1991 (15): 621-628. 3.Tofts PS, Kermode AG. *Magn Reson Med* 1991 (17): 357-367. 4.de Vries A, et al. *Radiology* 2000 (217): 385-391. 5.Ng QS, et al. *Int J Radiat Oncol Biol Phys.* 2007 (67): 417-424. 6.LC Stephens, et al. *Am J Pathol* 1986 (124): 469-478.