DCE-MRI for Predicting of Treatment Response of Head and Neck Squamous Cell Carcinoma

Steven K.K. Chow[1], Ann D King[1], David K.W. Yeung[1], Jing Yuan[1], Kunwar Bhatia[1], Anil T Ahuja[1], Alexander C Vlantis[2], and Brian K.H. Yu[3]

[1]Department of Imaging and Interventional Radiology, The Chinese University of Hong Kong, Sha Tin, N.T., Hong Kong, [2]Department of Otorhinolaryngology Head and Neck Surgery, The Chinese University of Hong Kong, Hong Kong, [3]Department of Clinical Oncology, The Chinese University of Hong Kong

Introduction: Dynamic contrast-enhanced MRI (DCE-MRI) provides useful information on the vascularity of cancers and early reports suggest that this technique has the potential to predict and monitor radiotherapy (RT)/chemo-radiotherapy (CRT) treatment response in primary tumours[1] and metastatic nodes[2,3] in head and neck squamous cell carcinoma (HNSCC). This study's aim was to investigate whether DCE-MRI at 3T may be used to obtain DCE parameters for predicting treatment response in HNSCC.

Material and Methods: DCE-MRI was performed in 20 patients (mean age, 61 years; age range, 41 - 93 years; males, 17; females, 3) with HNSCC before RT/CRT. MR imaging was performed on a 3T MRI scanner (Achieva, Philips Healthcare, Best, the Netherlands) using a 16 channel head and neck SENSE coil. T1 map was derived using two different flip angles [2º, 15º]. DCE-MRI sequence used was a short T1-weighted gradient echo sequence in the axial plane covering the entire tumor (TR 3.9 s, TE 0.9 s, pre-pulse TI 400 msec, flip angle 15º, matrix 128 × 128, number of slices 25, slice thickness 4 mm, number of dynamics 185, and scanning time 480 s). Contrast injection was given in the form of a bolus injection of gadopenetate dimeglumine (Dotarem, Guerbet, France) at a concentration of 0.1 mmol/kg of body weight. A power injection pump (Medrad, Pittsburgh, Pa) was used set at an injection rate of 2.5 mL/s through a 21-gauge intravenous catheter in the right antecubital vein. This injection was followed by a 20-ml saline flush at the same injection rate. Post-contrast enhanced images were also acquired as part of the routine clinical protocol. Data was processed using the Tofts[4,5] pharmacokinetic model implemented on a Philips PRIDE research tool v5.2. ROIs were drawn and analyzed manually around the whole lesion of primary tumors and metastatic nodes (Fig. 1) by in-house developed software under Matlab (The MathWorks, USA) for histogram analysis. Three K^{trans} parameters were measured: K^{trans} mean and median, K^{trans} skewness and K^{trans} kurtosis. At primary or nodal sites imaged by DCE-MRI disease failure (DF) was determined by histological confirmation of SCC or serial increase in size on follow-up; disease control (DC) was defined as absence of any new mass or increase in size of any existing residual mass (minimum follow up 6 months). Statistical analysis comparing the K^{trans} parameters and clinical outcome was performed using the Mann-Whitney U test.

Results: Pre-treatment DCE-MRI was performed at 19 primary and 21 metastatic nodal sites and residual tumour was identified at 4/19 (21%) primary and 5/21 (24%) metastatic nodal sites. No significant difference was found between the pre-treatment K^{trans} parameters of tumors with DC and DF (K^{trans} median p = 0.30; K^{trans} skewness p= 0.14; K^{trans} kurtosis, p = 0.48). However, there was a trend towards DF in tumors with a lower K^{trans} mean (Fig. 2), K^{trans} skewness(Fig. 3) and K^{trans} kurtosis (Fig. 4).

Discussion: Early results from this ongoing study have not reached statistical significance, however there appears to be a trend towards treatment failure in primary and nodal metastases with lower K^{trans} means, which is in keeping with the previously published data[1-3]. In addition, we have shown also that this histogram analysis to produces two further K^{trans} parameter, K^{trans} skewness and K^{trans} kurtosis which has potential benefit for predicting treatment response, especially the K^{trans} skewness which in accordance with the results of Shukla-Dave et al.[2] was lower in tumours that failed treatment.

References:

[1] Lee KH et al., EJR 2011(Article in press). [2] Shukla-Dave et al., Int J Rad Ono Biol Phys 2011(Article in press). [3] Kim et al., AJNR. 2010; 31:262-268. [4] Quantitative MRI of the Brain, Wiley, editor: Paul Tofts, 2003, chapter 10. [5] Tofts et al., JMRI. 1999;10: 223-232.

Acknowledgement: *This study is fully supported by a grant from the Research Grants Council of the Hong Kong Special Administrative Region, China. RGC grant CUHK (ID: 2140594, Ref: 466008).*

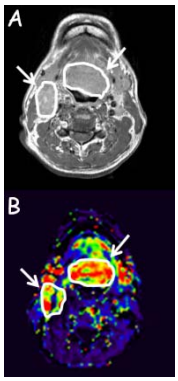

Figure 1 - A) Axial T1-W+C of a patient with a primary tongue base SCC (arrow) and a metastatic node (arrow), B) K^{trans} map at the same level.

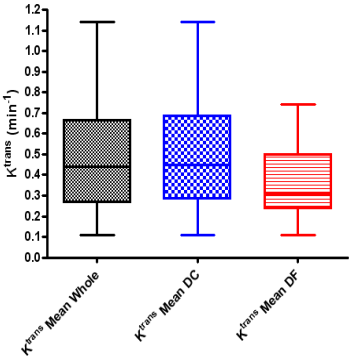

Figure 2 - The distribution of the pre-treatment K^{trans} mean for the whole group of tumour sites, and for tumour sites with disease control (DC) and disease failure (DF).

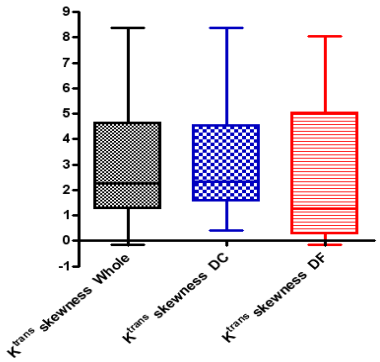

Figure 3 - The distribution of the pre-treatment K^{trans} skewness for the whole group of tumour sites, and for tumour sites with disease control (DC) and disease failure (DF).

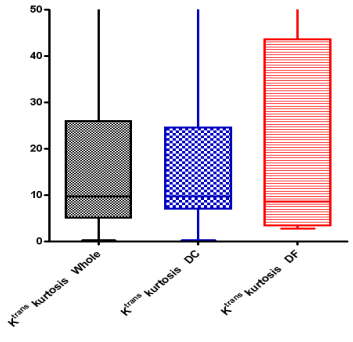

Figure 4 - The distribution of the pre-treatment K^{trans} kurtosis for the whole group of tumour sites, and for tumour sites with disease control (DC) and disease failure (DF).