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

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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 tumours¹ and metastatic nodes²,³ 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 [2°, 15°]. 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 15°, 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 Tofts⁴,⁵ pharmacokinetic model implemented on a Philips PRIDE research tool v5.2. ROIs were drawn and analyzed manually around the whole lesion of primary tumours and metastatic nodes (Fig. 1) by in-house developed software under Matlab (The MathWorks, USA) for histogram analysis. Three K\textsuperscript{trans} parameters were measured: K\textsuperscript{trans} mean and median, K\textsuperscript{trans} skewness and K\textsuperscript{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\textsuperscript{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\textsuperscript{trans} parameters of tumors with DC and DF (K\textsuperscript{trans} mean p = 0.30; K\textsuperscript{trans} skewness p= 0.14; K\textsuperscript{trans} kurtosis, p = 0.48). However, there was a trend towards DF in tumors with a lower K\textsuperscript{trans} mean (Fig. 2), K\textsuperscript{trans} skewness(Fig. 3) and K\textsuperscript{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\textsuperscript{trans} means, which is in keeping with the previously published data¹,³. In addition, we have shown also that this histogram analysis to produces two further K\textsuperscript{trans} parameter, K\textsuperscript{trans} skewness and K\textsuperscript{trans} kurtosis which has potential benefit for predicting treatment response, especially the K\textsuperscript{trans} skewness which in accordance with the results of Shukla-Dave et al.² was lower in tumours that failed treatment.

References:

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

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