Dynamic Contrast Enhanced MRI as a priori predictor of response in head and neck squamous cell carcinoma: Initial Analysis

A. Shukla-Dave[1], H. Stambuk[2], Y. Wang[3], S. Karimi[2], Y. B. Su[4], D. G. Pfister[4], N. Lee[5], J. A. Koutcher[6]

[1]Medical Physics and Radiology, Memorial Sloan-Kettering Cancer Center, New York, New York, United States, [2]Radiology, Memorial Sloan-Kettering Cancer Center, New York, New York, United States, [3]Medical Physics, Memorial Sloan-Kettering Cancer Center, New York, New York, United States, [4]Medicine, Memorial Sloan-Kettering Cancer Center, New York, New York, United States, [5]Radiation Oncology, Memorial Sloan-Kettering Cancer Center, New York, New York, United States, [6]Medical Physics and Radiology and Medicine, Memorial Sloan-Kettering Cancer Center, New York, New York, United States

Introduction

Currently one of the greatest challenges in the management of Head and Neck Squamous Cell Carcinoma (HNSCC) is to identify and select prior to or early in the course of therapy, patients who are likely to fail the chosen treatment, for consideration of alternative therapies, i.e. determining markers of poor prognosis for applying risk adjusted therapies. The present study has been designed to assess whether pretreatment Dynamic Contrast Enhanced MRI (DCE-MRI) changes can reliably predict response.

Materials and Methods

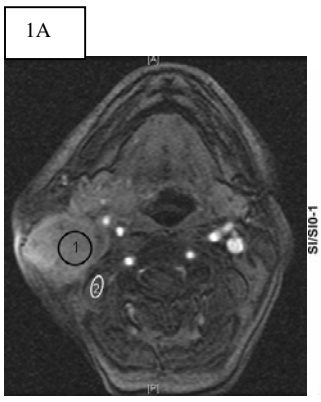
Tumor perfusion was performed in 17 HNSCC patients with nodal metastasis using DCE-MRI prior to chemotherapy and radiation therapy. Data were acquired on a 1.5 Tesla G.E. Signa scanner (GE, Milwaukee, WI). The study consisted of MR imaging using a neuro vascular phased array coil, intravenous injection of a bolus of 0.1mmol/kg gadodiamide (Omniscan) at 2 ml/sec, followed by saline flush. Dynamic perfusion studies were acquired using a fast multi-phase spoiled gradient echo (FMSPGR) sequence. The entire node was covered contiguously with 5-7 mm thick sections yielding 4-6 slices depending on the size of the node. Acquisition parameters include a 9ms repetition time (TR), a 2ms echo time (TE), 30° flip angle, 15.63 kHz receive bandwidth, 18 cm field of view (FOV), 40-80 time points, and a 256x128 matrix. These parameters provided a temporal resolution between 4-6 sec/image which was sufficient to observe the initial uptake of Gd-DTPA into the region. Data was exported to a Sun Ultra 10 workstation and the analysis was done using the Brix/Hoffman model (1-3). Software has been previously written (4) to display and analyze data using IDL 5.4 (Research Systems Inc., Boulder Co). The two compartment model measured the rate constants of the contrast agent transfer between the lesion and plasma compartments (k_{ep}) and elimination by the plasma (k_{el}). DCE-MRI parameters of uptake slope and the Ak_{ep} (amplitude of the exchange rate constant) were calculated for the nodal metastasis in each patient. The histogram analysis calculated the amplitude (α), width (σ), and median (μ) of the distribution from the fitting procedure. Follow up of the HNSCC patients was done radiologically based on response at 3-6 months after the end of treatment; patients were grouped as complete responders (CR, no evidence of disease), partial responders (PR, 50% or greater response to treatment), or non-responders (NR, failed treatment). Out of the 17 patients, 3 had only one radiological followup at 2 months after treatment and hence were excluded from the analysis but will be presented.

Results

Figure 1 shows the characteristic time intensity curves (TIC) for muscle and nodal tissue after injection with Gd-DTPA. The figure displays the typical temporal resolution that was consistently obtained throughout all acquisitions. Our preliminary DCE-MRI data on 14 HNSCC patients with nodal disease was analyzed with a two compartmental fit model for the rate constants and by linear regression to determine initial slope (1, 2, 4). The data showed a rapid rise in the characteristic time intensity curves for the tumor that appeared viable whereas the muscle showed minimal signal change. The mean Ak_{ep} value was higher for complete responders (CR, n = 7) than in incomplete responders (partial responders [PR] plus non responders [NR], n = 7); {12.29/min±4.09 vs 7.11/min±2.51 [P = 0.04]}. The histogram analysis for the slope showed that the width and median were able to differentiate between CR vs. PR+NR, P=0.039 and P=0.013 respectively (figure 2), while amplitude was not a significant (P=0.150) predictor. Further follow-up response data will be presented.

Discussion

So far few studies have described the characteristic enhanced patterns of tumors with DCE-MRI in the oral region (5, 6). The present study suggests that pretreatment DCE-MRI may prove to be a useful predictor of response in HNSCC patients. On initial analysis the Ak_{ep}, and slope histogram (width and median) data in complete responders vs. incomplete responders (PR+NR) shows a trend for predicting response. The pretreatment DCE-MRI patterns may represent a non-invasive tool that may enhance prognostication and patient selection and thus improve outcomes.



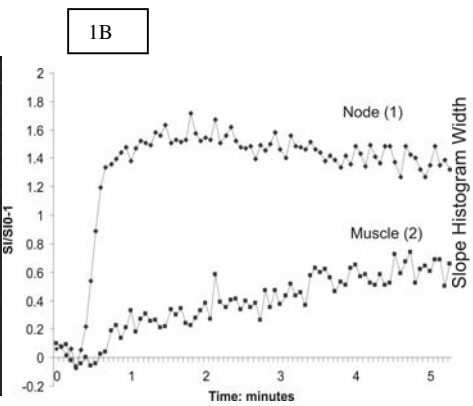
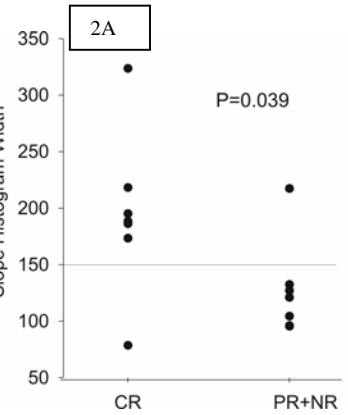


Figure 1A. Post contrast image with region of interest (ROI) marked. ROIs were drawn from 2 areas representing nodal tissue (1), and muscle (2).
1B. The graph exhibits the change in signal over time in the ROIs.



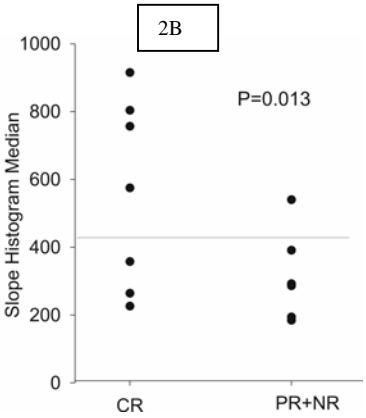


Figure 2A. Graph shows the histogram width of the initial slope for Complete Responders (CR, n=7) vs Partial Responders + Non Responders (PR+NR, n=7).
2B. Graph shows the histogram median of the initial slope for CR vs PR+NR.

Reference

1. U. Hoffman, G. Brix et. al., Magn Reson Med, 33, 506 (1995).
2. G. Brix, W. Semmler et.al., J Comput Assist Tomogr, 15, 621 (1991).
3. P.S. Tofts, J Magn Reson Imaging, 7, 91 (1997).
4. J.P. Dyke, D.M. Panicek et.al., Radiology, 228, 271 (2003).
5. H. Konouchi, J. Asaumi et. al., Oral Oncol, 39, 290 (2003).
6. P.J. Hoskin, M.I. Saunders, Br J Radiol, 72, 1093 (1999).