Monitoring response to chemoradiation therapy of squamous cell carcinomas of the head and neck using diffusion weighted MRI

S. Kim[1], L. A. Loevner[1], H. Quon[2], E. J. Sherman[3], G. S. Weinstein[4], and H. Poptani[1]

[1]Radiology, University of Pennsylvania, Philadelphia, Pennsylvania, United States, [2]Radiation Oncology, University of Pennsylvania, Philadelphia, Pennsylvania, United States, [3]Hematology and Oncology, University of Pennsylvania, Philadelphia, Pennsylvania, United States, [4]Otolaryngology, University of Pennsylvania, Philadelphia, Pennsylvania, United States

Introduction

Pre-clinical (1) and clinical (2) studies with diffusion-weighted imaging (DWI) have indicated its role as a sensitive marker for early detection of treatment response in tumors. DWI has also been used for diagnosis in patients with head and neck cancers (3). Recently, it has been reported that apparent diffusion coefficient (ADC) can be used to differentiate radiation response from recurrent squamous cell carcinomas of the head and neck (HNSCC) (4). However, the efficacy of ADC in monitoring treatment response in HNSCC has not been reported. The purpose of this study was to investigate the feasibility of using the ADC for the early detection of treatment response in HNSCC.

Materials and Methods

MRI data was acquired from 32 patients who were newly diagnosed with HNSCC with no prior treatment and were referred for pre-operative chemo/radiation therapy. All patients had palpable metastatic cervical lymph node masses. The MRI study was performed using a neck array coil for a 1.5T scanner (n=24) and a neurovascular coil for a 3T scanner (n=8). Since ADC is magnetic field independent, the ADC values from the patients studied at both scanners were combined together for this study. T_2 weighted images (TR/TE = 4 s/120 ms) were acquired initially to locate the tumor. 8 axial slices with FOV=26 cm and slice thickness =5 mm were selected to cover the metastatic cervical lymph node. Diffusion weighted images were acquired using a PGSE/EPI sequence with three b-values; 0, 500, and 1000 s/mm^2. The institutional review board approved this study, and written informed consent was obtained from all subjects before the scans.

MR studies were performed before treatment (Pre-Tx), 1 week into radiation therapy (Wk1-Tx), and within one to two weeks after the completion of the treatment (Post-Tx). The treatment response of the patients was determined at the end of chemo-radiotherapy, based on clinical or pathological (if surgery was performed) assessment. The patients have been categorized as complete responders (CR, with no evidence of disease), or partial responders (PR, with evidence of residual disease). The difference in ADC between the two groups of patients was tested using Mann Whitney U Test with 95% significance level.

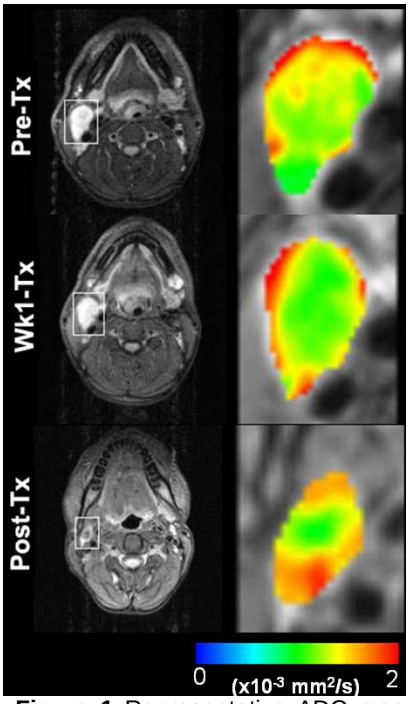

Figure 1 Representative ADC maps (right column) which correspond to the white boxes in the T2w images (left column).

Results and Discussion

Representative T2 weighted images and ADC maps of the lymph nodes from a HNSCC patient are shown in Fig.1. Due to the heterogeneity of the tumor, as evident on ADC maps, the median ADC value was used as a metric for group comparison.

Figure 2a shows ADC values from the node during treatment. Pre-treatment ADC of CRs was significantly lower than that of PR as shown in Fig.2a indicating increased extracellular volume fraction or hypoxic/necrotic areas in PRs compared to the CR group. A significant increase in ADC was observed in the CR group within one week of treatment (Wk1-Tx), which remained high until the end of the treatment (Post-Tx), indicating increased cell kill and thus effective therapy as reported earlier (2). The median ADC of PR also increased slightly, although not significantly. A separate analysis was performed to assess changes in ADC during treatment as compared to pre-treatment values. Figure 2b shows the median normalized ADC values from each individual with respect to the pre-treatment value. A significant difference between CR and PR was noted at Wk1-Tx time point. The common specificity and sensitivity was ~73% using Pre-Tx ADC and ~72% using the normalized Wk1-Tx ADC. Since the pre-treatment ADC values of PRs were higher than the CRs, these results suggest a role for ADC as a predictive marker for therapeutic response in HNSCC.

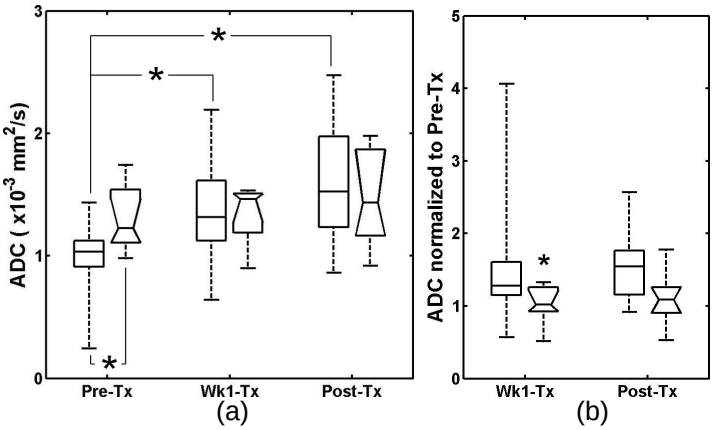

Figure 2: Comparison of ADC values of CR and PR at three time points (a). Relative change in ADC from each patient was assessed by normalizing the data to the pre-treatment level (b). * indicates significant differences ($p < 0.05$) between CR and PR.

Reference

1. Poptani H, et al. Cancer Gene Ther., 1998;5(2):101-109
2. Moffat BA et al., PNAS, 2005;102(15):5524-5529
3. Wang J, et al. Radiology, 2001;220:621-630
4. Razek AAKA, AJNR 2007; 28:1146-1152

Acknowledgement: The authors thank Alex Kilger for patient recruitment. This study was funded by the NIH grant RO1 CA102756.