Evaluation of Head and Neck Tumor Response to Therapy Using *In Vivo* ^{1}H MR Spectroscopy: Correlation with Pathology

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Introduction

Recently, it has been shown that *in vivo* ^{1}H MR spectroscopy (MRS) may offer an efficient and noninvasive means in the diagnosis and evaluation of therapy for head and neck cancer (1, 2). One relevant metabolite that is detected by ^{1}H MRS is choline-containing compounds (Cho), which, when enhanced, is a marker of active tumor (3).

In this study, by collecting proton MR spectra from patients with head and neck tumors pre- and post-treatment, we sought to evaluate tumor response to therapy, and to correlate MRS data with pathology. We hope to establish a noninvasive method with high sensitivity in determining head and neck tumor response or non-response to a specific treatment.

Methods

Six patients were diagnosed pathologically with head and neck malignancy, and were treated with chemotherapy and/or radiation. ^{1}H MRS examinations were performed pre-treatment, initial post-treatment, and follow-up post-treatment. Pre-treatment biopsy was obtained for each patient, and follow-up biopsy and/or resection was performed post-treatment.

All the MR scanning sessions were conducted with a 1.5 T Picker whole-body scanner. The body coil was used as the transmitter and the volume neck coil was used as the receiver. Axial T_2-weighted MR images collected with a FSE sequence (TE = 100 ms, TR = 4.5 s, ETL = 16, FOV = 24 cm, 5 mm slice thickness with 1 mm gap, and 192 × 256 matrix size) were used as scout images to locate the lesions. The PRESS sequence was employed to collect single-voxel proton spectrum from the lesion with TE = 135 ms, TR = 2 s, and 256 scan averages.

The raw spectral data were processed using 3 Hz line broadening, Fourier transformation, and phase and baseline corrections. In most cases, only resonance peaks of Cho and lipid/lactate (Lip/Lac) were identifiable. The Cho peak was fitted using a nonlinear-least-squares fitting procedure with a Levenberg-Marquardt algorithm. The ratio of Cho peak area to water resonance peak area, which was obtained from the reference spectrum collected without water suppression, was calculated and used as the measure of Cho level.

Results

Fig. 1 shows the axial T_2-weighted images of patient A pre- (Fig. 1a) and post-therapy (Fig. 1b), as well as the spectroscopic voxels placed in the lesion. Patient A had metastatic squamous cell cancer to a left neck node which decreased in size after treatment. The size of the spectroscopic voxel was reduced correspondingly from 5.5 cc pre-therapy to 2.4 cc post-therapy. Fig. 2 shows the proton spectra acquired from patient A pre- (Fig. 2a) and post-therapy (Fig. 2b). The prominent Cho peak revealed in the pre-treatment spectrum was basically undetectable following the treatment.

The ratio of Cho/water, as well as tumor size seen in the images, decreased in all six patients following treatment. Final pathology on five patients revealed no residual tumor. One patient had residual sarcoma. The Cho/water values and pathology results for all the patients were tabulated in the Table.

Discussion

In this preliminary study, we have observed strong correlation (5 out of 6 patients) between pathology results and changes in Cho/water from MRS data in the evaluation of head and neck tumor response to therapy. All of the patients whose post-treatment biopsy results showed no malignancy had decreases in Cho/water in the lesion. In cases where it is very difficult to perform biopsy, such as deep neck lesions, ^{1}H MRS may prove to be a valuable and sensitive alternate for differentiating tumor response and non-response to treatment. More patient studies, and better quantitations of pathology and Cho levels are needed to define a quantitative relationship between pathology and MRS results, and thus to establish ^{1}H MRS as an important modality for monitoring head and neck tumor response to therapy.

References

1. Star-Lack, J.M. *et al., Proc. Intl. Soc. Magn. Reson. Med.* **1**, 372 (1998).
2. Star-Lack, J.M. *et al., J. Magn. Reson.* **133**, 243 (1998).
3. Mukharjee S. *et al., Am. J. Neuroradiol.* **18**, 1057 (1997).

Fig. 1a 1b

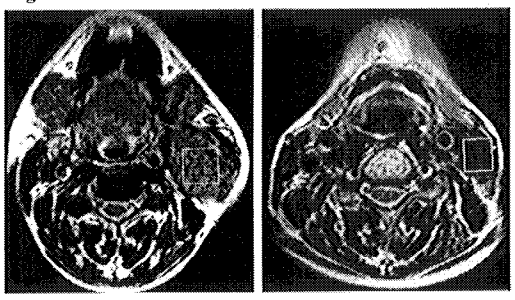

Fig. 2a 2b

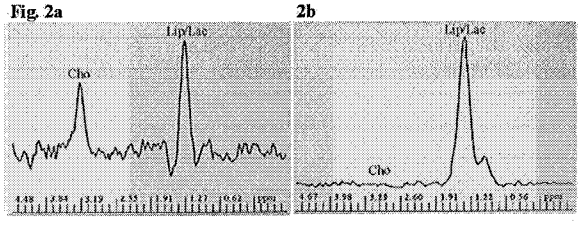

Table Cho/Water Ratios and Pathology Results Pre- and Post-Treatment of Head and Neck Cancer

Patient	Tumor Type	Pre-Treatment		Initial Post-Treatment		Follow-up Post-Treatment	
		Cho/water ($\times 10^{-3}$)	Pathology	Cho/water ($\times 10^{-3}$)	Pathology	Cho/water ($\times 10^{-3}$)	Pathology
A	met. SqCCa	0.56	positive	0.0005	no neoplasm	no data	no neoplasm
B	SqCCa	5.79	positive	1.03	no data	0.42	no neoplasm
C	malg. Sarc	1.63	positive	0.006	resi. neoplasm	0.004	resi. neoplasm
D	SqCCa	8.15	positive	1.42	no neoplasm	no data	no data
E	SqCCa	0.91	positive	0.0001	no neoplasm	no data	no data
F	SqCCa	2.45	positive	1.91	no data	0.91	no neoplasm

met. = metastatic; SqCCa = squamous cell carcinoma; malg. = malignant; Sarc = sarcoma; resi. = residual