In Vivo Proton MR Spectroscopy of Salivary Gland Tumors

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BACKGROUND & OBJECTIVES

The worldwide incidence of cancers of the upper aerodigestive tract is about 500,000 cases per year and about three to seven percent of these epithelial malignant neoplasms are found in the salivary glands (1). Although salivary gland tumors are uncommon and about 70% of these lesions are benign (2); surgery can be disfiguring especially for cancer of the parotid gland which may require additional major procedures in relatively young patients. Pre-operative diagnosis can alert the surgeon to the presence of a malignant tumor so allowing better pre-operative planning and patient counseling, identify those malignant tumors for which surgery is not the primary treatment, and identify benign tumors such as a Warthin's tumor where conservative treatment may be warranted in the elderly. Over the past few years, the role of in vivo proton MR spectroscopy has been evaluated in cancer. The results of proton MR spectroscopy have been reported for a wide range of tumors but because of the inherent problems in performing this technique in the head and neck there are only a few in vivo cancer series in this region (3), and none to our knowledge for salivary gland tumors. The purpose of this study was to use localized proton MR spectroscopy to document the spectral characteristics of salivary gland tumors and to examine whether the choline/creatine (Cho/Cr) and choline/water (Cho/water) ratios can be use to characterize these tumors.

MATERIALS AND METHODS

Forty-seven consecutive patients who were undergoing MR imaging of the salivary glands between August 2001 and November 2003 for a salivary mass greater than 1cm^3 were invited to participate in this study. Three patients with normal parotid glands were also examined as controls using the same protocol. MR imaging and ^{1}H MR spectroscopy examinations were performed on a 1.5-T whole-body system (Gyroscan ACS-NT, Philips, Best, the Netherlands). A standard head and neck coil was used to perform conventional MR imaging in the transverse and coronal planes to identify lesions of interest. Additionally, a 20-cm diameter surface coil placed over the lesion was used to optimize sensitivity for spectroscopy. The volume of interest (VOI) (mean volume: 4.6 cm^3, range: 1-16.3 cm^3) was carefully positioned within each lesion excluding air and normal structures such as bone, muscle and fat. Two water-suppressed spectra were acquired from each VOI using the point-resolved spectroscopic (PRESS) sequence at TE 136 and 272 msec and TR 2000 msec. Data were acquired at a spectral bandwidth of 1,000 Hz and 64 water-suppressed signals were acquired. An unsuppressed water signal with 16 averages was also acquired at each TE as a reference spectrum. The averaged signals were exported and processed on an off-line computer.

After the removal of residual water (4.65 ppm) and lipid peaks (0.90–2.02 ppm) from the free induction decay by means of the time domain Hankel-Lanczos singular value decomposition filtering (4), choline (Cho) (3.2 ppm) and creatine (Cr) (3.02 ppm) peak amplitudes were estimated by means of AMARES (4). As starting values in the fitting procedure, manually selected resonance frequency and linewidth of Cho and Cr peaks were used. Prior knowledge incorporated into the fitting procedure consisted of the following: linewidth of Cr equal to that of Cho; resonance frequencies were constrained to lie in the range ± 0.05 ppm of the known resonance frequencies of Cho and Cr; the zero and first-order phase correction estimated by AMARES were fixed to zero, and the resonances relative phase was also set to zero. For the measurement of water peak in reference spectra, manually selected starting values for resonance frequency and linewidth were used. A Gaussian model function was assumed in the estimation of Cho, Cr and water peak amplitudes. The calculated Cho, Cr and water peak amplitudes were used to determine the Cho/Cr and Cho/water ratio for each lesion. To test whether there were differences in Cho/Cr and Cho/water values between different salivary tumors classified according to histopathological findings, the Mann-Whitney non-parametric test was used. Differences were considered significant when P values were less than 0.05.

RESULTS

Of the 47 patients, 16 had pleomorphic adenomas, 23 had Warthin's tumors and 8 had parotid cancers (4 acinic carcinoma, 2 adenoid cystic carcinoma and 2 mucoepidermiod carcinoma). Interpretable spectra were obtained from all patients except one spectrum at 272 msec that was not successful. At TE 136 msec, Cho/Cr ratio was obtained from 20 out of 47 (42%) spectra and at TE 272 msec, Cho/Cr was obtained from 11 out of 46 (24%) spectra. Cho/water ratio was obtained from nearly all spectra. No Cho or Cr was detected in the normal parotid glands used as controls. Spectra of a Warthin's tumor, a pleomorphic adenoma and an acinic carcinoma are shown in Fig.1, Fig.2 and Fig.3, respectively. Table 1 summarizes the Cho/Cr and Cho/water results for these three disease groups. At TE 136 msec, both mean Cho/Cr (P = 0.04) and Cho/water (P = 0.01) ratios for Warthin's tumor were significantly higher than pleomorphic adenoma.

Table 1

	TE 136 msec		TE 272 msec	
	Cho/Cr	Cho/water (10^{-3})	Cho/Cr	Cho/water (10^{-3})
Warthin's	5.63 ± 2.00	1.29 ± 0.79	6.92 ± 1.47	3.21 ± 2.13
Pleomorphic adenoma	3.47 ± 0.89	0.74 ± 0.37	3.18 ± 2.32	1.80 ± 1.33
Cancers	2.03 ± 0.49	0.89 ± 0.57	2.62 ± 1.07	1.25 ± 1.01

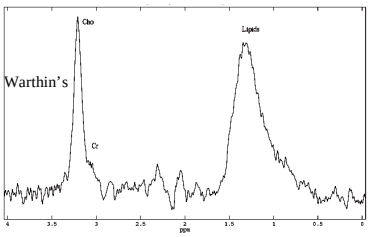

Fig. 1

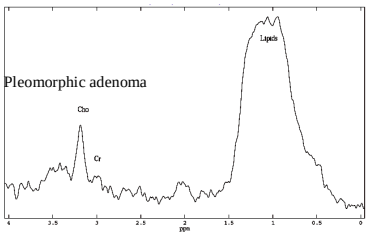

Fig. 2

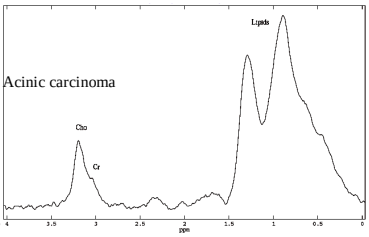

Fig. 3

DISCUSSION & CONCLUSION

Proton MR spectroscopy is a feasible technique for the evaluation of salivary gland tumors. Choline can be identified in both benign and malignant salivary tumors but not in the normal parotid gland. The Cho/Cr and Cho/water ratios were greatest in Warthin's tumors, followed by pleomorphic adenoma and then cancer. There was a statistically significant difference between the ratios for pleomorphic adenomas and Warthin's but the numbers were too small to compare these with the group of cancers. The high ratios for Warthin's tumor may reflect the highly cellular nature of this tumor that results from a large number of lymphocytes. These preliminary results suggest that proton MR spectroscopy may be of value in characterizing salivary gland tumors but a larger series is required to validate the results.

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