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Human cervical lymphadenopathy: evaluation with in vivo ^{1}H-MRS at 1.5 T

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AIM: To evaluate the feasibility of performing in vivo proton magnetic resonance spectroscopy (^{1}H-MRS) of cervical lymph nodes, and the clinical usefulness of the technique in the characterization of cervical lymphadenopathy.

MATERIALS AND METHODS: Cervical lymphadenopathy was examined in 20 individuals with malignant disease, i.e. 10 with squamous cell carcinoma (SCC), 6 with undifferentiated carcinoma (UDC) and 4 with non-Hodgkin's lymphoma (NHL). Cervical lymphadenopathy was also examined in 4 individuals with benign disease, i.e. 3 with tuberculosis (TB) and 1 with Castleman's disease. A point-resolved spectroscopic sequence with echo times (TE) of 136 and 272 ms and a time-domain spectral fitting procedure were used to estimate peak amplitude of choline (Cho), creatine (Cr) and unsuppressed water. Cho/Cr and Cho/water ratios were measured for each lesion. The mean ratio for each lesion group was obtained and results were compared statistically.

RESULTS: At TE of 136 ms, spectra were interpretable in all 24 cases and a Cr peak was identified with post-processing in 15 cases. The Cho/Cr and Cho/water ratios for NHL were 9.1 ± 5.2 and $1.7\pm0.2\times10^{-3}$, for UDC were 4.4 ± 0.9 and $1.2\pm0.4\times10^{-3}$, and for SCC were 2.1 ± 0.6 and $0.5\pm0.3\times10^{-3}$, respectively. Both Cho/Cr and Cho/water ratios for UDC were significantly higher than SCC ($p=0.002$ and 0.026, respectively). At TE of 272 ms, spectra were interpretable in 22 of 24 cases and a Cr peak was identified with post-processing in 11 cases. Cho/Cr and Cho/water ratios for NHL were 5.4 and $4.6\pm1.4\times10^{-3}$, for UDC were 4.2 ± 1.5 and $2.6\pm1.0\times10^{-3}$ and for SCC were 2.5 ± 1.1 and $1.3\pm0.6\times10^{-3}$, respectively. The Cho/water ratio for UDC was significantly higher than for SCC ($p=0.04$). The Cho/Cr ratio for UDC was also higher than for SCC, but this difference was not statistically significant ($p=0.07$). Neither Cho nor Cr was detected in the 3 cases of TB.

CONCLUSION: In vivo ^{1}H-MRS is a feasible technique for the evaluation of cervical lymph nodes and it offers potential as a clinical tool in the investigation of cervical lymphadenopathy. However, further studies with larger patient cohorts are needed to validate the findings of this initial report.

Introduction

In vivo proton magnetic resonance spectroscopy (^{1}H MRS) is a non-invasive technique capable of acquiring information on the cellular chemistry of tissues. Over the last few years, the technique has become an accepted tool for evaluating various cancers of the human body. Although ^{1}H MRS has been shown

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to be most useful in studying brain diseases,[1,2] reports are emerging that the technique may also be useful for cancers elsewhere, including prostate, breast, ovary, cervix and colon.[3] In the head and neck region, however, in vivo ^{1}H spectra often display overlapping peaks even at long echo time (TE)—mainly because of difficulties in achieving optimal shimming within the volume of interest in the presence of tissues with large susceptibility differences. Thus, only a few studies so far have reported the use of in vivo ^{1}H-MRS in the assessment of head and neck lesions.[4-8] Our aim in this study was to examine whether single-voxel ^{1}H-MRS would be a feasible technique in the assessment of persons presenting with cervical lymph node lesions, and whether it could be used to distinguish between different pathological causes of lymphadenopathy.

Materials and methods

This ^{1}H-MRS study involved 24 sequential patients (17 men and 7 women; mean age 55 years, range 39 to 91 years) MRI of whom showed at least one cervical lymph node greater than 1 cm^3 in size. These included 20 cases of lymphadenopathy due to malignant disease, including 10 of squamous cell carcinoma (SCC), 6 of undifferentiated carcinoma (UDC) and 4 of non-Hodgkin's lymphoma (NHL). There were also 4 cases of lymphadenopathy due to benign disease, including 3 of tuberculosis (TB) and 1 of Castleman's disease. In 17 cases the diagnosis was known at the time of radiography (16 diagnoses of primary head and neck malignancy, where MR was performed for staging, and 1 of TB). In the remaining 7 cases the MR was performed for the investigation of cervical lymphadenopathy, and the diagnosis was confirmed afterwards (4 diagnoses of malignancy, 1 of Castleman's disease and 2 of TB). The local ethics committee granted ethical approval for the study and informed consent was obtained from all subjects before the ^{1}H-MRS examination.

MRI and ^{1}H-MRS examinations were performed on a 1.5-T whole-body system (Philips ACS-NT, Best, Netherlands) with a 23 mT/m maximum gradient capability. A standard volume head-and-neck coil was used to carry out conventional MRI in the transverse and coronal planes for identifying affected cervical lymph nodes. Additionally, a circular receive-only surface coil, 20 cm in diameter, was placed over the node of interest to optimize signal-to-noise for spectroscopy. With image guidance, the volume of interest (VOI) (mean volume 7.9 cm^3, range 2.5 to 24 cm^3) within each lymph node was carefully positioned, excluding air and normal structures such as bone, muscle and fat. When multiple lymph nodes present, the largest node was selected for study.

Two water-suppressed spectra were acquired from each VOI, using the point-resolved spectroscopic (PRESS) sequence at medium (136 ms) and long (272 ms) TE and fixed (2000 ms) pulse repetition time (TR). The purpose of using two TEs in this study was to verify the presence of lactate (Lac) in affected nodes, to examine the effect of longer TEs on the detectability of choline (Cho) and creatine (Cr) peaks, and to determine whether intense lipid signals (0.5 to 2.1 ppm) with relatively short T_2 could be effectively reduced with a longer TE. Pre-acquisition optimization procedures consisted of automated receiver gain and frequency adjustment, shimming and gradient tuning. Water suppression was achieved by selective inversion recovery, starting the measurement at the zero crossing of the water signal. Data were acquired at a spectral bandwidth of 1000 Hz, and 64 water-suppressed signals resulted. An unsuppressed water signal with 16 averages was also obtained at each TE as a reference spectrum. The averaged signals were exported and processed on an offline computer by one investigator (D.K.W.Y.) who was blinded to the histopathological results.

Metabolite peak amplitudes and line widths displayed in the frequency domain were determined using magnetic resonance user interface (MRUI) v 97.2.[9] Resonances were considered significant if their amplitudes were at least twice the standard deviation of the noise as determined by MRUI. Spectra were initially assessed for the presence or absence of metabolites including Cho (3.2 ppm), Cr (3.02 ppm), unsaturated lipid (-CH_2-) (2.02 ppm), lipid methylene (-CH_2-) (1.30 ppm), lipid methyl (-CH_3) (0.90 ppm) and Lac (1.32 ppm) (seen as an inverted doublet at TE 136 ms and in phase again at TE 272 ms). Measured by the time domain analysis technique, the line widths of spectral resonances were defined as the damping factor parameters in kHz (divided by π) in the exponential decaying sinusoid model function.[10] The line width of the water peak acquired without water suppression was measured to assess the quality of shim achievable under examination conditions. Line width of the methylene lipid peak at 1.30 ppm was also measured to document the degree of signal overlap among lipid signals commonly found in cervical lymph node spectra.

The removal of residual water (4.65 ppm) and lipid peaks in the chemical shift range of 0.90 to 2.02 ppm from the free induction decay was achieved by means of time domain Hankel-Lanczos