Proton Magnetic Resonance Spectroscopy (^{1}H-MRS) of adrenal gland masses using a multiple array coil (32 channels) at 1.5T

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INTRODUCTION

Adrenal mass diagnostic is based on three steps: the clinical examination, the endocrine workup (glucorticoid, androgen and mineralocorticoid secretion measurements) and the imaging analysis. Computed Tomography (CT) and Magnetic Resonance (MR) imaging allow the classification of 85% of the adrenal tumors. In the remaining 15%, even without oversecretion, a tumor size of and up to 3 cm is a sufficient condition for surgery. There is nonetheless a need for a better diagnosis of these lesions. MR spectroscopy (MRS) is a powerful tool allowing access to the metabolic information. However, since the low signal-to-noise ratio (SNR) of the water-suppressed acquisition is strongly affected by noise, MRS at 1.5 T is an obvious application that can benefit from the increased SNR provided by the 32-channel body coil, improving the current performance and reliability of spectral data.

MATERIALS AND METHODS

^{1}H-MRS measurements were performed on 10 patients (mean age 60, 5 males, 5 females), who provided informed consent. This study was approved by our institutional review board. All patients previously underwent a routine endocrinological investigations and a standardized CT scan protocol, with and without iodine injection. The non-oversecretion of various adrenal cortical steroids and mineralocorticoids associated with the CT scan criteria of an unenhanced density below 10 HU (Hounsfields Units) and/ or a wash-out up to 60% between the first and the tenth minutes, classified the lesion as Adrenal Cortical Adenomas (ACA). Patients with biomarkers abnormalities and/ or untypical lesion on CT underwent a surgery and the final diagnosis was done by histological findings. The final diagnosis was as follow: four ACA, five malignant tumors (M) and one lipoma (L).

Imaging was performed on a 1.5 T whole-body system (Avanto; Siemens Medical Solutions, Erlangen, Germany) with the 32 channel phased array coil. T2 HASTE fat-saturated free-breathing anatomical images were acquired on the three planes (transverse, coronal, and sagittal) for positioning the spectroscopy voxel. Adrenal glands spectroscopy was performed with a point-resolved spectroscopy (PRESS) spin-echo sequence, synchronized with the respiration (TR~ 3500 ms) and TE = 30 ms. Water spectra were collected with 2 signal accumulation to assess the quality of shimming through line width (<15 Hz) and symmetric shape. Water-suppressed spectra were achieved with a three-pulse chemical shift selective (CHESS) saturation. A rectangular voxel (1.7 to 8 ml) was placed in the middle of the adrenal mass avoiding contamination of surrounding tissue. Six saturation bands were applied around the voxel. A total of 256 water-suppressed signal accumulations were acquired during an approximate spectrum acquisition time of 15 min. MRS data were analyzed with the Syngo spectroscopy package of Siemens. Spectroscopy signal analysis was focused on the following peak position based on cholesterol esther(1) CE(14:0) resonances: 0.9, 1.1, 1.3, 1.6, 2.26, 4;39, 5.3, choline (3.2), peaks at 2.08, 5.08 and peaks at 2.8, 3.8, 6.5, 6.8 ppm hypothesized as cathelonamine resonances(2). The values of the area under the curve (AUC) of these spectral peaks were submitted to a Principal Component Analysis.

RESULTS

The gain in signal of the 32 channel phased array coil resulted in an excellent spectral quality, even in a free-breathing acquisition at 1.5 Tesla (fig. 1). The masses differentiation was possible by visual analysis of the spectra, since each type of mass was characterized by a specific spectral shape. The area under each resonance peak was normalized by the value of the area under the peak of water and multiplied by 1000. The lipid content was significantly different among ACAs, malignant tumors and lipoma (Table 1). The lipid content was highest for the lipoma, followed by ACAs and lastly by the malignant masses. The resonance at 2.8 ppm was more important for the ACAs, then the lipoma and finally the malignant tumors. The PCA analysis clearly distinguished the three groups of patients, displaying the two first principal components (75.3% and 23.8%) (fig. 2). By using the resonances at (0.9+1.1), (1.3+1.6), 2.08, 2.8 ppm we were able to differentiate the 3 groups of masses.

DISCUSSION AND CONCLUSION

It is possible to distinguish the types of adrenal masses by their spectral characteristics and resonance values. To our knowledge, data from a spectral acquisition of adrenal masses using a multiple array coil (32 channels) has not been previously reported. The use of the 32 channel coil substantially improved the spectra quality in comparison to the existent literature (2-4) for the same type of lesions probed using 4 or 6 channel array coils.

It was already well known that the lipid content of this type of lesions was a good index for their classification. Tsushima et al. (5) quantified the signal reduction on the in/out of phase images for 53 adrenal masses and they were able to define a limit value that allowed to precisely differentiate 100% of the nonhyperfunctioning adenomas from the aldosterone-producing adenomas. MRS, being more specific for the determination of lipid content than imaging, is a promising tool for the characterization of adrenal lesions. A specific signature for each type of tumors can be visually determined. Ongoing work includes increasing the number of subjects.

	0.9+1.1	1.3+1.5	2.08	2.8
L (1)	332.55	234.11	41.46	2.65
ACA (4)	38.76 (12.69)	56.46 (21.55)	7.60 (3.21)	6.13 (2.88)
M (5)	3.95 (1.26)	6.01 (4.65)	1.83 (0.69)	0.96 (0.57)

Table 1: Mean and standard deviation of the area under the resonance peaks for the 3 type of lesions L: Lipoma, ACA: Adrenal Cortical Adenomas, M: Malignant tumor. The area is normalized by the area under the peak of water.
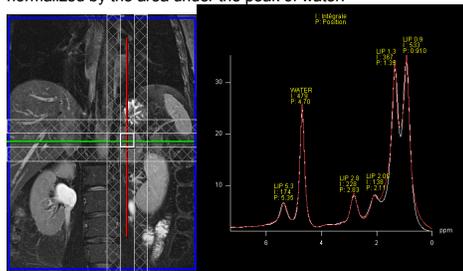

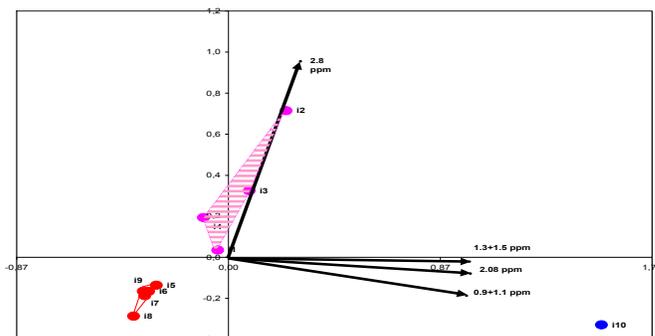Figure 1: Spectrum of an adrenal cortical adenoma ACA.

Figure 2: Principal component analysis; the four variables (black points) are (0.9+1.1), (1.3+1.5), 2.08 and 2.8 ppm peaks. The pink points represent the ACA lesions. Red points represent M tumors and the blue point represents the lipoma (L).

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