Magnetic resonance spectroscopy of human cervical spondylosis at 3T

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Introduction: Recent evidence suggests cervical spondylosis occurs as a result of intervertebal disc degeneration, which increases mechanical stresses at the endplates of the adjacent vertebral bodies, eventually resulting in osterophytes that extend into the spinal canal (1-2). Cervical spondylotic myelopathy is the most common cause of spinal cord dysfunction in older populations. The aging process results in degenerative changes in the cervical spine that, in advanced stages, can cause compression of the spinal cord. The degree of stenosis and clinical symptom is not always correlate with long term clinical outcome and it is difficult to predict spinal cord integrity using conventional MRI technique only. Functional assessment of the spinal cord with proton (^{1}H) magnetic resonance spectroscopy (MRS) has been used recently. Due to technical challenges such as poor sensitivity of signals, quantitative spinal cord MRS has hardly ever been used routinely. Hence, the major goal of this work was to record ^{1}H MRS in patients with spondylosis and healthy volunteers and to quantify metabolites using the LC-Model algorithm.

Methods: 21 patients (59.2y) and eight healthy controls (34.0y) were studied using a 3T Siemens MRI scanner (Siemens Medical Solution, Erlangen, Germany) running on the vb17 platform. First, T_2 weighted sagittal MR images (TR/TE=4000/103ms, Field of view, FOV=220mm) of the cervical spinal spine were obtained. T_2 weighted axial images (TR/TE=3500/82ms, FOV=180mm)) and coronal HASTE sequences were also obtained. Single volume of interest (VOI) was placed within the spinal cord at C2 level, where the spinal canal is the largest. ^{1}H-MRS was performed with single voxel based point resolved spectroscopy (PRESS) (3) sequence with the following parameters: TR of 2000ms, TE of 30ms, 256 Averages, voxel size of 1.72ml (7x7x35 mm^3). For the outer volume saturations (OVS), six slices were prescribed for presaturation of fat containing regions on each side of the VOI. Metabolites were quantified by the frequency domain fitting LC model algorithm (4).

Results and Discussion: Fig.1A shows the 1D MR spectrum recorded in a 56yo spondylosis patient, and 1B showsT2 weighted MRI of spinal cord with MRS voxel location. The metabolites ratio with respect to creatine calculated in 21 patients and 8 healthy controls are shown in Fig.2. In all short echo-based MRS, the total N-Acetylaspartate (NAA+NAAG), total choline (GPC+PCh), Glutamate and Glutamine (Glx), Lactate (Lac) and myo-inositol (mI) were quantified using the LC model algorithm. The cramer-rao lower bound (CRLB) less than 30% were used for the quantitative analysis. The mean and standard deviation metabolite concentrations with respect to creatine ratio of patients were:1.223±0.443 (NAA), 0.420±0.151 (total choline), 0.251±0.187 (Lac), 1.418±0.602 (mI); for controls the ratios were; 1.354±0.428 (NAA), 0.307±0.084 (total choline), 0.232±0.126 (Lac), 1.117±0.453 (mI). Significant increase of total choline ratio was found in the patients group compared to healthy (p=0.034). Also a trend of elevation of lactate and decreased total NAA were observed in the patients even though it was not significant which was reported in earlier study (5). The reason of the difference may be related to the sampled population of the patients; which has milder degree of spinal canal stenosis.

Fig.1. (A) 1D MR Spectrum of 57yo spondylosis patient and (B) Sagittal slice image showing the MRS voxel location.

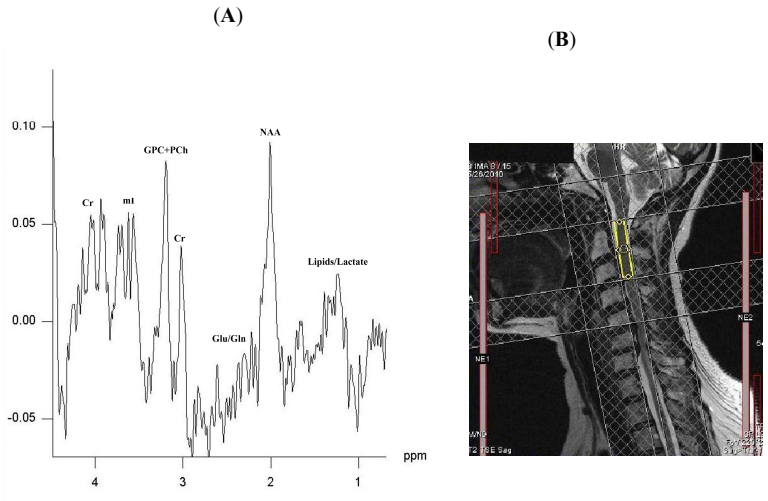
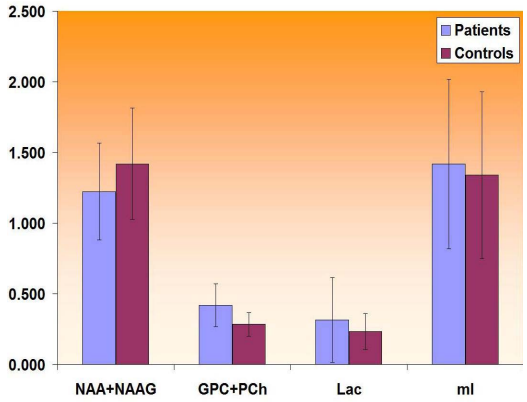


Fig.2. Metabolites ratios (with respect to creatine) calculated in patients and healthy subjects.



Conclusion: Our pilot results in a small cohort of spondylosis patients and healthy subjects demonstrate that MRS can provide valuable information non-invasively and LC-Model processed spectra show significantly increased choline.

References

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