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Modified Magnetic Resonance Spectroscopy for the Diagnosis of Painful and Non-painful Lumbar Intervertebral Discs
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The differentiation of painful and non-painful lumbar degenerative discs is an important determination for guiding management of patients with painful lumbar degenerative disc disease. A non-invasive radiographic technique to accurately differentiate between discs that are painful and non-painful would offer significant guidance in directing treatments and developing a more evidence-based approach to the care of these patients.

We previously reported on 11T HR-MAS Spectroscopy to compare chemical signatures of ex vivo disc nuclei removed at surgery1 and demonstrated that lactic acid (LA) and proteoglycan (PG) may provide quantifiable markers for discogenic back pain.

Our goal in this study was to acquire in vivo MRS signatures of lumbar intervertebral disc from patients with discogenic back pain and control subjects, and to correlate these findings with the clinical and radiographic presentation of these patients.

This single center study included 65 discs from 36 subjects. 38 discs were from 17 patients with chronic low back pain (LBP group), and 27 discs were from 19 asymptomatic volunteers (ASY Group). 25 discs in 12 of the LBP patients also received provocative discography (PD) due to clinical indications. All 65 discs were evaluated using single voxel magnetic resonance spectroscopy (SV-MRS) pulse sequence, data acquisition, and signal processing parameter development of a new DDD-MRS approach. Thirteen discography positive (PD+) discs were used as positive control (PC) discs, and 12 discography negative (PD-) discs plus all the ASY discs were used as negative control (NC) discs. All subjects completed outcomes questionnaires, including ODI and VAS. A diagnostic algorithm for positive (MRS+) and negative (MRS-) pain diagnoses was developed via multi-variate regression analysis of DDD-MRS data against PC and NC diagnoses. Receiver operator characteristic (ROC) and cross-correlation partition analyses determined overall diagnostic accuracy and generalizability of the algorithm, respectively. The diagnostic algorithm calculates a number for each disc based upon data from MRS regions associated with PG, LA, and alanine (AL) (lipid-LA/AL overlap observed in some cases) -- positive algorithm values are assigned MRS+, and negative values assigned MRS-. DDD-MRS diagnostic accuracy was compared to the clinical diagnoses.

DDD-MRS diagnoses strongly correlated with clinical diagnoses ($R^2= .89$, $p< .00001$), matching 50/52 (96.2%) of all PC & NC diagnoses. Twelve of 13 MRS+ discs were from the PC group (PPV = 92%). Thirty-nine of 40 MRS- discs were from the NC group (NPV = 97%). DDD-MRS sensitivity was 92% and specificity was 97%. DDD-MRS results matched PD results in 23/25 (92.0%) discs of the PD Group: 12/13 (96.2%) PD+ and 11/12 (91.7%) PD-.

The novel application of MRS developed under this study proposes a non-invasive and quantifiable measure of the composition of the disc. The MRS diagnostic algorithm developed demonstrates a high degree of sensitivity in identifying patients with a clinical assessment of lumbar discogenic pain, and a high degree of specificity in identifying levels that are not painful. Additional prospective studies are underway to confirm these findings and to solidify our diagnostic algorithms.