Identification of magnetic resonance spectroscopic markers for intervertebral disc degeneration and correlation to biochemical findings

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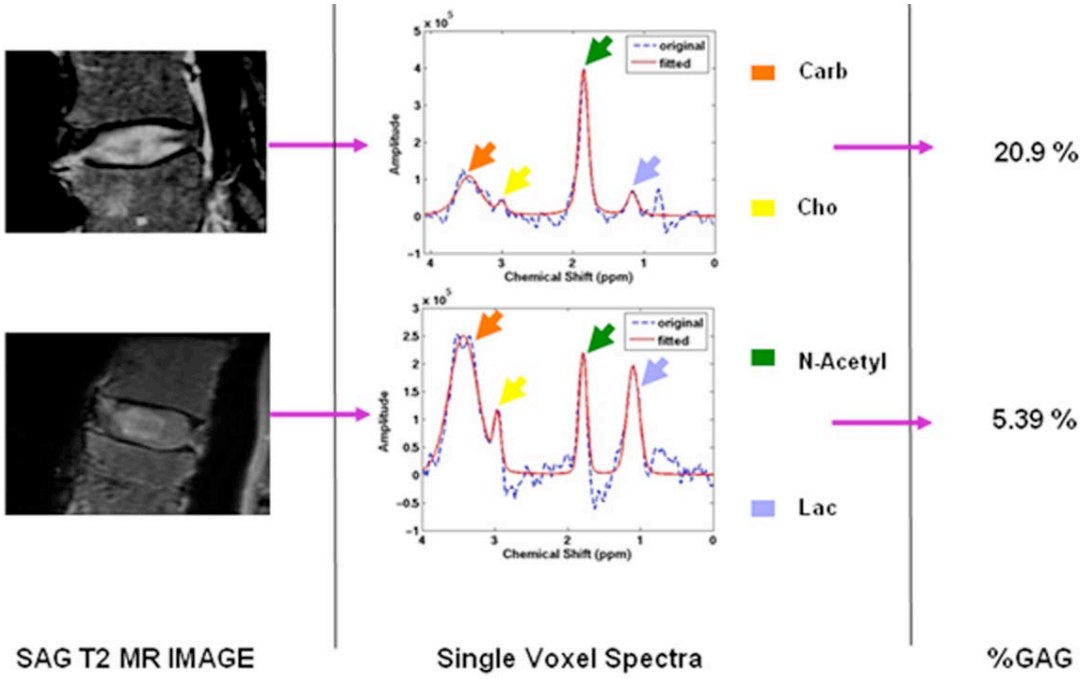
Intervertebral disc disease (IVDD) afflicts nearly 12 million people in the United States and is a leading cause of lumbar spine-related lower-back pain. It is thought that proteoglycan (PG) breakdown in the extracellular matrix (ECM) of the nucleus pulposus is a starting point for the degenerative process, reducing the hydration state of the tissue and lowering its mechanical properties. Conventional assessments of IVDD include discography, computed tomography and magnetic resonance imaging (MRI). These techniques are mainly based on morphological information and fail to detect disc degeneration at an early stage. Magnetic resonance spectroscopy (MRS) is a noninvasive spectroscopic technique that delivers a biochemical and metabolic representation of the tissue, providing insight into tissue changes with disease progression.

The goals of this study are, using MR single voxel spectroscopy (MRSVS): (i) to identify image biomarkers for disc degeneration; and (ii) to examine the correlation between the metabolite concentration changes and their corresponding biochemical findings.

Two ex vivo models were employed for the study: (i) cadaveric human intervertebral discs with different degeneration grades; and (ii) bovine intervertebral discs with degenerative changes introduced using papain injections into the nucleus pulposus. The figure below shows representative T2-weighted fast spin echo Images, the acquired MRSVS and the corresponding glycosaminoglycan (GAG) content of a healthier disc (top row) and a more degenerated disc (bottom row). A taller N-Acetyl peak was found in the healthier disc, representing higher proteoglycan (PG) content. This agreed with biochemical findings: The GAG (a major component of PG) percentage of dry weight was 20.9%, versus 5.39% in a more degenerated disc.



MR T2-weighted images, the corresponding MR single voxel spectrum and the GAG content (represented in GAG% dry weight of tissue). The top row demonstrates results from a healthier disc and the bottom row shows the results from a more degenerated disc.

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