Improving Predictability of Painful Discs by using T1ρ MRI and Disc Height

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OBJECTIVE: To determine the predictability of disc pain in LBP patients by combining T1ρ with disc height ratio measurements.

BACKGROUND: Degenerated intervertebral discs are marked by structural failure and accelerated aging, and when painful, are considered to have degenerate disc disease (DDD) (1), a common cause of low back pain (LBP). Healthy discs rely on diffusion to transport nutrients and waste products between the surrounding blood vessels and the ordered collagen fibers of the annulus fibrosus (AF), to the central gel-like nucleus pulposus (NP). Age-related degradation is marked by a loss of the gel-like consistency of the NP including decreased proteoglycan (PG) content and decreased water concentration (2), while late-stage DDD is characterized by an NP indistinguishable from AF and a collapsed disc space (3). Due to the lack of a proper gold standard, the presence of pain in each disc is currently determined by provocative discography. The technique relies on the patient’s subjective perception of pain as a needle is inserted into the disc. The early changes in PG content are detectable with T1ρ MRI (4,5). While disc height (to width ratio) is a measure of disc quality, it may also be a potential predictor of individual disc pain when combined with T1ρ measurements thus providing a more reliable, objective, and non-invasive determinant of pain in degenerate discs.

METHODS: All MRI scans were performed on a 3 Tesla Siemens Tim Trio clinical scanner using the vendor-supplied spine array coil with approval from the Institutional Review Board and with subjects’ consent. T1ρ and conventional (T1 and T2) MRI were performed on three cohorts of patients: those being treated for LBP (n=12, 49 levels, mean age 44±6 years, range 30-53) whose discs were split into painful and non-painful subgroups based on provocative discography, and age-matched control subjects not being treated for back pain (n=11, 44 levels, mean age 43±7, range 22-76). The average T1ρ (in millisecond) was measured by a single user from a region of interest located in the middle third of each lumbar IVD, corresponding to the NP region. The height of patients’ lumbar discs was measured from corresponding mid-sagittal T1-weighted images. Discs were manually segmented, and an automated program was developed to measure disc height as a ratio (DHR) between the average disc height spanning anterior to posterior, normalized by the width of the disc. Statistical descriptive and ANOVA analyses were performed to evaluate the relationships between DHR and the average T1ρ, relaxation time constant in the NP (NP-T1ρ) and disc opening pressure from discography.

RESULTS:

CONCLUSIONS: T1ρ MRI evaluated in the NP of human intervertebral discs may be useful to establish a threshold (120ms here) above which indicates a healthy disc, while discs measuring low NP-T1ρ (between 48-120ms here) would require disc height analysis to further distinguish the disc between painful and non-painful. Combining T1ρ and disc height analysis shows a promising ability to predict painful discs, without provocative discography, and predictive models could be developed.

SPONSORS: This study was funded by AO Spine Research Grant and was performed at an NCRR-supported Biomedical Technology Research Center.

REFERENCES: