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T1ρ-weighted MRI and Opening Discography Pressure are Quantitative Biomarkers of Disc Degeneration in Patients

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Introduction: A quantitative assessment of disc health is essential for selection of treatment options and to the future of biological research in the development of new spine technologies. The Pfirrmann grade determined from T2-weighted MRI is currently the gold standard to determine disc degeneration [1]. This method has been valuable for research, yet is extremely limited as it is not a continuous quantitative measure. T1ρ-weighted MRI evaluated in the nucleus pulposus (NP) correlates with the Pfirrmann grade, glycosaminoglycan content, and NP mechanical properties in cadaver spines [2,3] and human subjects [4]. We hypothesize that T1ρ-weighted MRI can serve as an accurate quantitative biomarker of disc degeneration across a population of lower back pain (LBP) patients. Provocative discography is an invasive test frequently used to determine if degenerative disc pathology observed using standard imaging is responsible for lower back pain symptoms. While somewhat controversial due to the subjective nature requiring the patient’s pain response, there are several important quantitative pressure measurements obtained as part of a manometric-controlled study. Specifically, we hypothesize that the Opening Pressure (OP, pressure where injected fluid first overcomes the internal osmotic pressure and enters the disc), is a potential indicator of degeneration and a sensitive biomarker of NP GAG loss. The objective of this study is to evaluate T1ρ-weighted MRI and discography pressure as quantitative biomarkers of disc degeneration in patients being treated for LBP.

Methods: Patients being treated for LBP (n=13, 63 levels, avg age 45 years, range 35-53) and control subjects not being treated for back pain (CTL, n=9, 45 levels, avg age 43, range 22-76) were imaged. A subset of LBP patients receiving multi-level provocative discography followed by MRI were also evaluated (n=8, 26 levels, avg age 47, range 42-53). Studies were performed with IRB approval. MRI parameters and image processing techniques are described in Witschey et al. [5].

Discography: Discography data was obtained, following the placement of 22 gauge needles into the center of the L2/L3 through L5/S1 discs, using the IntelliSystem (Merit Medical) with digital pressure display. Iohexol (Omnipaque 300), a low osmolar, nonionic, iodinated contrast agent was injected into each disc under continuous fluoroscopic imaging. The Opening Pressure (OP), when fluid first entered the NP, was recorded.

Results: T1ρ time was significantly correlated with degenerative grade (r= −0.57, p< 0.005, n=108 levels combined LBP and CTL). There was no significant difference in the correlation for LPB and CTL groups (p=0.15, ANCOVA), so a single correlation was calculated. The discography OP was significantly but moderately correlated with Grade (p=0.02, r=0.45, n=26). However, correlation between OP and T1ρ time was significant and strong (p< 0.0005, r=0.66, n=26).

Conclusions: T1ρ is a quantitative measure of degeneration that is consistent across both control subjects and LBP patients. A significant and strong correlation exists between non-invasive MRI T1ρ values and in vivo OP measurements.

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References:
[1] Pfirrmann+ Spine 26, 2001;
[3] Nguyen+ JBJS 90, 2008;