

Longitudinal Changes in T1ρ at Adjacent Level Discs

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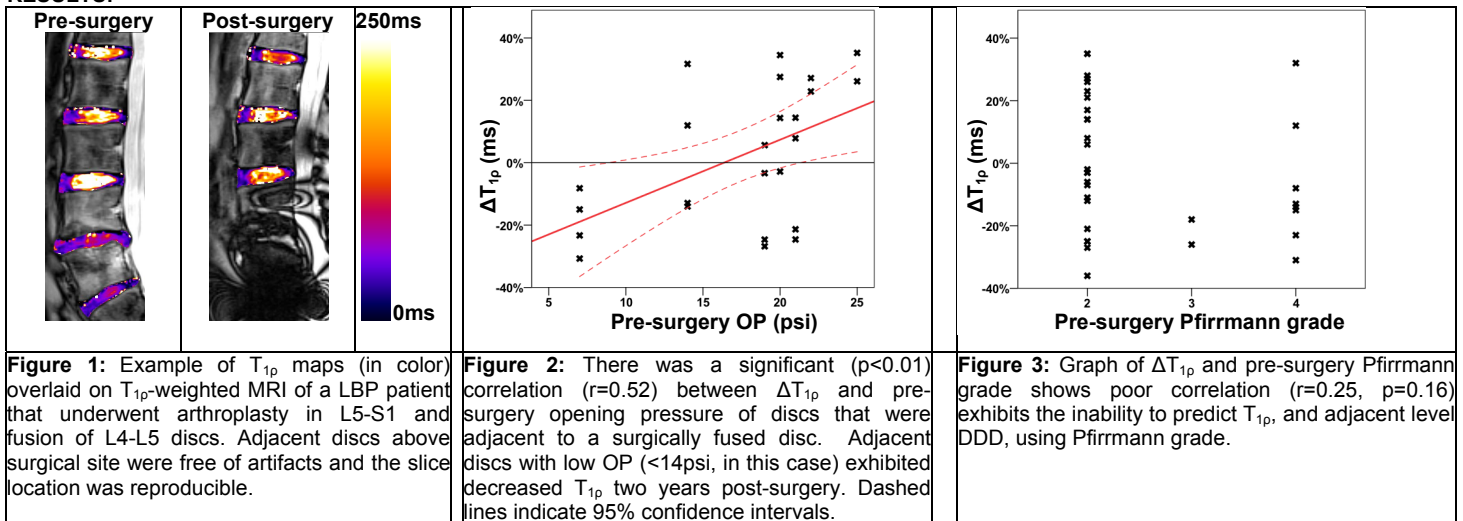
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OBJECTIVE: To determine changes in T_{1ρ} relaxation times in adjacent level discs in patients following surgery in order to relate these to pre-surgical opening pressure as measured by provocative discography.

BACKGROUND: Disc Degenerative Disease (DDD) is a strong etiologic risk factor of chronic low back pain (LBP) and is a common disabling condition for millions of individuals. Total disc arthroplasty is rapidly growing in popularity as an alternative to fusion to treat disc-related back pain. One motivation for arthroplasty is to preserve motion in order to prevent DDD at adjacent disc levels, a serious side effect of fusion surgery (1). However, standard diagnostic tools such as x-ray measurements of disc height and T₂ MRI signal intensity measurements are insensitive to adjacent level DDD (2). A better approach is to utilize non-invasive imaging methods that are responsive to subtle chemical biomarkers. To this end, T_{1ρ} MRI, which has been demonstrated to correlate with disc degeneration, proteoglycan content, and disc pressure in cadaver tissue and *in vivo* (3-6) was used as a quantitative biomarker to assess discs adjacent to surgically fused discs pre- and post-surgery. We evaluated whether a change in T_{1ρ} value was related to pre-surgical discography opening pressure (7) or T₂-MRI based Pfirrmann degenerative grades (8) of discs adjacent to fused discs. The hypothesis tested is that adjacent discs with low opening pressure (indicating low osmotic pressure and proteoglycan content) are more prone to degeneration and manifest decreased T_{1ρ} values.

METHODS: All MRI scans were performed on a 3 Tesla Siemens Tim Trio clinical scanner (Siemens Medical, Malvern, PA) using the vendor-supplied spine array coil with approval from the Institutional Review Board and with subjects' consent. T_{1ρ} and T₂-weighted MRI were performed on patients pre- and post-surgery (n=4, 12 levels {2 points per level – nucleus & total disc}, mean age 42±3 years, range 39-45) at time points ~2 years apart. Discography opening pressure (OP), the pressure where an injected contrast dye first overcomes the internal osmotic pressure, 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. Following co-registration and segmentation procedures, average T_{1ρ} (in milliseconds) was recorded from the discs a level above or below the surgically treated disc using algorithms written in Matlab (Mathworks, Natick, MA). Pfirrmann grading was performed on T₂ MRI of the same discs by a single-reader with several years of experience in disc MRI analysis. Statistical descriptives and regressions were performed in SPSS Statistics 19.0 (IBM, Chicago, IL) to evaluate any relationships between changes in T_{1ρ} pre- and post-surgery two years apart ($\Delta T_{1\rho}$) in the discs adjacent to fused discs and pre-surgery opening pressure and Pfirrmann grade of the adjacent discs.

RESULTS:



CONCLUSIONS: Pre-surgical opening pressure measurements of adjacent discs were significantly related to changes in T_{1ρ} pre- and post-surgery. The data suggests that a low OP may be used to establish a threshold below which these discs are likely to degenerate following surgical intervention at an adjacent disc. At the same time, in this limited number of subjects, Pfirrmann grading could not be related to changes in T_{1ρ}. We are continuing recruitment of more patients with an aim to develop T_{1ρ} MRI to detect adjacent level DDD in order to evaluate patient outcomes from back surgery.

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