Sensitivity of T1p MRI and Pfirrmann Grade to Discogenic Pain
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OBJECTIVE: To determine the sensitivity T1p and Pfirrmann grade in predicting painful discs that were subsequently surgical-treated in back pain patients.

BACKGROUND: Diagnosis of degenerative disc disease (DDD), a common cause of low back pain (LBP), remains difficult, subjective, and controversial (1). 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 content and decreased water concentration (2), while late-stage DDD is characterized by an NP indistinguishable from AF and a collapsed disc space. Due to the lack of a proper gold standard, the presence of pain in each disc is currently determined by provocative discography (3). The technique relies on the patients' subjective perception of pain as a needle is inserted into the disc. With limitations (4), imaging methods have relied on x-ray based methods to detect disc collapse and MRI-based Pfirrmann grading (5) method that relies on a semi-quantitative and subjective grading of the signal intensity on a mid-sagittal T2 MRI. An alternative technique is T1p MRI, which has been demonstrated to correlate with NP proteoglycan content, and swelling pressure in cadaveric tissue and in vivo (6-9). In this study, we compare T1p measurements and Pfirrmann grading of patients' lumbar discs pre-surgery in order to determine the sensitivity of both methods in predicting painful discs (as measured by provocative discography) that eventually required surgery.

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. T1p and T2 MRI were performed on patients a week prior to fusion surgery (n=12, 49 levels, mean age 44±6 years, range 30-53). Discography was performed with 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, and the presence of pain at each level was ascertained. Following co-registration and segmentation procedures, average T1p (in milliseconds) was recorded from all lumbar discs 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 descriptive and regressions were performed in SPSSStatistics 19.0 (IBM, Chicago, IL) to evaluate any relationships between T1p and Pfirrmann grade and painful discs that required surgery.

RESULTS:

![Figure 1: Examples of quantitative T1p maps (in color) corresponding to T2-weighted MRIs (grayscale) of a patient with DDD (A) and an asymptomatic normal volunteer (B). Average T1p values are indicated below each disc in ms and the L4-5 disc in A (T1p=42ms) subsequently treated by 360-degree fusion.](image1)

![Figure 2: Plot of ROC curve of T1p and Pfirrmann grade using a continuous rating scale of predictor of painful discs that subsequently underwent fusion surgery.](image2)

![Table 1: Results of ROC analyses.](image3)

CONCLUSIONS: T1p MRI was more sensitive than Pfirrmann grading in detecting painful discs that required fusion surgery. T1p MRI shows a promising ability to detect painful discs and has the potential to measure patient outcomes from back surgery.

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REFERENCES: