ABSTRACT: Annular Tears: Correlating Discogram and Endoscopic Findings with Electrothermal Response

Introduction: It is generally accepted that pain nociceptors in the outer annulus is a source of discogenic pain in the lumbar disc. When these fibers are disrupted and do not heal, chronic chemical as well as mechanical back pain can result. April and Boduk reported on the "high intensity zone" on a T2 weighted MRI of the lumbar spine. They concluded that this finding can be reliably detected, is diagnostic of an annular tear, and correlates highly with discogenic pain. Others, however, question the relationship of the association between HIZ and back pain. This prospective study correlates pain provocation diagnosed with provocative discography with annular tear patterns, and its response to controlled thermal shrinkage of the disc and annular fibers using a flexible radio frequency probe (Oratec Interventions, Inc.).

Materials and Methods: 50 patients with positive provocative discograms enrolled in a prospective study on the treatment of painful annular tears with the Oratec Endoflex Probe. The study was approved by the institutional review board at St Luke's Medical Center, Phoenix. All had annular tears with predominant back pain, but may also have leg pain from a chemically sensitized nerve root. Patients were examined preoperatively, at one month, three months and six months postoperatively. A modified SF36 questionnaire was filled out by each patient at each visit. A visualized endoscopic technique, (YESS), was utilized for diagnostic endoscopy. Each discogram was performed with a radio opaque contrast agent (Isovue-200) mixed 4:1 with indigo carmine dye. The dye stains degenerative structures within the nucleus pulposus and annular collagen. The patients' pain response to provocative discography was noted and recorded on a visual analog scale (1-10) separately for back pain and leg pain. Leg pain patterns were not required to be in dermatomal distribution to be considered valid, as the patient would not always have "exact" pain reproduction. The degenerated disc material was thermally contracted under direct vision through an operating endoscope. Loose, degenerated disc material was extracted. Inflammatory membranes, when encountered, were also ablated. The area of the annular tear was then treated with the Endoflex probe at 65 degrees C. Treatment endpoint was determined by observing tissue as it was thermally modulated. The annular tear(s) was not always visualized, but the radial fissure leading to the annular tear was always detected. When all interpositional tissue was removed, the collagen fibers of the inner annulus was easily visualized. The patients' clinical results were rated in accordance with modified MacNab criteria. The intraoperative discogram pattern was classified using Adam's classification for degenerative discs and the Dallas Classification by Sachs, et al. The tear pattern was further divided into radial and circumferential components per Osti, et.al. .

Results/Observations: Cotton ball and central lobular patterns and Grade I and II tears never produced pain. Grade III tears produce pain at moderate pressures, and were the most amenable to thermal shrinkage A high intensity zone on MRI is correlated with grade IV and V tears of the outer annulus on discography, but is detected only in the posterior annulus. The painful response is often non-dermatomal, and dependent on the location of the tear. Grade V tears are often associated with an inflammatory membrane, which can spread beyond the area of the tear. Annular tears far laterally and ventrally are usually undetected by HIZ, but readily identified with provocative discography and visualized endoscopically. Ventral and far lateral tears do not reproduce dermatomal pain. Both far lateral and dorsal tears have soft nucleus pulposus interposed between the collagen bundles of the annulus. The soft disc material is visualized to contract and pull away from the annulus. While most annular defects decrease in size, the defect

may sometimes open further if the tear is large. Ventral tears produce groin pain, even at L5-S1, possibly from irritation of the femoral genital nerve along the psoas muscle. Groin pain was a very common finding. Thermal-modulation of the nucleus pulposus will cause the degenerative disc material to shrink, loosening fragments of disc that are easily extracted with motorized shavers. Unstained disc tissue is usually more firm and is adherent to the annular wall. Granulation tissue and inflammatory tissue is seen with grade four and grade five tears. The combination of disc decompression and thermal modulation of the annular defect produced high patient satisfaction, as 45 out of 50 patients responded positively on the SF-36 questionnaire for pain relief and would opt for the procedure again. Grade three tears involving less than one half of the dorsal annulus responded fastest and best, with pain relief occurring in one week to three months. These tears are painful only with moderate pressure when the discogram is performed, and do not usually stain the outer annulus. Grade four tears involving 50% or more of the annulus took an average of 3 to 6 months for back pain relief and grade five tears may take up to 9 months to improve. These patients were followed for 6 to 15 months. Early results of 84% good/excellent by MacNab criteria is quite promising, as this procedure is minimally invasive and only minimally destabilizes the disc since the annulus is fenestrated bluntly. Complications have been limited to dysesthesia, attributed to thermal irritation of the dorsal root ganglion of the adjacent nerve by the spread of heat through annular fissures or defects. A 20% incidence of dysesthesia is troublesome, but usually temporary. A higher and more severe incidence in the first thirty patients was found to be related to large fluctuations of temperatures of as much as 40 degrees C as measured by the Endoflex probe. Symptoms take from 2 weeks to 9 months to resolve. Two patients continue to have paresthesia or residual numbness and quadriceps atrophy. This occurred when the probe tip was buried in the annulus or disc and the probe was not constantly irrigated by cold saline. The probe may not be able to modulate the temperature as quickly or accurately as desired. Fortunately, dysesthesias usually resolved completely, but can be very bothersome to the patient. Severe dysesthesia can be relieved by nerve root blocks until the pain resolves.

Discussion: The Oratec endoflex probe is unique due to its use of radio frequency technology that uses a sensor to record tissue temperature on contact. The unit can be set to produce temperatures within a given range. Temperature ranges utilized in this study were from 60 degrees C to 65 degrees C, the optimum range for collagen shrinkage and ablation of pain nociceptors without destroying tissue. The main issue is whether the temperature can be safely modulated by the current system to prevent the high incidence of dysesthesia observed.

Conclusion: This novel approach utilizing thermal modulation and collagen shrinkage for discogenic back pain warrants further study. It is possible to have discogenic pain from annular tears that do not produce concordant pain in a known dermatomal pattern. Those tears respond to thermal collagen modulation and disc shrinkage. More work is needed to identify the best and safest source of thermal energy for the disc and annulus. Based on these observations, adjunctive therapies are still needed to seal or heal the visualized tears.

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