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Disc Treatments for Low Back Pain: The Endoscopic Approach

Anthony T. Yeung, M.D., and Christopher Alan Yeung, M.D.
Arizona Institute for Minimally Invasive spine Care

Voluntary Associate Clinical Professor
Department of Orthopedics
University of California San Diego School of Medicine

INTRODUCTION

Chronic lumbar discogenic pain (CLDP) is a difficult condition to treat, as its pathogenesis is multifactorial and only partially understood. Non-operative therapeutic regimens often fail to achieve sufficient pain relief. Surgical options vary greatly, ranging from minimally invasive treatments such as Intradiscal Electrothermal Therapy to 360° fusion. **Posterolateral Selective Endoscopic Discectomy™ (SED) and radiofrequency (RF) thermal annuloplasty** is a minimally invasive treatment option for CLDP. This procedure, developed by the senior author was investigated in 1997 and approved by the IRB at St, Luke's Medical Center, Phoenix, Arizona.

Surgical Principle

The senior author's early experience with Laser Disc Decompression (LDD) and early studies on his use of the KTP laser and radiofrequency as an adjunct in arthroscopic removal of contained disc herniations concluded that 65% of the surgical patients also obtained relief of their back pain[1, 2]. Kambin's arthroscopic microdiscectomy instruments and technique allowed for visualization of the disc and annulus. This influenced the evolution of **Selective Endoscopic Discectomy™**[3] to include thermal modulation of disc, the inflammatory membrane, and granulation tissue surrounding the annular defect in disc herniations. Targeted thermal energy on these annular defects has demonstrated shrinkage of annular defects and ablation of inflammatory tissue visualized in the disc. Yeung coined and trademarked the term **Selective Endoscopic Discectomy™** and intraoperative **Evocative Chromo-discography™** [4, 5]using indigocarmine dye mixed with non-ionic radio-opaque radiographic agent Isovue -300 in every endoscopic discectomy procedure. The dye has an affinity for the acidic degenerative nucleus pulposus, and helped stain the degenerative disc tissue for selective removal. The SED and thermal annuloplasty procedure was approved by an IRB protocol investigating the use of a flexible temperature controlled probe by Oratec in the course of endoscopic foraminal surgery for the full spectrum of disc herniations and disc discogenic pain.

The treatment rationale for SED™ and RF thermal annuloplasty is similar to the rationale for Intradiscal Electrothermal Therapy (IDET), but **should not be confused with IDET** because the procedure incorporates the removal of degenerative nucleus via a visualized technique that also ablates patho-anatomical conditions contributing to the complex causes of chronic back pain and sciatica.

IDET is limited, because it is a fluoroscopically guided, "blind" procedure. Ideal wire placement is at the nucleus/annulus junction or within the annular wall, but cannot be guaranteed, because the patho-anatomy is not visualized . There is also uncertainty if the heat will actually reach the targeted fissures and associated nerve endings in each surgical patient or whether the 90 degree Celcius temperature is destroying annular tissue if the catheter is against an already torn annulus. Additionally, the physician cannot see when or if the electrothermal energy is achieving the desired tissue modulation to shrink the tear. The arbitrary length of annular heating may either be inadequate to achieve the desired tissue effect or worse, may be too long, creating tissue necrosis, as previously reported [6]

Selective Endoscopic Discectomy™ and RF thermal annuloplasty is a fully visualized and targeted discectomy with application of electro-thermal energy. An endoscope is inserted into the disc through the posterolateral transforaminal portal. Under direct visualization, the degenerative nucleus pulposus is removed and the disc cavity subsequently inspected. Disc tissue and granulation tissue is often identified embedded in the layers of the annulus. The disc and granulation tissue is removed with mechanical instruments and shavers or ablated with a bipolar flexible radiofrequency probe and Ho:Yag laser[7]. This not only removes the degenerative nucleus, but also creates an environment inducing the tear to heal as the edges re-approximate and the intradiscal pressure is reduced. The annular defects are endoscopically observed to contract and shrink after RF treatment. **Granulation tissue and inflammatory membrane often seen in sensitized discs is ablated. The inflammatory membrane may contain small nerve filaments, blood vessels, or occasionally, furcal nerve branches in the annular fat and embedded in the annulus. These nerves have never described in the traditional transcanal approach but are frequently seen in the "hidden" extraforaminal zone described by Macnab and McCulloch [8, 9].** This visual confirmation guides the extent of treatment. The RF electrode heating process is hypothesized to ablate the sensitized neural sensory endings in the inflammatory membrane that have grown into the fissures. Continuous saline irrigation during the endosopic procedure irrigates out the toxic metabolites within the disc. It also prevents the accumulation of any by-products of the thermal treatment which can be neural irritants. Scant carbonization of the treated tissue may be observed.

HISTORY

Lumbar posterolateral intradiscal nuclectomy for the purpose of indirect nerve root decompression was first independently attempted by Hijikata[10]and Kambin[11] in 1973. In 1989 Schreiber[12] injected indigo carmine, a blue color vital dye, for intradiscal differential staining. Indigo carmine (mixed 1cc/9cc with Isovue -300) selectively lightly stains the more acidic and fragmented degenerated nucleus pulposus, as demonstrated by direct visualization. The staining helps the surgeon locate and selectively remove or ablate this blue-stained degenerative tissue interposed within annular fissures. Although acute lumbar disc herniation has reliable correlating clinical symptomatology and imaging studies, CLDP has no generally agreed upon criteria in the literature in either area.

In two separate prospective randomized studies, Mayer[13] and Hermantin[14] showed equal or better satisfaction with posterolateral endoscopic discectomy versus posterior transcanal discectomy in treating contained HNP's.

Yeung and Tsou described SED™ for extruded HNP's[15, 16] and consistently documented a decrease in low back pain (LBP) in addition to the resolution of sciatica. After achieving clinical success in relieving LBP when laser and radiofrequency is utilized during endoscopic decompression of disc herniations [2], Yeung began treating discogenic LBP with RF thermal annuloplasty (back pain only) with encouraging results[17].

Indications

Patients with chronic lumbar discogenic pain who have failed non-surgical treatment and who have no contra-indications with foraminal access to the lumbar spine are candidates for this procedure. Although this is a minimally invasive operation, it has surgical risks, and is indicated or considered for patients who have few alternatives or after full disclosure of the risk/benefit ratio. Most surgical candidates are considered after extensive non-operative treatments including physical therapy, steroid injections, and pain management. Facing the prospect of fusion as a traditional surgical solution, patients are offered the option of SED with thermal annuloplasty. Evocative Discography™ will help the surgeon identify painful discs that may be amenable to treatment. Concordant pain production and an abnormal discogram during Evocative Discography™ is required for concluding that the discogram is positive. The extent of degeneration and the height of the disc will also influence the surgical result. A single quadrant radial annular tear in a tall disc will be more amenable to treatment versus a 360 degree circumferential annular tear in a collapsed disc. Equally important, discography by the surgeon can better identify those patients that are "pain sensitive" and may not do well surgical treatment. **In order to decrease the variability in interpreting discography results, and the incidence of "false positive" discography, the surgeon should do his own discography.** Patients who have severe pain with simple needle insertion into the skin, who lack a negative control level, have a normal MRI and a have normal discogram pattern, but complains of severe pain will obviously have a "false positive" test. If this test is not performed by the surgeon, it may be falsely interpreted as a "positive " test. This will alert the surgeon to seek psychologic support and evaluation before considering any intervention. The act of performing discography can also create false positive results. The author has also seen false positive reporting by experienced discographers who sedates the patient, inadvertently irritates the nerve during the discogram process, but did not report that severe pain was created while performing the discogram. Close follow-up examination determines that discographer actually created a neuropathy, but failed to address this event in his discogram report. If the surgeon does his own discography, he will be his own control, and will have more confidence in the validity of his discogram results.

Results

A retrospective review of 113 consecutive surgical cases treating chronic lumbar discogenic pain performed by one surgeon (ATY) was carried out between January 1997 and December 1999[17]. There was a minimum two year follow-up. Selection Criteria included failure of 6 months of non-surgical treatment in patients with chronic back pain without sciatica from lumbar disc herniation. Diagnoses included Internal Disc Disruption, Annular tear with HIZ, and Degenerative Disc Disease. The subjects had surgery at only one or two disc levels.

Two outcome measures were used for clinical assessment: a surgeon based modified MacNab method and a patient-based questionnaire. The results of this endoscopic procedure were each graded excellent, good, fair and poor for the modified MacNab and the questionnaire methods. A mandatory poor result was given to any patient who had repeat spine surgery at the same level, had indicated dissatisfaction with the surgical result on the questionnaire response, or who felt the same or worse after the surgery. Using the surgeon's assessment data, eighty-three patients (73.5%) were in the satisfactory outcome group. This group of patients included excellent, good, and fair categories. Excellent outcome was reported in seventeen patients (15%); good in thirty-two patients (28.3%); and fair in thirty-four (30.1%). Thirty patients (26.5%) were determined to have poor results. The specific reasons were as follows: twelve patients were not improved after the endoscopic surgery, eight patients had subsequent lumbar fusion; seven patients had repeat lumbar endoscopic surgery; and three patients had lumbar laminectomy. Twelve patients in the poor category elected to have no further back surgery. Of the eighteen patients who had secondary back surgery, ten reported improvement after the subsequent operation. The satisfied group of patients would select the lumbar endoscopic surgery again in the future given the knowledge gained from their endoscopic experience.

Out of the eighty-three patients that returned the questionnaire, sixty-six (77.1%) reported satisfactory results with fourteen (16.9%) rated excellent, twenty-four (28.9%) rated good, twenty-six (31.3%) rated fair, and nineteen (22.9%) rated poor. The response rate to the questionnaire was only 73%, but the distribution of the patient grading was very similar to the surgeon based assessment. In fact the questionnaire respondents have a higher percentage in the excellent group 16.9% (14/83) vs. 15% (17/113) and lower percentage in the poor group 22.8% (19/83) vs. 26.5% (30/113).

Peri-operative adverse events from this study were low and included three cases of dysesthesia, and one case of thrombophlebitis. All the dysesthesia patients eventually had significant resolution of their symptoms. Studies on treatment of multi-level discogenic pain have been independently reviewed and reported to show even better results than the one and two level patients[18, 19].

Discussion

Posterolateral transforaminal Selective Endoscopic Discectomy™ and RF thermal annuloplasty is a minimal access visualized surgical procedure. This article focuses on the role of annular defects as the first portal leading to pain sensitization.

This procedure thus has many theoretical advantages over some of the other percutaneous intradiscal procedures such as IDET and Nucleoplasty (Coblation). IDET and Coblation rely solely on fluoroscopic guidance and are thus blind procedures. IDET and Coblation are not designed to remove the interposed tissue within the annular tears or remove any by-products of their energy treatment. SED and thermal annuloplasty attempts to achieve one or more of the following: nucleus removal; changing the biomechanical properties of the interspace; and ablating annular neural sensors.

The author believes, in the absence of a better objective diagnostic test, that evocative discography™ provides a gross estimation of the presence or absence of discogenic pain and localizes the painful level(s).[20] Surgeon performed pre-operative provocation (evocative discography™) has patient selection advantages because the variability in discography is diminished by having the surgeon involved in the patient selection

process. The patient's behavior during the procedure provides additional clinical information that helps the surgeons' patient selection.
The posterolateral transforaminal Selective Endoscopic Discectomy™ technique has a steep learning curve and is equipment intensive. The technique was originally developed for nerve root decompression secondary to herniation lumbar disc and focal lumbar stenosis. Mastery in spine endoscopy developed for the original purposes has enabled the authors to expand its capabilities, including paying attention to the annular fissures. As spinal endoscopy continues to evolve, other spinal pathology can be addressed by using the transforaminal endoscopic method. The roles of annular defects, and the cellular and molecular interactions within the defects are worthy of further investigation. Intradiscal endoscopy has established a window into intradiscal pathology.

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