

MINIMALLY INVASIVE OPTIONS TO DISC SURGERY

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Consumer consciousness, the evolution of non-operative specialties involved in pain management, a continuing trend toward outpatient versus inpatient procedures and cost concerns have all generated interest in minimally invasive options to spine surgery. Accompa-

nying this movement are the aspirations of reduced convalescence, loss of functional limitations, lowered complications and diminished costs. Although new therapies offer future promise, there is currently a paucity of randomized controlled trials on these options. The fol-

lowing is a general review of several minimally invasive options to disc surgery.

Keywords: IDET, Nucleoplasty, Percutaneous disc decompression, percutaneous laser discectomy, automated percutaneous discectomy

The purpose of this article is to give a general overview of several minimally invasive options to disc surgery, proposed mechanisms of action, indications, clinical results and some of the reported complications. It is not intended to be an in depth discussion of the technical aspects of performing these procedures.

IDET (INTRADISCAL ELECTROTHERMAL ANNULOPLASTY)

Proposed Mechanism of Action

Although a precise mechanism for the effects of IDET is not known, several theories are currently in favor. One theory is that the resistive heating coil used produces an elevation in annular temperature sufficient to cause nociceptive fiber destruction (1). Shah et al (2) demonstrated collagen denaturation, shrinkage and coalescence with no evidence of damage to the endplates or untreated portions of the disc. Although the electrothermal coagulative effects on intradiscal nerve endings have not been determined, Bono et al (3) have demonstrated a potential zone of denervation within the annulus with this procedure. Another potential mechanism is stimulation of annular healing through cauterization of vascu-

lar in-growth (2). Others believe the underlying mechanism may lie in alteration of the motion segment biomechanics due to collagen modification, though Lee et al (4) failed to show any statistically significant decrease in spinal stability.

Indications

The IDET procedure is indicated for patients with intractable low back pain from internal disc disruption with adequate maintenance of disc space height (no greater than 50% collapse). The indications for this procedure have been published in detail (5) and are similar to those for patients who would otherwise undergo a spinal fusion. Symptomatic internal disc disruption (IDD) should be deter-

mined by concordant pain at the abnormal disc level, as well as, by the presence of a control disc injection on provocative discography (6). Many studies have discussed the significance of positive pain response on discography and its correlation with IDD (7, 8).

Technique

The IDET procedure is performed in a similar fashion to diagnostic disc injections, except a flexible catheter with a heating element in the tip is passed through the needle (trocar) (9). This flexible thermal coil wraps around the inner surface of the annulus within the nucleus (Fig. 1). New catheter designs are being developed for more localized effects at the

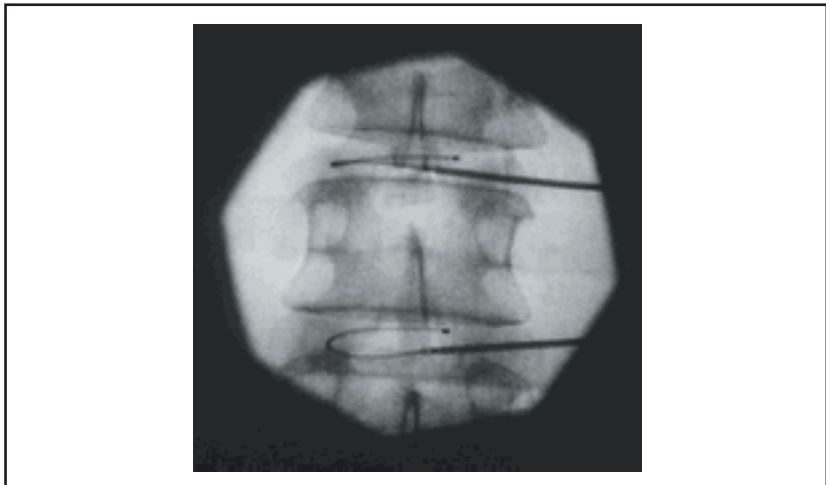


Fig 1. AP fluoroscopic image of two level IDET catheter placement with coil elements along ventral aspect of inner annulus

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site of focal disc protrusions. The catheter is gradually heated over a thirteen minute period to a maximum of 90°C and maintained at this temperature for four minutes (10). Bupivacaine and Cefazolin or Clindamycin are then instilled.

Post-Procedural Care

Post procedural care includes lumbosacral orthotic for six to eight weeks with limited work, sitting and driving activities, followed by low-intensity stabilization exercises for one month. Patients are asked to avoid strenuous and athletic activities for five to six months.

Results

Saal and Saal (5) demonstrated an improvement in 71% of patients on both the VAS and the SF-36 functional scales. In a 2002 Saal and Saal (11) two-year follow-up report, they noted fifty-three percent of their patients had at least a 21-point improvement in their SF-36 functional scale. Karasek and Bogduk (6), in 2000, reported fifty percent of their IDET group obtained greater than fifty percent relief using the VAS. Derby et al (12) reported 62.5% of IDET patients had a positive response based on several scales.

In a double blinded placebo controlled study, Pauza et al (13) showed a 2.4 point improvement in pain, using the visual analog scale, at six month follow up to IDET. The control group revealed only a 1.1 point improvement. There was also significant improvement in the mean Oswestry Disability scores. In a recent study Freeman et al (14) failed to show a significant change in any outcome measures at six month follow up to IDET. Both studies have not been published in a peer review journal (at the time of this writing).

Complications

Saal and Saal (5) reported no adverse events in their publications of this procedure. Others have reported cases of bacterial discitis, thermal nerve root injury, catheter breakage and a single report of intractable cauda equina syndrome.

PERCUTANEOUS LASER DISCECTOMY

Proposed Mechanism of Action

Percutaneous laser discectomy is believed to cause a decrease in intradiscal pressure through vaporization of nuclear material by laser light, ultimately leading

to diminished pain (15-17).

Indications

The indications for PLD are for the classic Mixter and Barr (18) herniated nucleus pulposus (posterolateral) with radicular pain, positive straight leg raise, and corroborating evidence on CT or MRI. This procedure is not indicated in the presence of stenosis, disc extrusion, disc sequestration or in patients with neurological deficits or previous surgery at same disc level, although the last is a relative contraindication (19).

Technique

An extra-pedicular approach comparable to that used for posterolateral discography is employed (20) to guide a trocar down through to the inner annulus. A laser fiber is then threaded into the nucleus pulposus at a distance of approximately one centimeter (19). A protocol of pulses and varying durations is then applied according to the type of laser light source and operator preference. The LASE® (Clarus-Medical, Minneapolis, MN) catheter, one design amongst a newer generation of laser discectomy instruments, employs the use of fluoroscopy as well as an in-line fiber optic for guidance of the laser tip (Fig. 2).

Results

Choy et al (21) employing Nd:YAG laser, obtained 78.4 percent good to fair results. Siebert (22) reported 78 percent good results with the Nd:YAG laser. Other researchers have noted results comparable to the above authors, performing laser discectomy with the KTP laser (23). Several studies have emphasized the importance of proper patient selection, including provocative discography, in significantly im-

proving the success rate of percutaneous laser discectomy. Ohnmeiss, Guyer and Hochshuler (24) reported a 70.7% success rate in patients with discography-supported contained disc herniation, versus a 44.4% success rate in those who either did not have discography or in whom contrast extravasation was seen.

Complications

Reported complications have included osteonecrosis and vertebral endplate injuries (25-26), nerve root injury (27), dural puncture, discitis (28), reflex sympathetic dystrophy (24), urinary retention (23), reflex ileus (29), hematomas, and abdominal perforations and cauda equina syndrome (30).

AUTOMATED PERCUTANEOUS DISCECTOMY OR APD

Proposed Mechanism of Action

First described by Hijikata (31) in 1975, percutaneous discectomy was initially performed through a 5 mm cannula employing modified pituitary forceps. The modern-day automated percutaneous discectomy (APD) device removes nuclear material which decompresses the disc, thereby alleviating pain. Shea et al (32) have shown a decrease in intradiscal pressure at rest and when loaded, after application of the Nucleotome® (Clarus-medical, Minneapolis, MN). The Nucleotome® APD device employs a modified vitrectomy instrument with a reciprocating suction cutter to aspirate, cut and circulate fluid during discectomy (Fig. 3). Another device the Dekompressor™ (Stryker Instruments, Kalamazoo, MI) employs a rotating spiral channel which cuts and mobilizes nuclear material down the cannula into a receptacle chamber

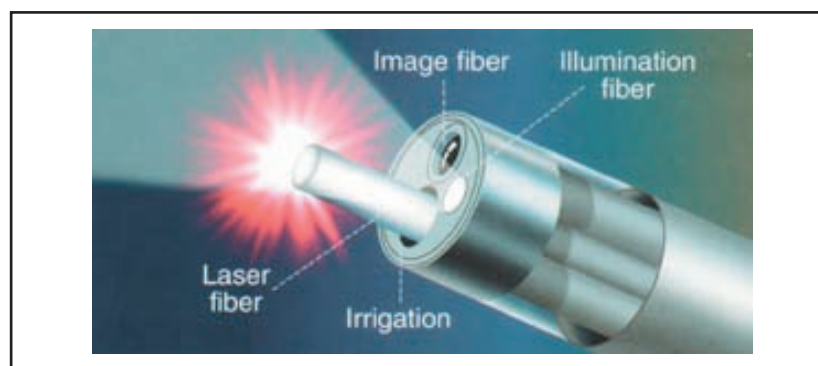


Fig. 2. Artistic rendition of LASE® catheter tip

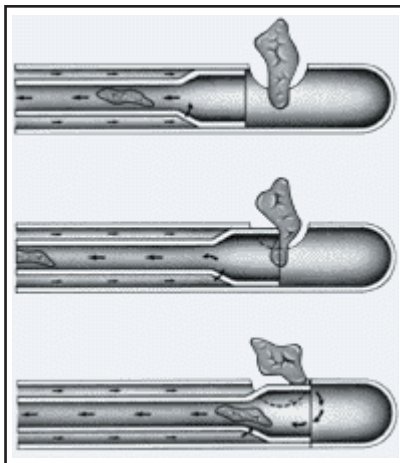


Fig. 3. Schematic drawing of Nucleotome® device with reciprocating cutting and suction tip

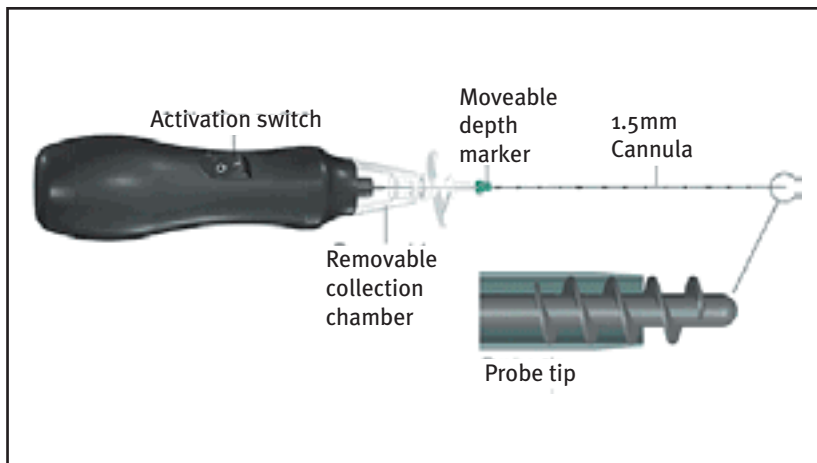


Fig. 4. Dekompressor™ percutaneous discectomy device with rotating spiral channel removes nuclear material and guides it down the cannula to a collection chamber

(Fig. 4). Both devices decrease intradiscal pressure by reducing the nuclear volume and thereby relieve pain.

Indications

The indications and contra-indications for percutaneous automated discectomy are the same as those for laser discectomy. Provocative discography with CT is recommended for pre-procedural evaluation. APD, like laser discectomy, is recommended only for contained disc herniations. Onik and Davis (33) the original investigators of the Nucleotome® suggest four primary indications for this procedure. The first is far lateral disc herniations. The second is in young athletes. The third indication is for the treatment of discitis. The fourth indication is for recurrent disc herniations.

Technique

Employing an extra-pedicular approach, an 18-gauge needle with removable hub is passed down to the center of the nucleus. After positioning has been verified fluoroscopically, from several angles, a cannula with a tapered dilator is advanced to the annulus. The dilator is removed, with cannula in place. A trephine is employed to create an annulotomy. Then the trephine and needle are removed and the Nucleotome® device is advanced through the cannula to the center of disc. A protective stop prevents the APD device from advancing past mid-nucleus. Once the Nucleotome® is engaged it aspirates fragments of nuclear material. The procedure is repeated with the patient in flexed and then

extended positions. Extirpation continues until only scant disc material is noted in the exiting irrigant line (a total device time of fifteen to thirty minutes).

Results

Although most reports are favorable, with outcomes comparable to laser discectomy, success rates for this procedure vary widely. Davis and Onik (34) reported a 78% success rate in 200 consecutive patients. Other studies reveal success rates ranging from 37% to 87% (35, 36).

Complications

Some reported complications associated with percutaneous automated discectomy include discitis, psoas hematoma, retroperitoneal hematoma and a case of cauda equina syndrome (37-39).

DISC NUCLEOPLASTY® (ARTHROCARE SPINE, SUNNYVALE, CA)

Proposed Mechanism of Action

An intradiscal catheter (Fig. 5) emits bipolar radiofrequency energy to the conductive nuclear material creating a highly charged ion particle or plasma field and consequent tissue dissociation (i.e., the formation of a tissue channel). On a molecular level, as the probe is advanced energized ions cause a low-temperature cleavage of organic molecular bonds within the concentrated plasma field. This process of radiofrequency plasma ablation® or Coblation® causes a volumetric decrease in disc material and



Fig. 5. DISC Nucleoplasty® Perc-D catheter tip creates bipolar radiofrequency energy to cause low temperature cleavage of organic molecular bonds within the nuclear material

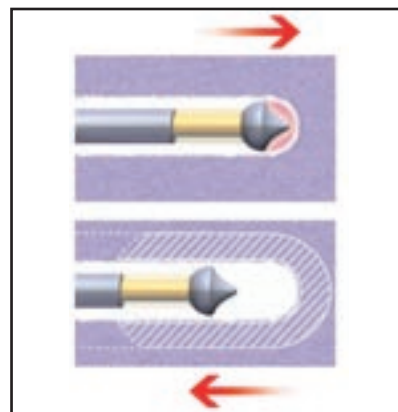


Fig. 6. DISC Nucleoplasty® Perc-D catheter tip causes coblation upon advancing into nuclear material and coagulation upon withdrawal

has the advantage of causing little collateral tissue damage compared to conventional thermal cauterization. As the catheter or "wand" is withdrawn, the bipolar radiofrequency coagulates tissue adjacent to the channel (Fig. 6). The tissue channels created result in lowered intradiscal pressure and decreased pain. Recent studies have suggested a histological or anti-inflammatory mechanism behind the decrease in post procedure pain.

Indications

Nucleoplasty is indicated in contained disc herniations with positive straight leg raise and radicular symptoms although this procedure has also been offered to patients with internal disc disruption (without significant collapse of the interspace).

Technique

An extra-pedicular/posterolateral approach is applied to insert an intradiscal cannula and radiofrequency "wand." Advancing the wand allows the formation of a small controlled channel in the disc and withdrawal permits radiofrequency coagulation adjacent to the channel for decompression. Withdrawal, rotation and repeated advancement of the wand allows lesions to be created at the 2, 4, 6, 8, 10 and 12 o'clock positions (Fig. 7).

Results

The success rate with this procedure lies at approximately eighty percent, based on studies by Singh et al (40). A recent study by Sharps and Zacharia (41) showed an overall success rate of 79% in all their subjects, with an 82% success rate in those who had not previously undergone surgical intervention. As with other minimally invasive procedures, studies have shown a significant decrease in intradiscal pressure after nucleoplasty on non-degenerated discs (42). This procedure has not, however, been shown to be very effective in decreasing intradiscal pressures in highly degenerated discs.

Complications

In general this procedure has proven to be very safe. Nirschl et al (43) reported the most common complaints at 24 hours post procedure to be pain at the procedure injection site, new numbness or tingling and pain in other areas of the back. At two weeks post procedure no patients complained of pain at the injection site or of new back pain. A small number of subjects (15%) still had some residual numbness or tingling.

SUMMARY

A growing number of promising minimally invasive options to disc surgery are currently available. Despite the relative safety, high yielding success rates, and

decreased healing time, the long term efficacy of these procedures is unknown, as most investigations have been open trials. Research and development of minimally invasive discectomy techniques should continue, since preliminary research seems to support the role of these procedures as effective and safe alternatives to major surgical intervention.

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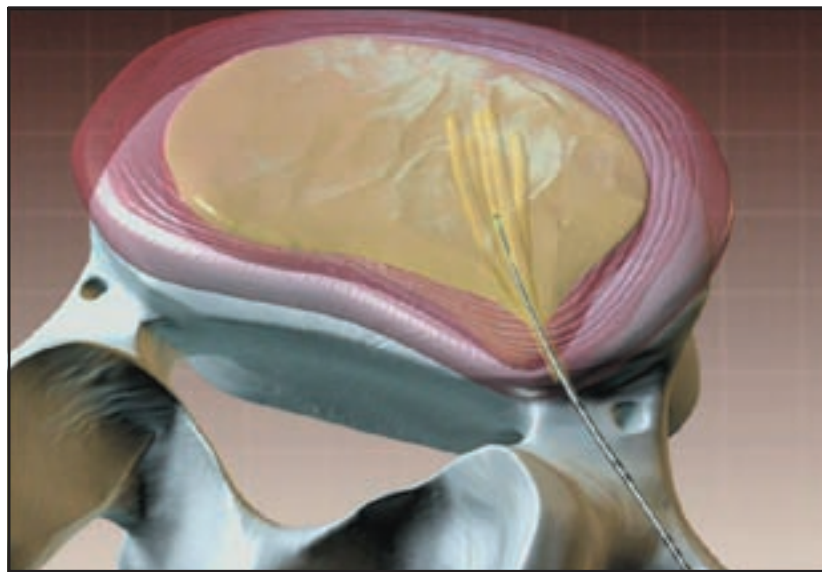


Fig. 7. Channels created in the nuclear material by DISC Nucleoplasty® create a decrease in intradiscal volume and pressure

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