Arthroscopic Microdiscectomy:

An Alternative to Open Disc Surgery

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Abstract

Objective: To assess minimally invasive spinal surgery under endoscopic magnification and illumination (arthroscopic microdiscectomy) as a reliable alternative to open microsurgery for most herniated lumbar discs.
Method: A total of 600 cases are evaluated retrospectively in terms of patient selection and technique. One series of 300 operations was performed by a key academician in the development of arthroscopic microdiscectomy. A second series of 300 patients was treated by a neurosurgeon in private suburban practice.
Results: In terms of patients self-evaluation, satisfactory outcome rates of 85–92% were realized. The patients considered brief intravenous anesthesia and same-day scheduling preferable to general anesthesia and hospitalization needed for open laminotomy and discectomy. Fewer than 2% of the cases required a second surgery.
Conclusion: The authors are of the opinion that advantages include: (1) one-hour operative time, (2) negligible blood loss, (3) avoidance of significant scarring in the spinal canal, and (4) anterolateral fenestration of the annulus for continuing relief of intradiscal pressure and nerve root decompression.

Key Words: Arthroscopic microdiscectomy, fluoroscopy, laser, percutaneous discectomy, endoscopy, lumbar spine.

Introduction

Ottolenghi and Argentina (1) in 1955 and Craig (2) in 1956 described posterolateral biopsy of the spine. A similar technique was used for discography (3) and chemonucleolysis (4). In 1942, Poole (5) had already employed a modified cystoscope for percutaneous endoscopy of the subarachnoid space; 400 myeloscopic examinations of the cauda equina allowed the differential diagnosis of herniated nucleus pulposus, hypertrophied ligamentum flavum, adhesive arachnoiditis, benign neoplasm, and metastatic carcinoma. Beginning in 1973, Kambin (6) combined decompression of the spinal canal by laminectomy with introduction of a tube by posterolateral approach for evacuation of a protruding disc. Hijikata (7) in 1975 independently developed instrumentation for percutaneous debulking of the nucleus pulposus. Other percutaneous methods included medial nucleotomy by an automated aspiration probe (8) and disc vaporization by a fluoroscopically placed laser fiber (9).

The introduction of arthroscopic illumination and magnification allowed identification of the triangular "working zone" (Figs. 1A & 1B). As the spinal nerve descends diagonally across the intervertebral disc, the annulotomy site is defined inferiorly by the proximal vertebral plate, and posteriorly by the articular process of the lower segment. Departing from the foramen, the exiting root moves anteriorly, distally, and laterally, and forms the anterior boundary of the triangular working zone. Within the triangle, there is generally ample room for introduction of the coaxial instruments (Fig. 2). The initial open technique with posterolateral introduction of a tube was gradually replaced by a completely percutaneous operation employing a modified discoscope, a working sheath with a 6.4 x 6.4 mm or 6.4 x 9.4 mm outer diameter, and coring instruments and forceps designed for a 5 x 5 mm or 5 x 8 mm inner access (10).

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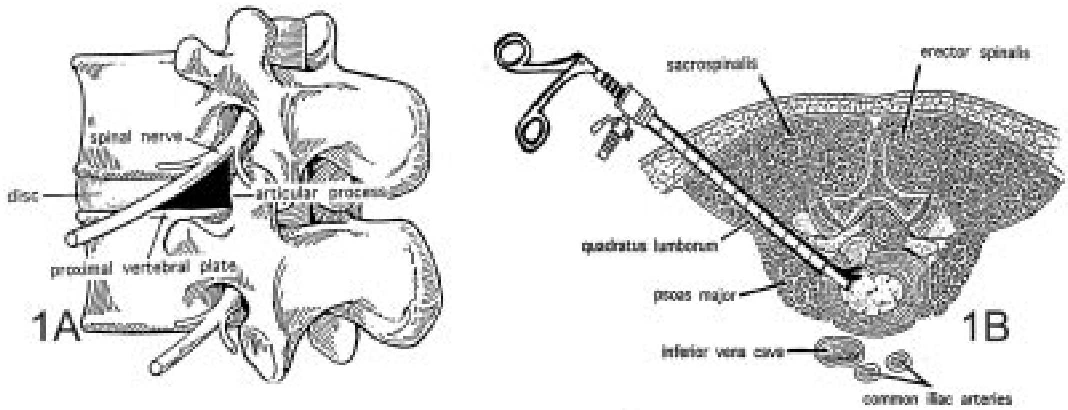

Fig. 1. Drawings depicting the operative area. **(A)** Lateral view. The black triangle represents the working zone. **(B)** Cross-sectional drawing of the anterolateral surgical approach to the disc space.

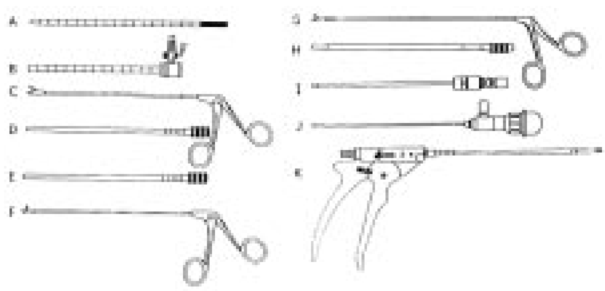

Fig. 2. Arthroscopic microdiscectomy instruments: **(A)** blunt cannulated trocar, **(B)** working sheath, **(C)** straight forceps, **(D)** small core, **(E)** large core, **(F)** upcutting forceps, **(G)** flexible forceps, **(H)** deflector tube, **(I)** power shaver, **(J)** discoscope, and **(K)** suction punch.

Savitz reported a series of 120 same-day, microsurgical, arthroscopic, lateral-approach, laser-assisted fluoroscopic discectomies (1). In 1996, the neodymium:yttrium-aluminum-garnet (Nd:YAG) laser, which had been confined to hemostasis, was replaced by the holmium: yttrium-aluminum-garnet (Ho:YAG) laser, manufactured by New Star Lasers, Inc. (Auburn, CA) and approved by the FDA for disc vaporization. A portable unit allowed the procedure to be scheduled at three community hospitals in two suburban counties within a 25-mile radius of New York City.

Patient Selection

Initially, ideal cases were defined as having: (1) symptoms for up to 6 months of unilateral sciatica which responded to rest; (2) mechanical signs of nerve root irritation when erect; and (3) one protruding or prolapsed disc having positive tension signs, as interpreted by CT or MRI. In addition to disc extrusion, there were other factors considered nonideal for percutaneous endoscopic discectomy. Unrelieved foraminal compression due to segmental spondylosis is a known cause of failed back syndrome. Cauda equina syndrome is considered an indication for urgent open decompression of the nerve root. Prior disc surgery is often complicated by scar tissue in the spinal canal which is not resected by arthroscopic technique. Obese patients do not fit easily on the radiolucent frame, and their spinal anatomy is difficult to visualize on fluoroscopic imaging. Diabetic neuritis and neuropathy can mimic the signs and symptoms of a herniated nucleus pulposus. Inaccessibility was defined in some individuals with a central herniation or an elevated iliac crest.

The diagnosis was made by computerized tomography, magnetic resonance imaging, and/or myelography. Half of the cases had undergone two neuroradiologic studies. The patients selected fell into 3 categories: (a) disc prolapses occupying up to 50% of the spinal canal (Fig. 3 left), (b) extremely lateral disc herniations (Fig. 3 middle), and (c) lateral recess stenosis with sequestered but not migrated herniation (Fig. 3 right). All of the cases were studied retrospectively.

Unilateral Technique

With the patient positioned prone on a radiolucent frame suitable for fluoroscopy, the skin entry site was 8 – 12 cm from the midline. Insertion of a spinal needle at about 45°, followed by a guide wire, cannulated obturator, and working sheath at the triangular working zone, was accomplished by C-arm monitoring (Fig. 4). Prior to annulotomy by circular coring instruments, the safety of the nerve root was ascertained. In order to confirm the posterior positioning of the instruments, dorsal and ventral tilting of the medial end of the cannula were carried out. Repeated perforation of the annulus with the spinal needle demonstrated correct placement of the working sheath on the disc space. Visualization of annular

Fig. 3. Preoperative neuroradiologic studies: **Left:** MRI demonstrating disc herniation (arrow) into left lateral recess. **Middle:** MRI showing left foraminal herniated disc (arrow) compressing the exiting nerve root. **Right:** CT showing air (A) consistent with degenerative disc disease, superimposed facet hypertrophy (H) causing stenosis and asymmetrical disc protrusion (arrow) extending to the left lateral recess.

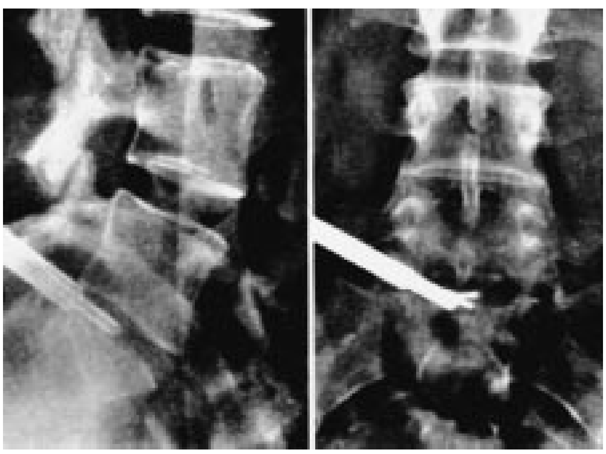

Fig. 4. Intraoperative photographs taken via the fluoroscopic image intensifier. **Left:** Lateral view showing the working sheath resting on the annulus and a small circular cutting instrument within the disc space. **Right:** Anteroposterior view showing the working sheath aligned with the midpart of the pedicle and flexible forceps delivered within the disc space by a deflector tube.

fibers and periannular adipose tissue (Fig. 5A) further assured the absence of any part of the spinal nerve within the operative field. Removal of disc material was accomplished manually with a straight forceps and an upcutting forceps. The flexible forceps used in conjunction with a deflector tube (Fig. 3) allowed access to subligamentous and interannular fragments. A suction punch forceps and an automated shaver employing irrigation were also available. After removing 2–5 g of degenerative disc and completing the discectomy, the arthroscope showed the cavity created (Fig. 5B).

Bilateral Biportal Technique

Two working cannulas were inserted into the intervertebral disc from the left and right paramedial approaches (Fig. 6). The arthroscope was introduced through one portal to visualize the forceps, suction punch, and automated shaver being manipulated through the second portal. Under direct illumina-

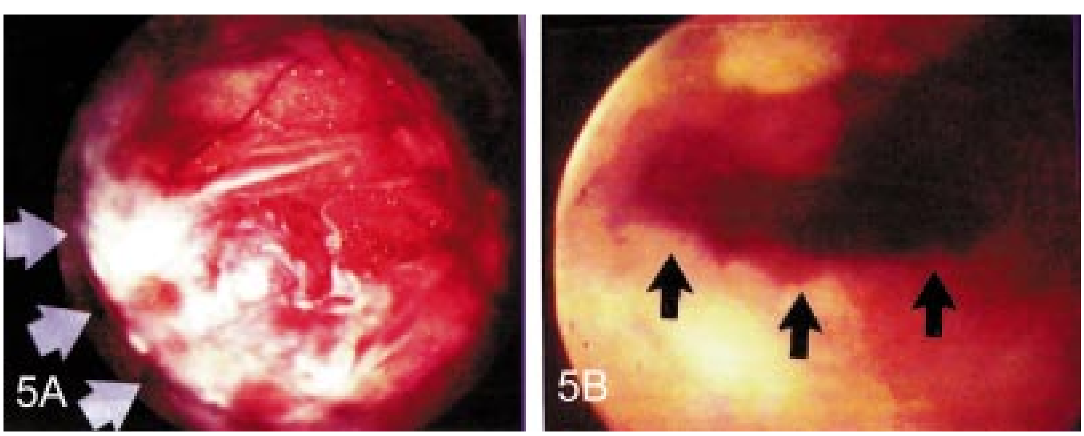

Fig. 5. Intraoperative photographs, arthroscopic views: **(A)** Loose fatty tissue (arrows) prevents unobstructed inspection of annular fibers. **(B)** Appearance of the cavity (arrows) created behind the annulus.

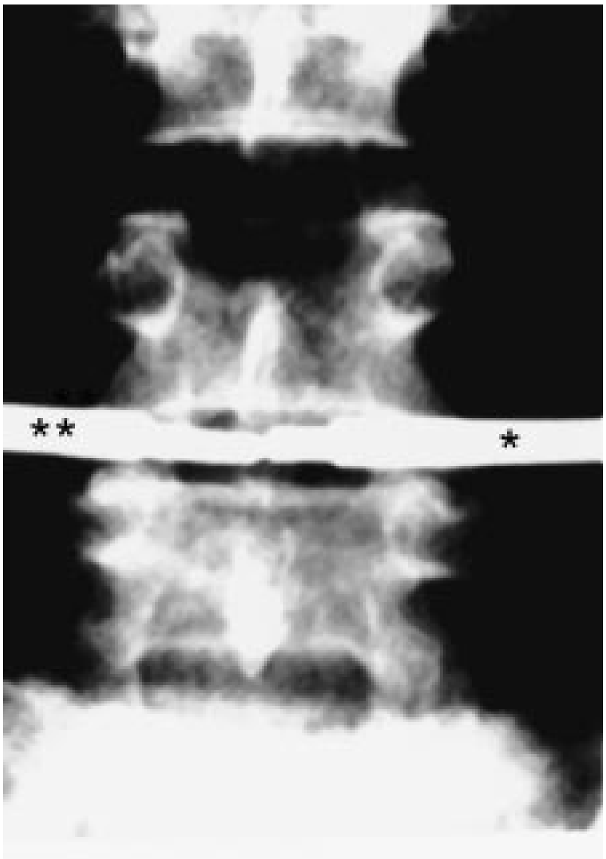

Fig. 6. Intraoperative photograph taken via the fluoroscopic image intensifier. Anteroposterior view showing the point of contact inside the intervertebral disc with the discoscope (*) inserted from one side and the deflecting suction forceps (**) from the opposite side.

tion and magnification, the posterior longitudinal ligament can be identified; the dural sac can be exposed for retrieval of intracanalicular fragments (Fig. 7).

Laser Annular Hemostasis

Kambin (12) employed a radiofrequency coagulator, while Savitz (11) preferred a laser, to stop any bleeding from small vessels in the annulus. A working discoscope allowed video monitoring of the laser fiber. On settings of 17 – 21 watts and 1.5-second pulses, the Nd:YAG laser was shown to cause hemostasis to take place suddenly and without predictability as the wattage was increased (Fig. 8A). The Ho:YAG laser provided more limited areas of charring (Fig. 8B) and had the added safety feature of audio feedback with settings of "CONTINUOUS" and 5 – 10 pulses per second.

Anesthesia

The neuroleptanalgesic agent, either fentanyl or midazolam, was generally selected by the anesthesiologist. Xylocaine was employed for infiltration of the skin and the annulus. A nasal cannula for oxygen, pulse oximeter, blood pressure monitor, and continuous EKG were regularly in use. Conscious sedation produced a comfortable, cooperative, and amnestic patient for positioning of the working sheath, coring of the disc space, insertion of the instruments, and simple questioning: "Is the pain now in your back or your leg?" and "Can you move your toes, your ankle, your leg?" Kambin (10) performed a small number of procedures while the patients were under general or spinal anesthesia.

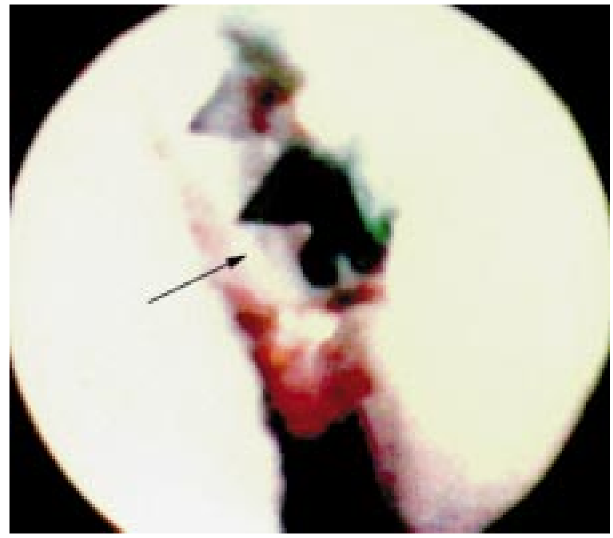

Fig. 7. Deflecting suction forceps (arrow) reaching the subligamentous region.

Outcome Data

Kambin's reported series (12 – 16) and Savitz's reported series (11, 17, 18) now include more than 600 patients. In terms of patient self-evaluation, satisfactory outcome rates of 85 – 92% were realized. The patients considered brief intravenous anesthesia and same-day scheduling preferable to general anesthesia and hospitalization necessary for open laminotomy and discectomy. Fewer than 2% of the cases required second surgery.

Complications

One transient peroneal palsy attributed to restraining straps for the operating table and one postoperative wound infection which responded to appropriate antibiotics occurred in Kambin's (15) series. In 175 consecutive patients, Kambin recorded 5 incidents of postoperative causalgic-type pain. Savitz (11, 18) reported one psoas muscle hematoma resulting in transient weakness and a 5% incidence of sympathetic mediated pain (SMP); one additional

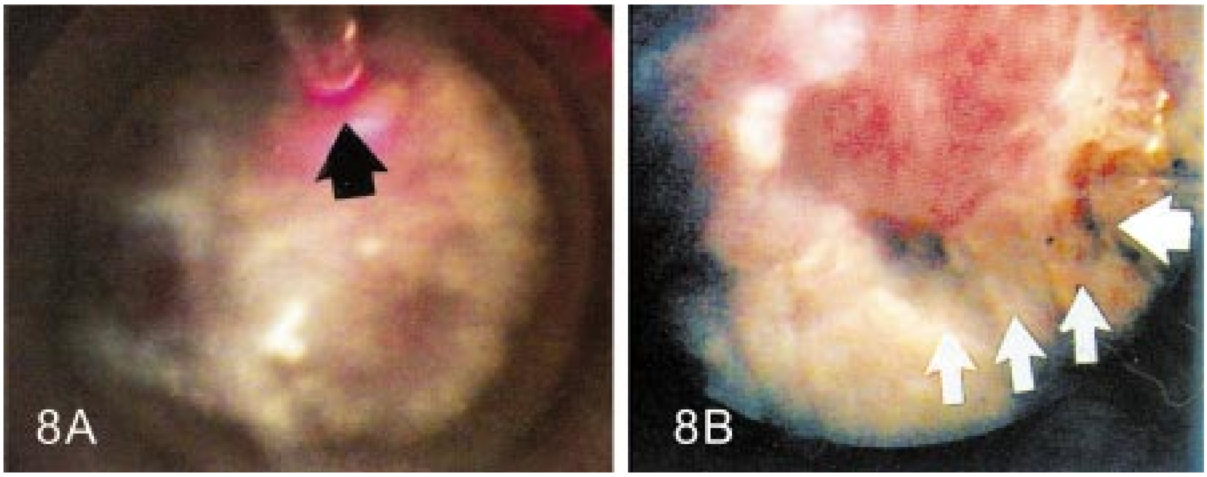

Fig. 8. Intraoperative photographs, arthroscopic view. **(A)** Diffuse charring caused by Nd:YAG laser fiber (arrow). **(B)** Ho:YAG laser (large arrow) producing areas of localized hemostasis (small arrows).

case of unilateral L5 radiculopathy following discectomy at L1–2 has not been previously reported.

SMP may occur with any injury or surgical manipulation of a peripheral nerve (19). Kambin's patients responded to steroids or nonsteroidal anti-inflammatory drugs. Alpha-blockers were administered to, and sympathetic blocks performed in, those patients of Savitz who developed SMP 4–7 days after surgery. The mechanism and cause of SMP in patients undergoing percutaneous endoscopic discectomy remain unidentified and poorly understood. More recently, Kambin (15) has been employing local delivery of 1 cc of fentanyl mixed with 3 cc of saline in the periannular region as soon as the spinal needle is in place. In addition, avoidance of vibratory disc resecting instruments has virtually eliminated the complication.

Conclusions

Proper patient selection includes careful review of preoperative imaging studies and assessment of radiculopathy and radiculitis if outcomes comparable to that of open laminotomy are to be obtained. Same-day scheduling, negligible blood loss, avoidance of general anesthesia, and minimizing scar tissue all lead to satisfactory outcomes as judged by the patients themselves. The authors are of the opinion that percutaneous endoscopic discectomy belongs in the armamentarium of every spinal surgeon.

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