Automated percutaneous discectomy

Long-term clinical experience with the Nucleotome® System

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The lifetime prevalence of sciatica is 40 percent, but only 1 percent of patients with acute back pain have nerve-root symptoms. Sciatica usually occurs in patients during the fourth and fifth decades of life; the average age of patients undergoing lumbar discectomy is 42 years (1). The introduction of chymopapain and chemonucleolysis in 1964 brought about the era of percutaneous treatment for herniated discs. The clinical success with chymopapain led to its extensive use. Unfortunately, it had an anaphylaxis rate estimated to be 1 percent (2). This led Onik and Maroon in 1984 to look for an alternative method for percutaneous disc removal.

This automated percutaneous lumbar discectomy technique uses a 20.3-cm needle, 2.2 mm wide, attached to a plastic handle. The automated technique developed by Onik and the Surgical Dynamics Corporation (Alameda, California) employs a modification of a vitrectomy instrument, only larger. To date, more than 80,000 of these procedures have been performed worldwide by approximately 5,000 surgeons trained in this new technique for removal of disc material.

The purpose of this report is to give the experience of two orthopedic spine surgeons using this percutaneous technique in the surgical treatment of contained herniated disc.

Material and methods

In this report one hundred and nine patients were reviewed, including 53 private pay and 56 workers' compensation patients. In an earlier report, 62 of these patients were reviewed and reported (13). This report includes 31 women and 78 men with an average age of 38 (16–58) years.

In 95 patients, the chief complaint was leg pain greater than back pain. In 14 patients, leg pain was equal to back pain. All patients completed an Oswestry Pain Questionnaire, pain drawing, and a Visual Analogue Scale (3–6). Physical examination confirmed a positive bow-string or straight leg raising examination in all cases. 100 of 109 patients had either sensory or reflex alterations. All patients completed a CT scan or MRI after history and physical examination. CT scanning (40 cases) was performed in routine axial imaging as well as sagittal reconstructions. MRI was performed in 69 patients using sagittal T1, T2, and spin echo images as well as T2 axial images. Fourteen patients had discography after CT or MRI to document the level of pathology by confirming disc degeneration and pain provocation response (Figure 1). The CT scan, MRI, and discography were reviewed by an independent radiologist to document containment of the nuclear material and size of the herniated nucleus pulposus.

The surgeries was performed from July 1986 until July 1991. In this study period the shortest follow-up length was 1.3 years, while the longest was 5 years.

Figure 1. T1 weighted MRI sagittal image confirming a contained herniated nucleus pulposus at L4-5. Degenerative disc disease is seen at L5-S1.

The automated percutaneous technique is well outlined in other articles and will not be reviewed in this paper (7–9).

The average Visual Analogue Scale number was 7.5 (4–10) in the patients prior to the procedure. The average Oswestry questionnaire number was 68 (37–90) (10).

Eight patients with a far-lateral disc herniation were treated. No patients with prior surgery or discitis were treated in this study.

A day surgery setting was used in all but three cases. The postoperative rehabilitation followed a standard protocol over 2 weeks and included predominantly stretching-strengthening exercises of the low back and a graduated aerobic conditioning program.

Table 1. MacNab Criteria of Response to Treatment (11)

Good
Resumed preoperative function
Occasional backache or leg pain
No dependency-inducing medications
Activity appropriate
No objective signs of nerve root impairment
Fair
May be nonproductive if unchanged from preoperative status
Intermittent episodes of mild lumbar radicular pain and/or low back pain
No dependency-including medications
Activity appropriate
No objective signs of nerve root impairment
Poor
Subjective
No productivity
Continued pain behavior
Medication abuse
Inactive
Compensation and/or litigation focus
Objective
Objective signs of continuing radiculopathy

Results

The results of lumbar discectomy with the Nucleotome® were considered successful if radicular pain was moderately improved to totally eliminated, the patient was satisfied with the result, the patient no longer needed narcotic analgesia, and the patient returned to full preinjury functional status or was significantly improved. The MacNab Criteria was used to determine the outcome (Table 1).

All 109 patients were available for follow-up. Oswestry questionnaire, pain drawings and Visual Analogue Scale were used at each follow-up visit. 85/109 patients categorized their procedure as successful using the criteria described above. This represents 79 percent in the overall group (Table 2). 39/53 (85%) of the private pay individuals had a successful outcome, and 39/56 (70%) of the workers' compensation patients had a successful outcome. The 24 patients who failed to obtain any significant relief of back and leg pain were given further treatment options.

Twenty-three patients chose to have additional surgery. Ten had microdiscectomy only, and 13 underwent posterior lumbar interbody fusion (PLIF). In all 10 patients treated with microdiscectomy, a free fragment of disc material was found between the posterior annular complex and the vertebral body just anterior to the nerve root. In the 13 patients who underwent PLIF, 10 had good relief of back and leg pain. All patients had discogram-CT scan prior to PLIF to confirm the findings of CT/MRI.

In the 109 patients undergoing the Nucleotome® procedure no neurologic injuries or major blood vessel injuries occurred. One patient obtained an eight point hematocrit loss from a psoas hematoma which was monitored by CT scan and serial blood counts (Figure 2). Symptoms of the psoas hematoma resolved after 10 days (12). One patient developed a dural leak which spontaneously resolved with bed rest.

Seventy percent of the patients returned to work within 2 weeks of the procedure. The patients with workers' compensation issues pending returned an average of 4 to 6 weeks after the procedure, while those with private pay usually returned within 3 to 5 days after the procedure.

Table 2. Summary of authors' clinical experience with automated percutaneous discectomy

	N	Injury site Level	(n)	Diagnosis	Disc material (gm)	Results	Follow-up (yr)
Gill, Blumenthal (1990) (13)	109	L3-4 L4-5 L5-S1	(8) (56) (45)	History of sciatica, Positive root tension sign, CT, MRI	1–5	79% good to excellent; no serious complications	1.3–5.0

Table 3. Summary of selected automated percutaneous discectomy reports

	N	Injury site Level	(n)	Diagnosis	Disc material (gm)	Results	Follow-up (yr)
Kambin, Sampson 1986 (14)	50	L3-4 L4-5	(8) (42)	Positive root tension sign, myelography	2–3 (Mean)	88% good to excellent; no serious complications	27
Maroon, Onik 1987 (15)	20	L3-4 L4-5	(1) (19)	CT, myelography	1–7	88% good to no significant complications	6
Onik, Maroon 1987 (16)	36	L3-4 L4-5 L5-S1	(2) (28) (6)	CT	Not reported	31 successful; no complications	4
Maroon, Onik, Morris 1988 (17)	6	L3-4 L4-5 L5-S1	(1) (4) (1)	CT, MRI	2–7	Improved strength relief of pain in 5 patients; para vertebral spasm for 4 days in 1 patient	10

Figure 2. Axial CT image of the L4-5 disc level noting enlarged size of psoas muscle confirming the presence of a hematoma.

Discussion

With the advent of improved image modalities and society's concern for cost containment, the use of percutaneous discectomy for contained herniated nucleus pulposus is appropriate.

Kambin and Gellman (18) performed many of the procedures with 88 percent good results and minimal complications. Maroon and Onik (19) reported 80 percent good results in a multi-center study with percutaneous discectomy, which agree with the results found in this review (Table 2 and 3). The results here, particularly with the private pay individuals, emphasize the need for a percutaneous approach to the herniated nucleus pulposus by allowing early return to a functional lifestyle.

A day surgery procedure with a 2-mm skin incision is an important advance without the inherent anaphylaxis risk seen with chymopapain. Percutaneous discectomy with the Nucleotome® accomplishes a mechanical nucleolysis without the risk of a chemical agent. No general anesthesia is necessary, no epidural fibrosis is seen, and an early return to work is expected.

Onik and Davis (7) recently reported four primary indications in 250 cases utilizing the Nucleotome® procedure. The first is the far-lateral disc herniation. They noted success in 10 of 11 cases. Our series also contained successful results in all eight cases with a far-lateral disc herniation. Immediate relief is seen in these cases as the Nucleotome® is directed straight into the herniation. This is a difficult herniation to treat with a microdiscectomy approach because of its position outside the facet joint. The surgeon must choose to operate through the facet joint or from the lateral side under the intertransverse ligament. As McCullough and Montminy (20) have reported, this is a difficult open technique.

Second, Onik and Davis (7) feel that the young athlete is a good candidate for percutaneous discectomy. In all 10 patients under age 19, they noted successful results. Our series also noted four successful patients under age 18.

As a third indication Onik and Davis suggest discitis. They report obtaining a positive tissue culture utilizing the Nucleotome® device in all 7 discitis patients treated. In four of the seven, the needle biopsy culture was negative. Onik and Davis suggest careful radiographic monitoring in the oblique position during the procedure to avoid deep penetration of the poor annular integrity seen in discitis.

The fourth indication Onik and Davis suggest is recurrent disc herniations. They recommend CT discography as the diagnostic procedure of choice if MRI is not helpful.

Our remarkably good results in private pay patients seems to agree with those findings of Onik and Davis. Young patients and those with far-lateral disc herniations were all private patients. Patients with back pain equal to leg pain were all workers' compensation patients as were 18 of 24 failed percutaneous procedures. The 100 percent successful results in far-lateral discs and young patients clearly raises the successful results in private patients. The poor results in those working patients with significant back pain indicates a relative contraindication for this procedure.

Patient selection is the key to procedure success. Modern diagnostic techniques such as the high resolution MRI scan assure radiographic detail of the contained herniated nucleus pulposus. A careful history and physical examination where the patient's complaints and physical findings agree and are consistent with the imaging studies are essential to a successful outcome. Those discs that are either in the posterolateral quadrant or the far-lateral quadrant of the herniation zone, as described by Zindrick et al. (21) are suitable for percutaneous discectomy if they are contained by the posterior annulus fibrosis, posterior-longitudinal ligaments or the combined complex.

These results indicate that percutaneous discectomy, because of its safety and efficacy, should play a valuable and additional role in the treatment of the herniated nucleus pulposus in the years to come. This procedure has the lowest morbidity of all invasive treatment options in the care of patients with herniated lumbar discs. Currently research in this area includes the Flex II Nucleotome® which allows movement of the tip of the device during the procedure. By turning a rotating dial the tip can be pulled 90° from its normal extended position which allows additional removal of nuclear material. Additional research in this will explore the possibility of using small fiber optic technology to visualize the area of nucleotomy. The next few years may also reveal additional indications for percutaneous techniques such as anterior discectomy and visualization.

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