Prospective Comparison of Microsurgical, Tubular-Based Endoscopic, and Endoscopically Assisted Diskectomies: Clinical Effectiveness and Complications in Railway Workers

Evgenii Belykh[1,2], Morgan B. Giers[2], Mark C. Preul[2], Nicholas Theodore[2], Vadim Byvaltsev[1,3]

■ OBJECTIVE: **Although endoscopic diskectomy is superior to microsurgical diskectomy in terms of incision size, postoperative pain, and cosmetic appeal, the effectiveness and indications for endoscopic versus microsurgical diskectomy remain active discussion topics. Because of the increasing incidence of diskectomies being performed in Russia, further assessment of these techniques is needed. We performed a comparative analysis of 1-year clinical results and complications of microsurgical, tubular-based interlaminar endoscopic, and endoscopically assisted microsurgical diskectomies for patients with herniated lumbar disks.**

■ METHODS: **The patient cohort included 131 patients who were enrolled in a prospective, randomized controlled study and 617 patients for whom data were gathered retrospectively. The quality of life was assessed using the Oswestry Disability Index (version 2.1a) and pain severity was analyzed using the visual analog scale for pain preoperatively, at discharge, and at 3, 6, and 12 months postoperatively.**

■ RESULTS: **Microsurgical, tubular-based endoscopic, and endoscopically assisted microsurgical diskectomies were all effective in relieving acute radicular symptoms. Recurrent disk herniation occurred more frequently after tubular-based endoscopic diskectomy than after the other approaches.**

■ CONCLUSIONS: **Our findings indicate that these 3 surgical techniques are highly effective and have similar clinical results at 1-year follow-up. Although this study points to differences in complications resulting from the 3 techniques, larger prospective studies are needed to more definitively assess possible surgical differences, complications, and outcomes. The endoscopically assisted diskectomy technique allows for minimally invasive surgery and offers enhanced visualization of the anatomy that is hidden from view in microscopic procedures.**

INTRODUCTION

Spinal surgery has evolved tremendously since the first work by Mixter and Barr in 1934[1] and since the first successful intervertebral disk operation to resolve diskoradicular conflict. With the introduction of the operating microscope, laminectomy was refined, becoming an open microdiskectomy performed through the interlaminar space, usually with partial bone resection.[2,3] Widely accepted by spine surgeons, microdiskectomy has become the gold standard of treatment for herniated lumbar disks. Rapid technological advancement led to the introduction of minimally invasive tubular endoscopic approaches for herniated disk treatment. Foley and Smith,[4] and later Destandau,[5] published reports of their experiences with minimally invasive endoscopic tubular approaches to herniated lumbar disks as

Key words
- Diskectomy
- Endoscopic assistance
- Endoscopy
- Herniated disk
- Microdiskectomy
- Prospective comparison

Abbreviations and Acronyms
EAD: Endoscopically assisted microsurgical diskectomy
ED: Endoscopic diskectomy
IQR: Interquartile range
K-W: Kruskal-Wallis test
MD: Microsurgical diskectomy
ODI: Oswestry Disability Index
VAS: Visual analog scale

From the [1]Laboratory of Neurosurgery, Irkutsk Scientific Center of Surgery and Traumatology, Irkutsk, Russia; [2]Department of Neurosurgery, Barrow Neurological Institute, St. Joseph's Hospital and Medical Center, Phoenix, Arizona, USA; and [3]Center of Neurosurgery, Irkutsk Railway Clinical Hospital, Irkutsk, Russia

To whom correspondence should be addressed: Vadim Byvaltsev, M.D., Ph.D. [E-mail: neuropub@dignityhealth.org]

Citation: World Neurosurg. (2016) 90:273-280.
http://dx.doi.org/10.1016/j.wneu.2016.02.047

Journal homepage: www.WORLDNEUROSURGERY.org

Available online: www.sciencedirect.com

viable alternatives to open surgical techniques. Endoscopic tubular diskectomies are perhaps the next step in the trend toward minimally invasive spinal surgery; however, indications for this type of surgery still require more precise definition.[6,7]

Although tubular endoscopic diskectomy (ED) is associated with smaller incisions, decreased postoperative pain, and better cosmetic outcomes compared with microsurgical diskectomy (MD), its effectiveness, indications, and contraindications remain the subjects of discussion and debate. Few studies have investigated long-term results of quality of life after ED, and even fewer have described positive outcomes; most published studies on ED describe controversial results because of the potential for increased complications.[6-8]

In this study, we conducted a prospective, blinded, and randomized trial to determine 1-year results of MD, tubular-based ED, and endoscopically assisted MD (EAD) in patients with lumbar disk herniation. We also retrospectively reviewed data to assess the complication rates associated with each technique.

METHODS

Study Design

From January 2008 to December 2010, a prospective randomized trial and a retrospective registry were conducted for patients with lumbar disk herniation who were candidates for surgical diskectomy. The study aimed to assess effectiveness of MDs, tubular-based EDs, and EADs in terms of improved quality of life and pain reduction in the first postoperative year. The early and late complication rates of patients were determined by performing a retrospective assessment of operative dictations, and by gathering follow-up data from patients not included in the prospective randomized study.

This study was approved by the hospital ethics committee, and written informed consent was obtained from all patients.

Inclusion Criteria

All patients in this study underwent neurologic and instrumental examinations that included plain and lateral lumbar radiographs, lumbar magnetic resonance imaging (MRI), and electroneuromyography. Patients were included in this study if they met the following criteria:

- Age between 18 and 70 years old
- Conservative treatment of more than 3 months' duration was ineffective
- Experienced frequent low back pain and sciatica recurrence ($\geq$3 times per year)
- Displayed evidence of root neurologic symptoms
- L3/L4, L4/L5, or L5/S1 intervertebral disk herniation was evident on MRI or computed tomography
- Able to sign a voluntary informed consent form for participation in the study, surgery, and data collection

Patients were excluded from study if they had undergone previous spinal surgery or had multilevel herniation, degenerative stenosis of the lumbar spine, vertebral segment instability, or severe somatic disease.

Patient Groups

For the prospective portion of the study, patients were randomly assigned to 1 of the 3 surgical diskectomy technique groups (MD, ED, or EAD) using Statistica 8 (StatSoft Inc., Tulsa, Oklahoma, USA). Patients were blinded to the type of surgical technique. The same surgical team, consisting of 3 neurosurgeons who were experienced in MD, ED, and EAD, performed all operative procedures. Standard surgical instrument sets were used in all cases. The patient population in this study consisted of railway workers with physically demanding jobs that regularly require heavy lifting, pushing, and pulling. Postoperatively, most patients were discharged to the corporate rehabilitation center. The inpatient rehabilitation program was typically 11–14 days and may have included therapeutic medications, massage, physical therapy, reflexotherapy, traditional Eastern medicine, and dietary management.

Surgical Intervention Techniques

General operative descriptions are given below for each type of procedure because the procedures may vary slightly among surgeons. All patients underwent intravenous general anesthesia with artificial pulmonary ventilation. Patients were placed in a prone position with positioning pads under the shoulders and superior iliac crests. The affected level was verified by intraoperative C-arm fluoroscopy.

MD Technique. A 3-cm longitudinal incision was made at the midline, above the spinous processes of 2 adjacent vertebrae. The aponeurosis was opened with an arciform incision. The paraspinal muscles were dissected from the spinous processes and from adjacent vertebrae arches in a subperiosteal layer. The Caspar Micro Lumbar Discectomy retractor (Aesculap, Tuttlingen, Germany) was inserted into the operative field and dilated to the appropriate size. The operation took place under 4–12× magnification of the operative microscope, and Aesculap microsurgical spinal instruments were used in all cases. An interlaminar approach was used, and the ligamentum flavum was excised. When necessary, adjacent vertebral arches were partially resected. At this point, the nerve root and the dural sac served as landmarks. After dissection of adhesions, the microdiskectomy was performed. Nerve root pulsation and its free displacement indicated adequate diskectomy. Hemostasis was obtained by bipolar coagulation and, in some cases, application of Surgicel (Ethicon Inc., Somerville, New Jersey, USA).

Tubular-Based ED Technique. The ED technique and instruments (Karl Storz, Tuttlingen, Germany) in this study followed the manner described by Destandau.[5] A 2.0- to 2.5-cm longitudinal incision was made 1–2 cm lateral to the midline. The aponeurosis was then exposed and cut longitudinally with a scalpel. Next, the operating tube with obturator was introduced through the muscle incision, toward the interlaminar space. The obturator was removed and hemostasis was achieved by bipolar coagulation. The endoscope was fastened in the working channel of the tube, and the prolapsed disk was then approached under endoscopic