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CLINICAL STUDY

Efficiency of interlaminar uniportal endoscopic lumbar discectomy

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ABSTRACT

AIM: Prospective evaluation of the results of endoscopic lumbar discectomy.

METHODS: 95 patients were consecutively enrolled in the study between 2017 and 2021. We monitored low back pain and sciatica according to the Visual Analogue Scale (VAS), the limitations in daily activities (Oswestry Disability Index, ODI), overall satisfaction according to a 0–100 % scale, and the rate of surgical complications and reoperations.

RESULTS: Postoperatively, the VAS values of low back pain and sciatica decreased significantly from 5 to 1 point and from 6 to 1 point, respectively, and the pain remained in the tolerable range (VAS 1–2) throughout the follow-up period. The ODI score improved significantly from severe disability (46 %), preoperatively, to moderate disability at discharge and one month after surgery (29 % and 22 %, respectively), down to minimal disability at 3 and 12 months after surgery (12 % and 14 %, respectively). Overall patient satisfaction improved significantly at all follow-up time points (46 %, 70 %, 77 %, 80 %, and 78 %, respectively). Reoperation rate was 6.3 %. Cerebrospinal fluid leakage was observed in one case only (1.1 %). Transient postoperative perianogenital sensory impairment occurred in two patients (2.1 %). There was no evidence of surgical site infection or haematoma.

CONCLUSION: Endoscopic discectomy provides significant pain relief and improves the patient's ability to perform activities of daily living, contributing to greater satisfaction. It is a safe method with a low risk of surgical and neurological complications *(Tab. 3, Fig. 3, Ref. 27)*. Text in PDF *www.elis.sk*

KEY WORDS: uniportal spinal endoscopy, recurrent disc herniation, cerebrospinal fluid leakage, Visual Analogue Scale, Oswestry Disability Index, low back pain, sciatica.

Introduction

Surgical methods across different surgical disciplines are experiencing a worldwide trend of transformation from conventional open to minimally invasive techniques. Lumbar disc herniation surgery has undergone an evolution of minimizing the surgical approach and visualization, from traditional open surgery to the use of mini-retractors, tubular retractors, magnifying glasses with a headlight and then microscope.

Indirect visualization of the surgical field during surgical procedures is increasingly replacing traditional forms of direct visualization. Endoscopic techniques allow surgeons to perform the same procedures on anatomical structures with significantly less tissue damage during the surgery and with improved visualization of the surgical field. Arthroscopy and laparoscopy have transformed surgical patient care over the past few decades, bringing economic effects in the form of shorter hospital stays and faster recovery, in addition to the more gentle surgical technique itself. For many reasons, spinal surgery has lagged behind other specialties in adopting indirect visualization, primarily because of the fear of damage to neural structures by robust instrumentation in a small spinal canal space. The 1970s were marked by the progressive development of microscopic surgical techniques in neurosurgery that still dominate most worksites due to their standard good results. Publications on the first endoscopic spinal procedures date back to the late 1990s (1–3). At that time, spinal endoscopy had very narrow indications (practically sequestrectomy only) and, in addition to it, a long learning curve, which rather discouraged surgeons. Important technological advances and a trend towards worldwide spread have occurred in the last decade only. The faster implementation of spinal endoscopy into practice is driven by surgeons' desire to provide patients with a safe alternative to conventional microsurgical techniques, with the aim of less postoperative pain, faster return to home care and employment, or for

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cosmetic reasons. Patient interest in less invasive spinal procedures is increasing.

Various endoscopic systems and techniques are currently in use and are rapidly evolving with experience. The most commonly used techniques include: uniportal (full) endoscopy, microendoscopy, and biportal endoscopy (4). Endoscopic procedures are now performed on the cervical, thoracic and lumbar spine for various diseases.

We started the new technique of uniportal spinal endoscopy in November 2017. In recent years, this method has started to be implemented in other neurosurgical departments in the Czech Republic.

Materials and methods

Aim of the study

The aim of the study was to evaluate the efficiency of surgical treatment of lumbar disc herniation using spinal endoscopy technique.

Inclusion criteria

Ninety-five adult patients with an indication for interlaminar endoscopic surgery for lumbar disc herniation were consecutively enrolled in this prospective study between November 2017 and June 2021. All cases involved primary surgery for disc herniation in one compartment of the lumbar spine. Surgery for intervertebral disc herniation is indicated in the acute setting for motor wasting symptoms or cauda equina syndrome. We proceed to elective surgery in the case of correlated algic syndrome after exhaustion of conservative treatment for a minimum of six weeks.

Exclusion criteria

Patients with a history of previous surgery in the same localization and the following radiological pathological findings were excluded from the study: disc osteochondrosis (not soft herniation), spondylolisthesis, instability, inflammation, post-traumatic changes.

Surgical method

The Vertebris uniportal endoscopic set (RIWOspine GmbH, Knittlingen, Germany) is used at our department. The procedure is performed under general anaesthesia in the prone position (the patient is lying on his/her stomach). A longitudinal skin and transfascial incision of about 1 cm is made with a distance of up to 5 mm from the midline and should be sufficient to insert an 8 mm endoscopic tube. The insertion and localization of the trocar or working tube is verified by fluoroscopy first in the anteroposterior, then in the lateral projection. After trocar insertion, in case of a small interlaminar window, we enlarge the access using a special endoscopic cutter and Kerrison rongeur. The next important step is to visualize the dural sac and the spacing of the incriminated nerve root which we need to release or mobilize to safely remove the disc herniation. The released nerve can then be displaced medially with the working tube to facilitate removal of the medial herniated remnant or osteochondrosis edges. In some cases, partial extraction of the free sequestrum from the axilla of the nerve is offered. Pulsation of the nerve root is a sign of its sufficient release. The procedure is accompanied by haemostasis at all tissue levels using radiofrequency ablation (RFA) which is much gentler on the nerve structures and does not cause thermal damage when working in an aqueous medium. The endoscope with its 25° oblique optics offers perfect illumination and wide-angle viewing when the camera is moved sideways. A continuously flowing saline solution whose flow rate (60–100 ml/min) is regulated by a pump is used as the working medium. Due to the minimal access, we do not introduce a drain at the end of the procedure. Only one skin suture is needed to close the surgical wound. In our department, the procedure is performed by one surgeon without a surgical assistant. At the time of the start of the study, two experienced spinal surgeons were able to use the surgical method.

After the procedure, the patient is monitored for 2 hours in the postoperative room and stands up and walks 4 hours after surgery. This is followed by a normal exercise regime in a standard ward and rehabilitation care. Depending on the clinical condition, the patient is discharged on the 1st–3rd day after the surgery.

Data collection and processing

Demographic data of the original cohort of 95 operated patients were obtained from the hospital information system. Questionnaires were submitted to the patients before surgery on the day of admission, on the day of discharge (to home care), and subsequently mailed at 1 and 3 months, and 1 year after the surgery. During the processing of the questionnaires, clinical data were lost due to incomplete or unreturned questionnaires in 23 patients. Thus, a total of 72 patients were evaluated statistically for a complete clinical data set.

Evaluation of the effectiveness of therapy

Low back pain (LBP) and sciatica were assessed by questionnaires with a Visual Analogue Scale (VAS) score of 0–10 points. The patient's subjective complaints and the degree of limitation in normal daily activities due to low back pain (Oswestry Disability Index, ODI) were quantified using the Czech version of the Oswestry questionnaire (version 2.1a) with a score of 0–100 % (5). ODI 0–20 % means minimal disability, 20–40 % means moderate disability, 40–60 % means severe disability, 60–80 % means crippled patient, and 80–100 % means bed-bounded patient. The evolution of the patient's subjective feeling in relation to the surgery was also assessed by a questionnaire according to the satisfaction scale 0–100 %, where 0 % is the worst imaginable and 100 % is the best imaginable health condition.

Statistical analysis

Qualitative data are presented as frequencies and percentages. Age is described by the mean and the range. A two-sample t-test was used to compare the age between men and women. Questionnaire parameters are described by the median and the interquartile range (1st, 3rd quartiles). Comparison of their change before surgery and at discharge was performed using the nonparametric

Wilcoxon paired test. Comparison of the evolution of these data throughout the follow-up was evaluated by the nonparametric Friedman analysis of variance. The Wilcoxon paired test was used to assess the difference at discharge and at one year. The chosen significance level was p=0.05. NCSS 2021 Statistical Software (NCSS, LLC. Kaysville, Utah, USA) was used for the statistical analysis.

Informed consent

All patients signed a standardized informed consent for surgery. Verbal informed consent for inclusion in the observational study was obtained from each patient at the first interview; by completing the questionnaires, patients consented to the processing of their personal and medical data from the questionnaires. Institution's ethics committee approved the study.

Results

Cohort characteristics

The demographic data of the patients were evaluated from a cohort of 95 operated patients and are presented in Table 1. The surgery was undergone by 42 women and 53 men in the age range 18–67 years (mean age 41.6 years). The mean age of men was 42.1 years and the mean age of women was 41 years. Age in the study population was comparable between men and women (p = 0.568).

The average duration of hospital stay was 2.7 days.

Results of questionnaires

Table 2 shows the values of VAS for LBP and VAS for sciatica intensity, ODI and overall patient satisfaction during the follow-up.

VAS for low back pain and VAS for sciatica

After surgery, there was a significant decrease in VAS for LBP and VAS for sciatica (Tab. 2, Fig. 1), both p < 0.001. In LBP, this condition persisted for 3 months after surgery, followed by a 1-point increase in VAS values 1 year after surgery. The difference between the VAS values for LBP at one year after surgery and those at discharge was not statistically significant (p = 0.270).

In the first month, there was a non-significant elevation of VAS for sciatica (p = 0.081) compared to the value at the time of discharge, and the median value remained stationary until the end of the follow-up. However, the difference between VAS for sciatica values at one year after surgery and values at discharge was statistically significant (p = 0.023).

ODI

A significant reduction in the degree of disability was observed throughout the postoperative period (Fig. 2, Tab. 2). Thus, on average, patients improved from the level of severe disability (46 %) preoperatively to the level of moderate disability at discharge and one month after the surgery (29 % and 22 %, respectively), and to the level of minimal disability at three months and one year after the surgery (12 % and 14 %, respectively). Overall, the decrease was statistically significant (p < 0.001) and the decrease at one year compared with the discharge value was also statistically significant (p < 0.001).

Overall satisfaction

Overall patient satisfaction also showed a positive trend from surgery onwards (Fig. 3, Tab. 2) (p < 0.001), although there was a marginal 2 % decrease in mean values in the period between the third month and one year after surgery. The increase in overall satisfaction between the status at discharge and at one year was statistically significant (p = 0.019).

Complications

Reoperations and other complications were evaluated in a cohort of 95 operated patients and are shown in Table 3. Reoperation in the first year of follow-up was indicated in six cases of recurrence of intervertebral disc herniation (6.3 %). Endoscopic revision surgery was performed three times: once for residual herniation and twice for recurrence. Tubular microscopic revision by METRx® was indicated in two cases, early in case of unsatisfactory perioperative and clinical postoperative findings. Open microscopic reoperation was performed once. There was no revision for haematoma. There was no evidence of surgical site infection. Clinically, cerebrospinal fluid (CSF) leakage was present in one case only (1.1 %), requiring an additional suture and prolonging the patient's hospitalization for 4 days due to liquor hypotension syndrome. Deterioration of neurological findings after surgery was observed in two patients (2.1 %); it was a transient perianogenital sensory impairment that resolved rapidly after pharmacotherapy (corticosteroids, B vitamins, alpha-aescin).

Tab. 1. Demographic data of patients (n = 95).

Parameters	Category	Values
Gender	Women	42 (44.2 %)
	Men	53 (55.8 %)
Age, average in years (range)	Women	41 (18–59)
	Men	42.1 (24–67)
	Total cohort	41.6 (18–67)
Surgery level	L4/L5	14 (14.7 %)
	L5/S1	81 (85.3 %)
Herniation side	Right	47 (49.5 %)
	Left	48 (50.5 %)

Tab. 2. Results of questionnaires (n = 72).

Questionnaire	Before surgery	At discharge	1 month	3 months	1 year	p
VAS for LBP	5 (3. 7)	1 (1. 3)	1 (1. 2)	1 (1. 3)	2 (1. 3)	<0.001
VAS for sciatica	6 (4. 8)	1 (1. 2)	2 (1. 3)	2 (1. 3)	2 (1. 3)	<0.001
ODI, %	46 (33. 62)	29 (13. 44)	22 (10.30)	12 (5. 24)	14 (4. 30)	<0.001
Overall satisfaction, %	46 (36. 55)	70 (60. 82)	77 (60. 5)	80 (66. 90)	78 (69. 90)	<0.001

Values are presented as median (1st quartile, 3rd quartile)

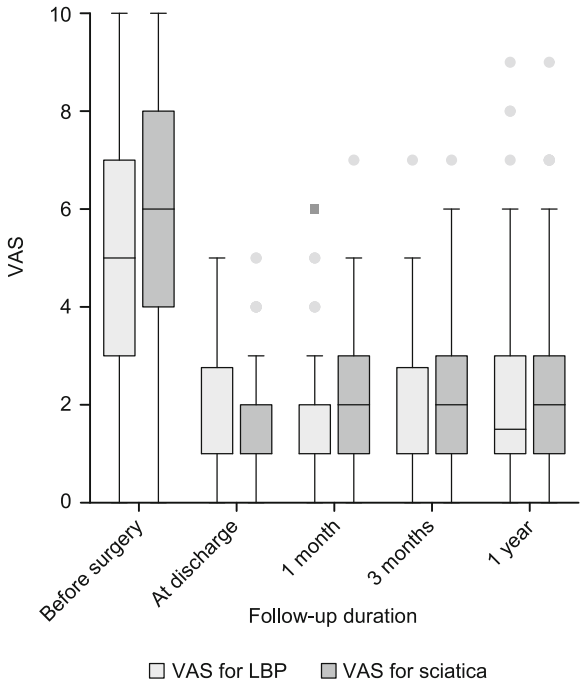

Fig. 1. VAS for LBP and VAS for sciatica.

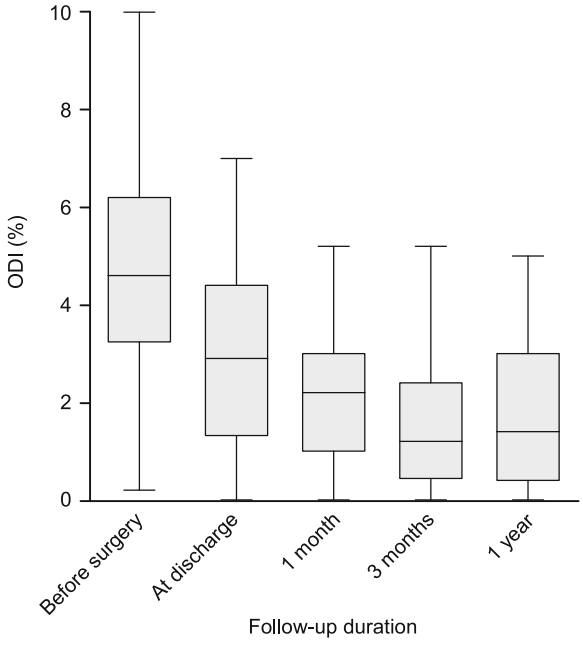

Fig. 2. ODI score.

Discussion

Interlaminar endoscopic procedures only were included in the study population as the transforaminal surgical approach is structurally and methodologically different, and could have different outcomes in terms of pain and complications. The predominance

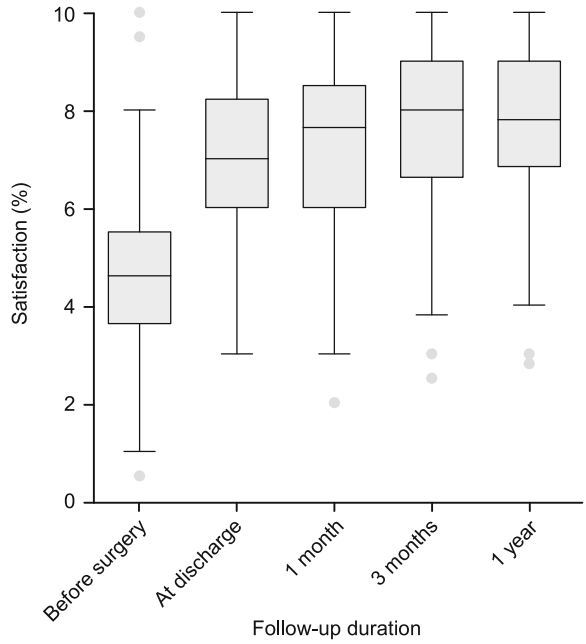

Fig. 3. Overall patient satisfaction

of L5/S1 localization of intervertebral disc herniation in this cohort is given by the indication preference recommended at the beginning of the method learning curve.

Postoperatively, there was a significant improvement in all four monitored parameters, and this was fairly consistent during the follow-up. The observed slight increase in the VAS for sciatica at one year after surgery compared to the value at discharge is not considered clinically significant, as it remains in the tolerable pain range (VAS 1–2).

In 2019, Máca et al. published the results of the first experience with endoscopic discectomy in a cohort of 15 patients in whom they observed a significant decrease in VAS for LBP from 6 points and VAS for sciatica from 8 points to consistent VAS 2 values after 6 weeks and 6 months (6). Wasinpongwanich et al. evaluated retrospectively 545 patients and observed a reduction in low back pain from VAS of 5 and sciatica from VAS of 5.69 to values in the tolerable pain range after surgery (1.66 and 1.79) and at 6 months (1.89 and 1.59), with a subsequent slight worsening of VAS at 1 year after surgery (3.14 and 2.66) (7). In both studies, a decrease in ODI score to the level of minimal impairment was observed throughout the follow-up period.

Tab. 3. Complications (n = 95).

Complications	Number (%)
Reoperation	6 (6.3 %)
Haematoma	0 (0 %)
Surgical site infection	0 (0 %)
CSF leakage	1 (1.1 %)
Sensory lesions	2 (2.1 %)
Motor deficit	0 (0 %)

We believe that the observed minimal worsening of the monitored parameters at 1 year after surgery could be explained by the reduced use of analgesics and increased activity by the patient.

In the interim evaluation of the study cohort in September 2020, the percentage of reoperations within a year was 7.7 %; it decreased to 6.3 % at the end of follow-up, and it was evaluated as a result of the greater experience of the surgeons in their learning curve. The reoperation rate in our study corresponds to the range of 3.7–12.1 % shown in larger published series or meta-analyses (7–14). At the time of this publication, the reoperation rate at our department had dropped to 4.4 %. In our cohort, half of the reoperations were performed endoscopically. Li et al. demonstrated that the choice of endoscopic method for reoperation appears to be more effective in terms of shorter operative time, less blood loss, and lower risk of complications, compared with the conventional open surgical method (15).

Minimal soft tissue damage and better visual control of bleeding significantly reduce the risk of haematoma formation in the surgical field. The occurrence of this complication is rare and is practically not mentioned in published reports. Zhou et al. report the occurrence of haemorrhagic complication in two cases out of a series of 426 operations (0.47 %) (13). Continuous saline irrigation of the operative field throughout the procedure significantly reduces the risk of local infection, although this risk still exists at 0.1–0.9 % (11, 16). No haemorrhagic or infectious complications were observed in our cohort.

The dural tear during endoscopic surgery for disc herniation occurs in 0.1–2.3 % of cases (7, 12–18). Some dural tears are small, and therefore CSF leakage may not even be detectable during continuous irrigation. Even a known dural tear may not manifest clinically as a wound CSF leakage because the endoscopic procedure creates minimal dead space in the operative field, and moreover, the narrow working channel created by the tube is virtually closed after the tube extraction. This fact is cited as one of the advantages of spinal endoscopy. Lewandrowski et al. report the absolute incidence of wound CSF fistula after endoscopic spinal surgery as 0.025 % in a multicentre cohort of 64,470 interventions (18). In our cohort, wound CSF leakage occurred only once (1.1 %) and was managed by one additional skin suture.

Transient perianogenital or acral sensory impairment after surgery can be explained by mechanical manipulation of the dural sac in the small space of the spinal canal. In both patients, the follow-up MRI scan performed for postoperative complaints did not show any other structural cause. This phenomenon was observed at the beginning of the learning curve and has been described in the literature in 1.24–3.3 % of cases (7, 12–14). We did not observe a new postoperative motor lesion of the released nerve in this cohort, although the incidence of this complication reported in the literature ranges from 0.57 to 1.2 % (7, 13, 14).

Currently, this new method is more expensive, mainly due to the initial purchase of the equipment and the cost of disposable consumables. The reimbursement of endoscopic spine procedures is not yet settled in the Czech Republic. A cost-benefit analysis from the perspective of societal benefits could be performed by monitoring the following parameters: number of days of hospitalisation, treatment of recurrences and complications, consumption of analgesics and duration of incapacity for work. Gadjradj et al. report a greater cost benefit of endoscopic discectomy compared to open discectomy, with a difference of €450 (19).

In recent years, endoscopic methods have also become an alternative to other traditional open interventions, such as decompression of spinal canal stenosis, management of spondylolisthesis (20, 21) or spondylodiscitis surgery (22–24). Even these endoscopic methods are considered by some authors to be more efficient and safer in reoperations for recurrence of disc herniation after conventional open surgeries (10, 25–27).

The authors of the presented study believe that this innovative method will prove its worth in spinal surgery practice. It has all the prerequisites to become in the future an equivalent alternative to classical surgical approaches, especially in departments with a comprehensive approach to spinal pathologies.

Conclusion

Interlaminar uniportal endoscopic extraction of lumbar disc herniation is one of the promising methods of spine surgery. It brings significant pain relief, improves patients' ability to perform normal daily activities, and contributes to their greater satisfaction. In addition to its high efficiency, it is a safe method with a low risk of surgical and neurological complications.

Ethical principles

The study was conducted in accordance with the Helsinki Declaration of 1975, revised in 2000. The study was approved by the Ethics Committee of the University Hospital in Hradec Králové (reference number 201705 S11P, 4 May 2017). All patients signed a standardized informed consent for surgery. Verbal informed consent for inclusion in the observational study was obtained from each patient at the first interview; by completing the questionnaires, patients consented to the processing of their personal and medical data from the questionnaires.

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