Original Article

Early Outcomes: A Comparison between Biportal Endoscopic Spine Surgery and Open Lumbar Discectomy for Single-Level Lumbar Disc Herniation

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Objective: To compare early outcomes between biportal endoscopic spine surgery (BESS) and open lumbar discectomy (OLD) for treating single-level lumbar disc herniation.

Materials and Methods: A retrospective cohort study was conducted in 80 cases of single-level lumbar disc herniation that underwent either BESS or OLD. The author compared the perioperative data between BESS and OLD, including operative time (OT), level, side, estimated blood loss (EBL), surgical drain output, hospital stay (HS), hospital costs, visual analogue scale (VAS) scores, morphine consumption, complication, and McNab's satisfaction outcome.

Results: Forty-three patients underwent BESS and 37 underwent OLD. There was 55% female and 45% male. The mean age was 37.8±9.5 years. The BESS group showed significantly (a) lower median morphine consumption than the OLD group (five mg versus nine mg, p<0.001), (b) lower postoperative pain (VAS) at 2-, 4-, 12-, 24-, 48- (p<0.001), and 72-hours post-surgery (p=0.017), and (c) shorter HS (4.8±2.9 days versus 7.4±4.6 days, p=0.003). McNab's satisfaction outcome of a good or excellent result was comparable between BESS and OLD group (97.7% versus 86.5%, p=0.090). The BESS group, however, had a longer OT than the OLD group (100.4±28.5 versus 67.9±23.2 minutes, p<0.001), and had a higher hospital cost (1,256±360.9 USD versus 910.6±269.8 USD, p<0.001). Complications were not significantly different between the BESS and OLD groups.

Conclusion: BESS for single-level lumbar discectomy had less postoperative pain for up to 72 hours, less opioid consumption, and shorter HS, but longer OT and higher hospital costs than OLD. Patient satisfaction outcomes were comparable between the two groups.

Keywords: Biportal endoscopic spine surgery, Unilateral biportal endoscopic discectomy, Open lumbar discectomy, Single-level lumbar disc herniation

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Lumbar disc herniation (LDH) is a common spinal problem. The hallmark clinical symptom is back pain radiating to the leg. The principal treatment is conservative treatment consisting of bed rest and pain control. Surgical treatment is considered in cases of persistent pain or progressive neurological deficit. The most common surgical treatment for LDH is open lumbar discectomy (OLD)[1]. The OLD is an invasive surgery that can increase the risk of postoperative spinal instability and chronic postoperative back pain[2,3]. Several minimally invasive lumbar discectomies have been developed. Minimal invasive surgery has advantages over OLD, including a smaller incision, less muscle damage, and a faster recovery[4]. Percutaneous endoscopic lumbar discectomy via the intervertebral foramen and percutaneous endoscopic interlaminar discectomy were developed, but have disadvantages, including high cost of special instruments and a steep learning curve for practitioners[5]. Biportal endoscopic spine surgery (BESS) or unilateral biportal endoscopic spine surgery (UBE)[6] was introduced[7] and became popular in many hospitals[8,9]. BESS combines the advantages of the standard OLD and the endoscopic spine surgery.

A previous study revealed that BESS lumbar discectomy yielded similar clinical outcomes to OLD, including pain control, functional disability, and patient satisfaction. Its advantages are that it incurred minimal estimated blood loss (EBL), shorter hospital stay (HS), and less postoperative back pain one week postoperatively[10]. Another two studies showed

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greater invasiveness of microdiscectomy than biportal endoscopic discectomy, revealed by higher creatine phosphokinase (CPK) levels and C-reactive protein (CRP) levels on postoperative day one and three[4,11]. However, there is limited data on early postoperative pain outcomes after BESS compared with OLD for single-level LDH. Therefore, the current study aimed to compare the clinical outcomes in terms of early postoperative pain between BESS and OLD for single-level LDH.

Materials and Methods

A retrospective cohort study was conducted in Khon Kaen Hospital between January 2015 and April 2020. The author included the cases with single-level LDH that fulfilled the following criteria, 1) more than 18 years of age, 2) neurologic claudication or radicular leg pain referring to LDH, 3) single LDH per magnetic resonance imaging, and 4) failure of conservative treatment after at least six weeks or severe pain that did not respond to conservative treatment. The exclusion criteria were 1) pregnancy or lactating, 2) prior history of lumbar surgery, 3) refused surgery, 4) had medical conditions unfit for surgery, and 5) had greater than a Grade I spondylolisthesis per Mayerding.

The present study included 80 eligible patients with single-level LDH that underwent surgery at Khon Kaen Hospital, 37 with the OLD and 43 with the BESS technique. The outcome of the study was pain intensity assessment using the visual analog scale (VAS; scores from 0 to 10) at pre-operation, then at 2-, 4-, 12-, 24-, 48-, 72-, and 96-hours post-operation. Peri- and post-operative data were collected from the medical records, including operative time (OT), level of surgery, side, EBL, complication, surgical drain output, HS, and hospital costs. Patients satisfactory outcome were assessed using the Macnab criteria, which is scaled with excellent, good, fair, poor, and clinical outcomes at the last follow-up.

Intervention

BESS for lumbar discectomy: After general anesthesia, the patients were positioned prone in a Wilson spinal frame. The operated level was identified with an image intensifier and the spinous process, disc level, and interlaminar space were marked with a surgical pen. The portal landmarks were at the lower edge of the lower lamina of the upper spine and upper margin of the upper lamina of the lower spine about 2 cm apart just lateral to the spinous process. The side of the approach was chosen with respect to the symptomatic side.

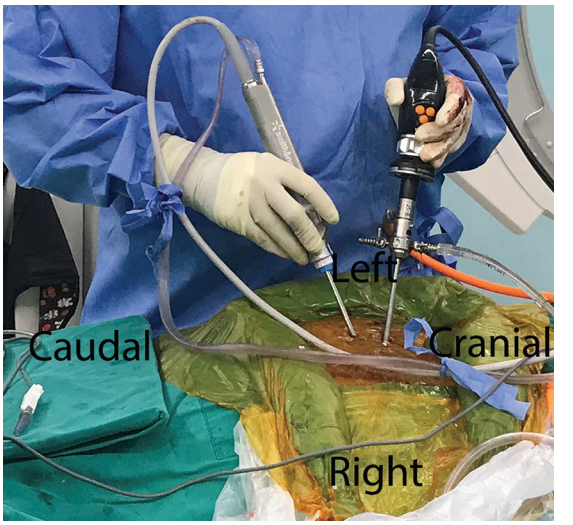

Figure 1. Left-sided BESS: two small skin incisions for the scope and working portal.

Dilators were used to dilate the portal and detach the paraspinal muscle at the interlaminar space. The endoscope portal (upper portal) and working portal (lower portal) were inserted through two separate skin incisions and docked onto the upper lamina (Figure 1). Potential space was created with a shaver and Arthrocare® cautery, set the level to 2. The water pump was set to 30 to 50 mmHg and the irrigation flow was done through the skin portal. Unilateral laminotomy was performed with a high-speed blur and Kerrison rongeur. The ligamentum flavum was remove and the dural sac exposed. For disc herniation (Figure 2), the traversing nerve root was identified and protected with a Penfield or semi tubular retractor. Discectomy was done with knife, curette and pituitary forceps. Annuloplasty was done by coagulation.

Open lumbar discectomy: The surgery was performed under general anesthesia in a prone position on a radiolucent table under fluoroscopic control. The incision was made from the mid-spinous process of the upper vertebra to the spinous process of the lower vertebra at the involved level. After creating a 3- to 5-cm incision in the midline, the fascia was dissected to the lateral edge of the inferior articular facet on the pathologic side. The surgical procedure followed the standard method using a retractor system under loupe magnification or operative microscope. Soft tissues, including the paraspinal muscles, were cleaned using a monopolar cautery system (Covidien Force FX™ Electrosurgical Generator), exposing the interlaminar space and ligamentum flavum. A

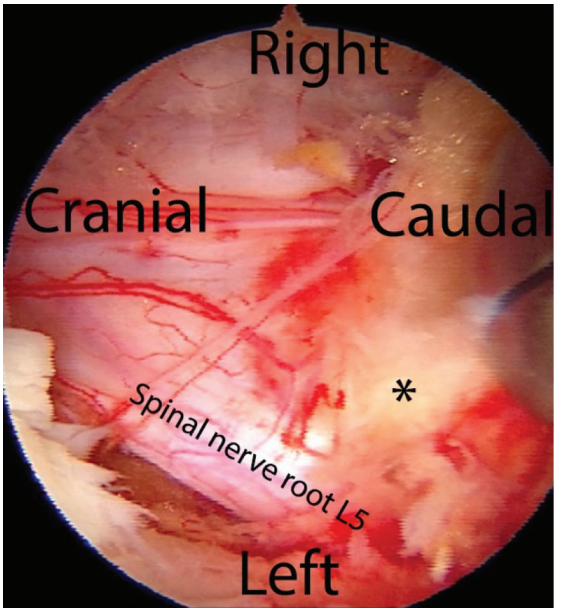

Figure 2. Biportal endoscopic view of the LDH L4/5 Lt. Asterisk indicates sequestrated disc material on the axilla of the left spinal nerve root L5.

curette was then applied to elevate the superficial layer of the ligamentum flavum from the leading edge of the lamina. A Kerrison rongeur and a high-speed drill were used to perform a partial laminotomy of the lower lamina of the upper lumbar spine and upper lamina of the lower lumbar spine after which the ligamentum flavum was removed. The dura and traversing nerve root were then identified and retracted with a nerve root retractor. The herniated disc was removed with pituitary forceps and Kerrison punches. The mobility of the root was checked with a Penfield dissector.

After the operation, a redivac drain was put in place and the incision closed. Antibiotic prophylaxis with Cefazolin was injected intravenously for two days and the patients were encouraged to ambulate with lumbar support as soon as possible. Postoperative pain control consisted of an intravenous analgesic drug and morphine on request. Postoperative patient care was the same for both groups.

Statistical analysis

Clinical data were categorized then divided into dichotomous or polytomous or continuous variables. The continuous data were presented as means and standard deviations, while the categorical data were presented as proportions or percentages. The continuous data were analyzed using the unpaired Student's t-test or the Mann-Whitney U test as appropriated. For serial measurement of post-operative VAS scores, the author analyzed intra- and inter-group using generalized estimating equations (GEE) model and Bonferroni test. Categorical outcomes were assessed with the Chi-square or Fisher's exact test, where appropriated. All p-values were two-tailed, and statistical significance was set at p-value less than 0.05. All statistics were analyzed using Stata Statistical Software, version 16.0 (StataCorp LLC, College Station, TX, USA).

The study was designed by the author and approved by the Human Research Ethics Committee of Khon Kaen Hospital per the Helsinki Declaration and the Good Clinical Practice Guidelines (KEXP63018).

Table 1. Baseline characteristics

Item	BESS (n=43); n (%)	OLD (n=37); n (%)	p-value
Sex			0.289
Male	17 (40)	19 (51)	
Female	26 (60)	18 (49)	
Age (years); mean±SD	39.1±8.8	36.2±10.2	0.182
Level of discectomy			0.961
L2/3 case	1 (2)	1 (2)	
L3/4 case	2 (5)	0 (0)	
L4/5 case	22 (51)	18 (49)	
L5/S1 case	18 (42)	18 (49)	
Side			0.522
Right	19 (44)	19 (51)	
Left	24 (56)	18 (49)	
Preoperative leg pain VAS score; mean±SD	3.3±2.9	3.6±2.6	0.535

BESS=biportal endoscopic spine surgery; OLD=open lumbar discectomy; SD=standard deviation; VAS=visual analogue scale

Results

There were 80 single-level LDH patients included in the present study, 36 were male and 44 were female. The mean age was 37.8±9.5 years of age. The most common level of the operation was L4/5 (40 cases, 50%), followed by L5/S1 (36 cases, 45%), L3/4 (two cases, 2.5%), and L2/3 (two cases, 2.5%). Forty-three of the patients underwent BESS discectomy and 37 underwent OLD. There were no statistically significant differences in the baseline data (Table 1).

The respective mean, post-operative, surgical site pain VAS score was significantly lower in the BESS group versus the OLD group at 2-, 4-, 12-, 24-, 48-,

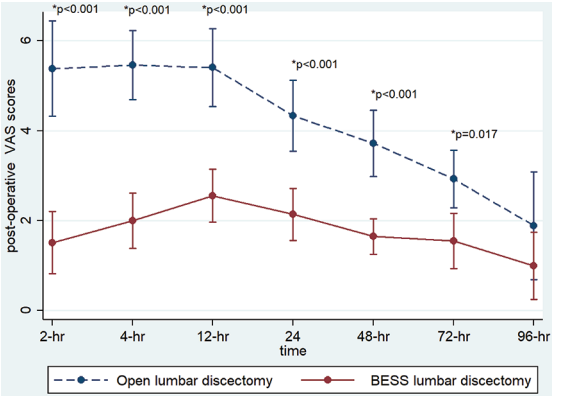

Figure 3. Post-operative surgical site pain VAS scores slope for each treatment and time point in a generalized estimating equation (GEE) model.

* Statistically significant with 95% confidence interval

Comparison surgical site pain between open lumbar discectomy and BESS lumbar discectomy at post-op 2-hour, 4-hour, 12-hour, 24-hour, 48-hour, 72-hour and 96-hour with Bonferroni test

and 72-hours post-surgery (p<0.001, <0.001, <0.001, <0.001, <0.001, and 0.017, respectively), but there was no statistically significant difference at 96-hours (Figure 3). The median morphine consumption was lower in the BESS group than the OLD group (5 mg versus. 9 mg, respectively, p<0.001). EBL and surgical drain output were not significantly different between the two groups. The mean HS was significantly shorter in the BESS group than the OLD group (4.8±2.9 days versus 7.4±4.6 days, p=0.003). Perioperative complications were comparable in both groups with one case in the BESS group that developed postoperative spinal epidural hematoma and needed revision surgery, and one case in the OLD group that had a retained redivac drain, requiring surgical removal.

The median duration of follow-up was comparable between the BESS group and the OLD group (p=0.157). McNab's outcome assessment of patient satisfaction in terms of good to excellent was not statistically different between the BESS and OLD groups (97.7% versus 86.5%, p=0.090). OT was longer in the BESS group (100.4±28.5 minute) than the OLD group (67.9±23.2 minute) (p<0.001), but hospital costs were significantly higher in the BESS group (1,256±360.9 USD) than the OLD group (910.6±269.8 USD) (p<0.001). The outcomes comparison between BESS and OLD are presented in Table 2.

Discussion

The current standard treatment for single-level LDH is OLD and yet minimally invasive spinal surgery has evolved, so that there are numerous minimally invasive surgical options. For example, endoscopic spine surgery, originated to minimize soft tissue damage, increases surgeon vision. BESS discectomy was popularized because it has low surgical technique demand, and the surgical instruments are available in most hospitals[8,9].

The author described the advantages of BESS over OLD in terms of its resulting in less pain for 2 to 72 hours postoperatively, resulting in reduced morphine consumption as well as shortened HS. The findings might be explained by minimal tissue damage during and after BESS surgery as reported in the previous studies[4,11]. Those other studies also reported that the patients that underwent BESS had lower CRP and CPK levels than patients that underwent OLD. Unfortunately, the current study did not explore the differences in CRP and CPK levels between BESS and OLD before and after surgery because CRP

Table 2. Outcomes comparison between BESS and OLD

Factor	BESS (n=43)	OLD (n=37)	p-value
Estimated blood loss (mL); median (IQR)	20 (20 to 50)	30 (20 to 50)	0.079
Operative times (min); mean±SD	100.4±28.5	67.9±23.2	<0.001*
Surgical drain output (mL); median (IQR)	80 (30 to 130)	50 (10 to 150)	0.630
Morphine consumption (mg); median (IQR)	5 (0 to 12)	9 (6 to 16)	<0.001*
Hospital stay (days); mean±SD	4.8±2.9	7.4±4.6	0.003*
Hospital costs (US Dollar); mean±SD	1,256±360.9	910.6±269.8	<0.001*
Duration of follow-up (months); median (IQR)	5 (2 to 10)	6 (3 to 12)	0.157
McNab's outcome (good or excellent); n (%)	42 (97.7%)	32 (86.5%)	0.090

BESS=biportal endoscopic spine surgery; OLD=open lumbar discectomy, SD=standard deviation; IQR=interquartile range; VAS=visual analogue scale

* Statistically significant, p<0.05

and CPK are not routinely checked among patients with single-level LDH undergoing elective surgery. Consequently, the author cannot compare the degree of tissue damage between patients undergoing BESS versus OLD surgery. Notwithstanding, the findings in the present study confirm that early postoperative outcomes in BESS are better than those for OLD and BESS is arguably the better choice for single-level LDH.

Although most of postoperative outcomes of BESS in the current study were better than OLD, the OT was longer in BESS than OLD. This finding agreed with a previous study[10] that reported that the BESS technique demanded a learning curve for the surgeon, so the operation took longer time than the open surgery. The author suggests that the attending surgeon be prepared to use the BESS technique for patients who are unable to tolerate prolonged anesthesia. The current study did not, however, find any difference in EBL between the BESS and OLD technique despite the longer OT for BESS. The BESS technique thus resulted in minimal blood loss.

A minimal invasive technique such as BESS increases hospital costs compared to open surgical techniques. The current study revealed that the cost of treatment by BESS was greater than for OLD because of the additional cost of disposable cautery (Arthrocare®). Further study could determine whether disposable cautery could be reused to mitigate costs.

The present study had some limitations as this was a retrospective study and the OLD was used more commonly a few years ago before shifting to BESS. A randomized controlled trial should be done to confirm the advantages of BESS over OLD. Furthermore, the data were limited because of the retrospective nature. Additionally, the postoperative pain evaluation was not evaluated by a single assessor. Morphine consumption was, however, evaluated to clarify the severity of pain in the same patients. The strengths of the present study are that the author included public health parameters of interest and not only those related to surgical outcomes, particularly HS, hospital costs, and McNab's outcome. In addition, the present study preliminary findings provide information of value for attending surgeons that can be used as guides for choosing surgical technique and planning better care.

Conclusion

For single-level lumbar discectomy, BESS had less early postoperative pain for up to 72 hours and less opioid consumption than the OLD. BESS also had shorter HS albeit longer OT and higher hospital costs than OLD, but comparable patient satisfaction outcomes.

What is already known on this topic?

BESS has comparable outcomes and complications as OLD.

What this study adds?

Compared to OLD, BESS has less early-postoperative pain, less morphine usage, and shorter HSs but greater OT and higher cost of treatment.

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Authors' contributions

Thanit Foocharoen designed the study, did data collection, drafted the manuscript, and proofread the manuscript.

Data availability statement

Data or materials are available per request.

Consent for publication

The author consents to publication and grants the Publisher exclusive license of the full copyright.

Conflicts of interest

The authors declare no conflict of interest.

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