

Outcomes of Unilateral Biportal Endoscopic Surgery for Prolapsed Intervertebral Disc: A Single-center Study

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Learning Point of the Article:

UBES is a safe, minimally invasive technique offering durable pain relief, neurological recovery, and excellent functional outcomes.

Abstract

Introduction: Unilateral biportal endoscopic surgery (UBES) has emerged as a promising minimally invasive technique for treating lumbar spine disorders. However, a comprehensive evaluation of its long-term outcomes still needs to be improved.

Aims and Objectives: This prospective study aimed to evaluate the efficacy and safety of posterior decompression for lumbar disc prolapse done by unilateral biportal endoscopy (UBE), including neurological improvement, functional status, and complications.

Materials and Methods: Consecutive patients undergoing UBES were included from a tertiary care center, Hamidia Hospital, associated with Gandhi Medical College, Bhopal, Madhya Pradesh. Demographic data, pre-operative clinical characteristics, and surgical details were collected. Neurological improvement was assessed at preoperative, 2 weeks, 6 weeks, 3 months, 6 months, and 1 year postoperatively. Functional assessment using Visual Analog Scale (VAS) scores, Oswestry disability index (ODI), and Macnab criteria was performed at pre-operative, 2 weeks, 6 weeks, 3 months, 6 months, and 1 year postoperatively at each follow-up visit.

Results: 50 patients of lumbar disc prolapse (66% male and 34% female) with a mean age of 40.38 ± 9.76 were enrolled, who underwent posterior decompression by UBE surgeries, most performed at L4-L5 (42%) and L5-S1 (40%) levels. Neurological status significantly improved postoperatively, with sustained enhancement in 1 year (96% improvement). Functional assessment revealed significant reductions in ODI scores (from 84.52 ± 4.04 preoperatively to 14.18 ± 3.2 [$P = 0.001$] at 1 year), VAS scores for back and leg pain (from 8.40 ± 0.756 preoperatively to 0.40 ± 0.495 [$P = 0.001$] at 1 year), and Macnab criteria outcomes as excellent at 1 year in 96% of patients.

Conclusion: UBES demonstrates favorable outcomes for lumbar disc prolapse on 1-year follow-up, including neurological improvement, pain relief, and functional outcomes. UBES represents a promising minimally invasive approach for treating lumbar spine disorders, potentially enhancing patient quality of life.

Keywords: Unilateral biportal endoscopic surgery, lumbar spine, minimally invasive surgery, short-term outcomes, pain relief.

Introduction

Lumbar disc herniation remains one of the leading causes of low back pain and radiculopathy, significantly affecting quality of life and functional capacity worldwide [1]. With rapid

advancements in minimally invasive spine surgery, unilateral biportal endoscopic discectomy (UBED) has gained considerable attention as it offers superior visualization, reduced muscle trauma, faster post-operative recovery, and preservation

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Author's Photo Gallery



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of spinal stability compared with traditional open or microdiscectomy techniques [2,3,4,5]. Over recent years, UBED has been increasingly adopted due to its dual-portal system, which allows independent viewing and working channels, enabling more precise decompression of neural elements while minimizing collateral tissue damage [6].

Despite expanding clinical use, high-quality prospective evidence evaluating UBED outcomes remains limited. Current literature is dominated by retrospective analyses or short-term follow-up studies, leaving important questions unanswered regarding long-term pain relief, neurological recovery, functional improvement, and complication rates [7,8]. In addition, variations in surgical expertise and technique create uncertainties about its reproducibility across different clinical settings. Consequently, there is a need for robust prospective data to determine the true clinical effectiveness of UBED in managing prolapsed intervertebral discs [9].

To fill this gap, the present study conducts a single-center prospective analysis to assess clinical outcomes following

UBED in patients with lumbar disc herniation. By systematically evaluating pain scores, functional outcomes, neurological improvement, and procedure-related complications, this research aims to provide stronger evidence on the efficacy, safety, and applicability of UBED as a minimally invasive surgical option for treating prolapsed intervertebral discs.

Materials and Methods

Study design

This prospective observational study was employed to evaluate the outcomes of unilateral biportal endoscopic surgery (UBES) for lumbar disc prolapse in 50 patients. The study was conducted by the principles outlined in the Declaration of Helsinki and approved by the Institutional Ethics Committee.

Patient selection

The required sample size was computed using the standard formula based on an estimated prevalence of lumbar disc prolapse of 1.7% ($P = 0.017$), with a confidence level of 95% ($Z = 3.84$) and an allowable margin of error of 13% ($d = 0.13$). The minimum calculated sample size was 32 subjects [10]. Furthermore, all consecutive patients meeting the inclusion criteria and operated during the study period were enrolled to enhance the power of the study. Patients undergoing UBES for symptomatic lumbar spine disorders at a tertiary care center, Hamidia Hospital, associated with Gandhi Medical College, Bhopal, Madhya Pradesh, were considered for inclusion in the study. Inclusion criteria comprised adult patients (age ≥ 18 years) diagnosed clinically and radiologically by X-ray and magnetic resonance imaging (Fig. 1a and b) with lumbar disc herniation or disc prolapse refractory to conservative management for at least 3 months. Patients with previous lumbar spine surgery, significant comorbidities precluding surgery, or incomplete follow-up data were excluded.

Data collection

Demographic data (age, sex, occupation), pre-operative clinical characteristics (pathology, level of surgery), and surgical



Figure 1: (a) Pre-operative X-ray anteroposterior and dynamic view, (b) Pre-operative magnetic resonance imaging.

details (operative time, intra-op and post-operative complications) were collected prospectively. The pre-operative neurological status was assessed using standardized criteria, and comparisons were made at 2 weeks, 6 weeks, 3 months, 6 months, and 1 year postoperatively. Functional assessment was performed using the Oswestry disability index (ODI), Visual Analog Scale (VAS) scores for back and leg pain, and Macnab criteria outcomes at pre-operative, 2 weeks, 6 weeks, 3 months, 6 months, and 1 year postoperatively.

Outcome measures

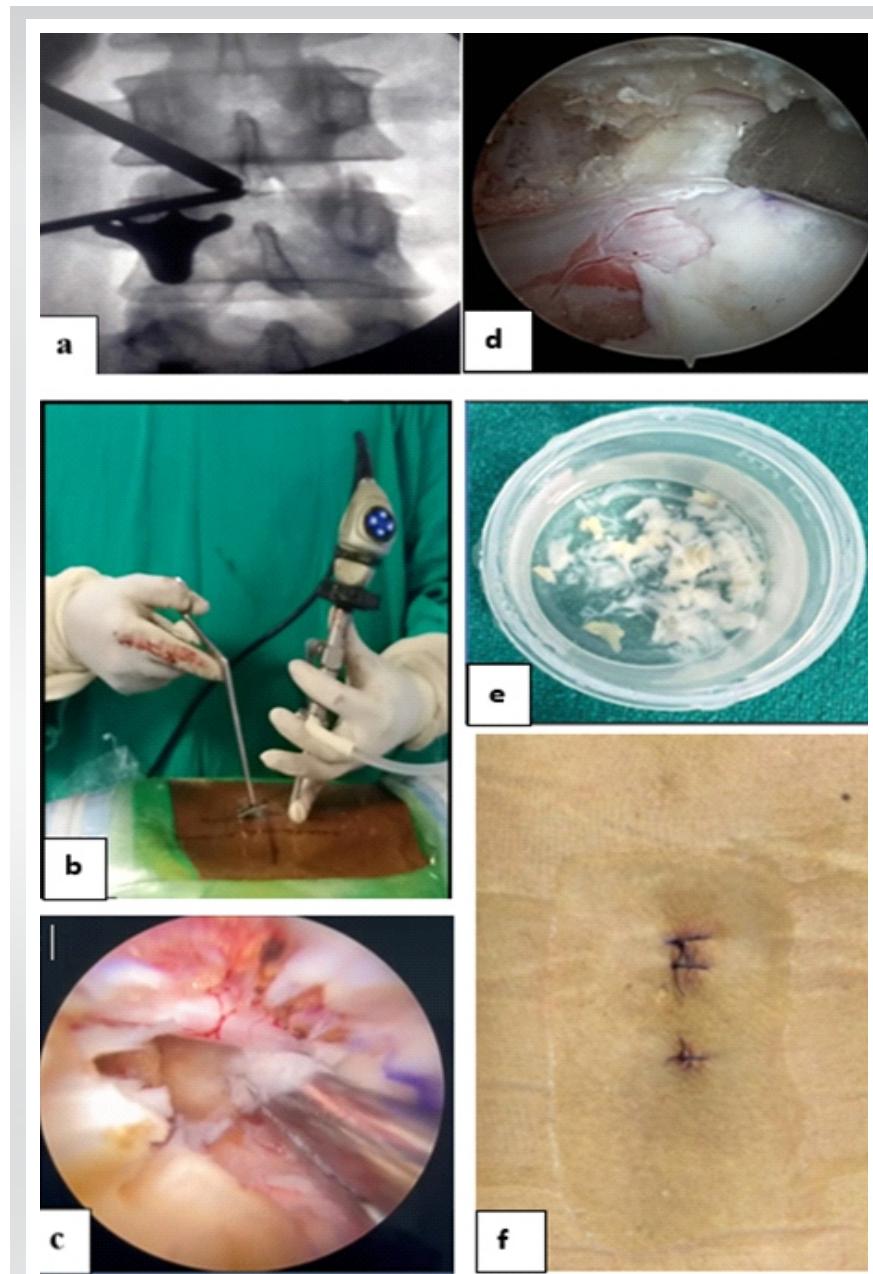


Figure 2: Intraop images. (a) Fluoroscopic image (b) image showing disc removal with Kerrison punch (c and d) endoscopic images (e) disc sample. (f) Post-operative image of surgical wound closure.

The primary outcome measures included changes in VAS scores for back and leg pain, ODI scores, and Macnab criteria. Pain relief was defined as a reduction in VAS score by $\geq 50\%$. Functional improvement was assessed using the ODI, with lower scores indicating better functional status and Macnab criteria, categorized as excellent, good, fair, or poor [11]. Complications, reoperation rates, and length of hospital stay were also recorded.

Surgical technique

All surgeries were performed by experienced spine surgeons proficient in UBES techniques. Patients were placed in the prone position under general anesthesia. A standard posterior approach was employed, and the surgical level was confirmed using fluoroscopy (Fig. 2a). Two small portals were created unilaterally, allowing for direct visualization of the targeted pathology. Sequential dilation of the portals was performed, followed by inserting the endoscope and working instruments (Fig. 2b). Decompression of neural structures, including discectomy, laminectomy, and foraminal decompression, was performed as indicated, under direct monitoring on the endoscope (Fig. 2c,d,e). Hemostasis was achieved, and the portals were closed (Fig. 2f).

Statistical analysis

Data were compiled using MS Excel and analyzed using IBM Statistical Package for the Social Sciences software version 20. Categorical data were expressed as frequencies and proportions, whereas continuous data were expressed as means and standard deviations with ranges. The Chi-square test was used to assess the improvement in ODI and MACNAAB scores over various follow-ups, whereas paired t-tests and repeated-measures analysis of variance were used to assess the improvement in VAS scores at various follow-ups. $P < 0.05$ was considered statistically significant.

Ethical considerations

The Institutional Review Board approved the study protocol of Hamidia Hospital, associated with Gandhi Medical College, Bhopal, Madhya

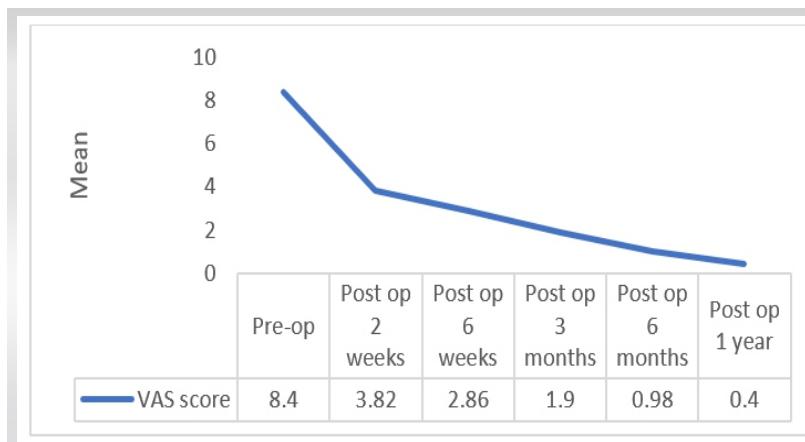


Figure 3: Comparison of Visual Analog Scale score before and after treatment.

Pradesh, IRB Number 91/IEC/2023 on April 25, 2023, and all patients provided written informed consent before enrollment. Patient confidentiality was maintained throughout the study process.

Results

This study was conducted on a total of 50 patients with lumbar disc prolapse and lumbar canal stenosis, who underwent posterior decompression by unilateral biportal endoscopy (UBE). The findings of the present study are tabulated (Table 1).

The study included a total of 50 patients with a mean age of 40.38 ± 9.76 years, ranging from 19 to 62 years. The majority of

Table 1: Distribution of patients according to baseline variables

Baseline variables	Number of patients (n=50)	Percentage
Age (years)		
≤ 30	8	16
31–40	17	34
41–50	18	36
>50	7	14
Mean \pm SD	40.38 ± 9.76 (Range: 19–62)	
Gender		
Male	33	66
Female	17	34
Comorbidities		
Diabetes	2	4
Hypertension	6	12
None	42	84
SD: Standard deviation		

patients were in the 41–50-year age group (36.0%), followed closely by those aged 31–40 years (34.0%). In terms of gender distribution, males were predominant, comprising 66.0% (n = 33) of the cohort, whereas females accounted for 34.0% (n = 17). Regarding comorbidities, a large proportion of the participants (84.0%) did not report any associated medical conditions. Among those with comorbidities, 12.0% (n = 6) had hypertension and 4.0% (n = 2) had diabetes mellitus (Table 1).

The most common spinal level operated on was L4–L5, accounting for 42.0% of cases, followed closely by L5–S1 in 40.0% of patients. The mean procedure time was 72.58 ± 19.24 min, with a range between 48 and 160 min. Most surgeries (66.0%) lasted between 60 and 120 min, while 28.0% were completed in 60 min or less, and only 6.0% extended beyond 120 min. Intraoperatively, complications were rare, with only one case (2.0%) of dural tear reported; the remaining 98.0% experienced no complications. Postoperatively, 4.0% of patients developed disc infections, whereas the vast majority (96.0%) had an uncomplicated recovery (Table 2).

The ODI scores in this study showed a significant and progressive improvement following surgery. Preoperatively, patients had a mean ODI score of 84.52 ± 4.04 , with the majority (74%) categorized as having complete disability

Table 2: Intraoperative and postoperative characteristics of the study population

Intraoperative and post-operative characteristics	Number of patients (n=50)	Percentage
Level operated		
L3-L4	8	16
L3-L4, L4-L5	1	2
L4-L5	21	42
L5-S1	20	40
Procedure time (minutes)		
≤ 60	14	28
60–120	33	66
>120	3	6
Mean \pm SD	72.58 ± 19.24 (Range: 48–160)	
Intraoperative complications		
Dural tear	1	2
None	49	98
Post-operative complications		
Disc infection	2	4
None	48	96
SD: Standard deviation		

Table 3: Comparison of ODI score before and after treatment

Time interval	ODI						P-value
	Mean±SD	Minimal disability (0–20%) (%)	Moderate disability (21–40%) (%)	Severe disability (41–60%) (%)	Crippled: (61–80%) (%)	81–100% (%)	
Pre-op	84.52±4.04	0 (0)	0 (0)	0 (0)	13 (26)	37 (74)	-
Post-op 2 weeks	61.8±5.7	0 (0)	0 (0)	14 (28)	36 (72%)	0 (0)	0.03
Post-op 6 weeks	47.5±6.9	0 (0)	11 (22)	38 (76)	1 (2)	0 (0)	0.01
Post-op 3 months	35.8±6.2	0 (0)	40 (80)	10 (20)	0 (0)	0 (0)	0.001
Post-op 6 months	23.08±4.8	20 (40)	30 (60)	0 (0)	0 (0)	0 (0)	0.001
Post-op 1 year	14.18±3.2	50 (100)	0 (0)	0 (0)	0 (0)	0 (0)	0.001
P-value		0.001					

SD: Standard deviation, ODI: Oswestry disability index

(81–100%), and the remaining 26% as crippled (61–80%). At 2 weeks postoperatively, the mean ODI improved to 61.8 ± 5.7 , with 72% still in the “crippled” category and 28% in the “severe disability” range, showing a statistically significant improvement ($P = 0.03$). By 6 weeks, the mean ODI had decreased to 47.5 ± 6.9 , with the majority (76%) in the “severe disability” category and 22% in “moderate disability” ($P = 0.01$). Continued improvement was seen at 3 months, where the mean ODI dropped to 35.8 ± 6.2 , with 80% of patients now classified as having “moderate disability” and 20% as “severe disability” ($P = 0.001$). At 6 months, the mean ODI further improved to 23.08 ± 4.8 , with 60% in the “moderate disability” range and 40% achieving “minimal disability” ($P = 0.001$). Finally, at 1 year postoperatively, all patients (100%) achieved minimal disability, with a mean ODI of 14.18 ± 3.2 ($P = 0.001$). The trend across all time intervals was highly statistically significant ($P = 0.001$), indicating a consistent and meaningful recovery following surgical intervention (Table 3).

The Macnab criteria outcomes showed a clear and statistically significant improvement in patient satisfaction and functional recovery following surgery over the 1-year follow-up period. At 2 weeks postoperatively, the majority of patients (92%) reported only fair outcomes, with just 8% rating their recovery as good, and none reporting excellent or poor outcomes. By 6 weeks, improvement was noted, with 34% of patients reporting good outcomes and 66% still at fair level ($P = 0.042$). At 3-month post-operative, 68% reported good results, and 30% experienced excellent recovery, with only 2% still in the fair

category ($P = 0.001$). This positive trend continued at 6 months, where 94% rated their outcome as excellent, 4% as good, and only 2% remained in the fair category ($P = 0.001$). Finally, at 1 year, 96% of patients rated their outcome as excellent, and the remaining 4% reported a good outcome. There were no patients in the fair or poor categories. The overall P-value across all time intervals was 0.001, confirming a statistically significant and steady improvement in functional outcomes as per Macnab criteria following surgical intervention (Table 4).

The VAS scores demonstrated a marked and statistically significant reduction in pain levels over 1 year following the surgical procedure. Preoperatively, patients reported a high mean VAS score of 8.40 ± 0.756 , indicating severe pain. At 2 weeks postoperatively, the mean score dropped significantly to 3.82 ± 0.691 ($P = 0.001$), reflecting substantial early pain relief. Continued improvement was observed at subsequent follow-ups, with the score decreasing to 2.86 ± 0.729 at 6 weeks, 1.90 ± 0.614 at 3 months, and 0.98 ± 0.742 at 6 months. By 1 year postoperatively, the mean VAS score had further declined to

Table 4: Comparison of Macnab before and after treatment

Time interval	Macnab				P-value
	Excellent (%)	Good (%)	Fair (%)	Poor (%)	
Post-op 2 weeks	0 (0)	4 (8)	46 (92)	0 (0)	-
Post-op 6 weeks	0 (0)	17 (34)	33 (66)	0 (0)	0.042
Post-op 3 months	15 (30)	34 (68)	1 (2)	0 (0)	0.001
Post-op 6 months	47 (94)	2 (4)	1 (2)	0 (0)	0.001
Post-op 1 year	48 (96)	2 (4%)	0 (0)	0 (0)	0.001
P-value		0.001			

0.40 ± 0.495, indicating minimal residual pain. Each of these reductions was statistically significant ($P = 0.001$), highlighting the sustained efficacy of the surgical intervention in alleviating pain over time (Fig. 3).

Discussion

UBES has emerged as a promising minimally invasive technique for treating lumbar spine disorders, offering significant advantages in terms of reduced tissue trauma, faster recovery, and improved patient outcomes. In this study, we evaluated the long-term outcomes of UBES for lumbar disc prolapse, considering various factors such as neurological improvement and functional status.

Our findings demonstrate significant improvements in neurological status following UBES, with most patients experiencing improvement in neurological deficits in 2 weeks, 6 weeks, 3 months, 6 months, and 1 year postoperatively. This aligns with previous studies indicating the efficacy of UBES in relieving neural compression and restoring neurological function [12, 13]. Notably, the sustained improvement observed for 1 year postoperatively suggests the durability of surgical outcomes.

Functional assessment using the ODI, VAS scores, and Macnab criteria revealed substantial improvements in pain relief and functional status following UBES. The significant reductions in ODI scores and VAS scores for back and leg pain at all post-operative time points reflect the effectiveness of UBES in alleviating symptoms and improving overall quality of life. These findings are consistent with previous literature supporting the favorable functional outcomes of UBES for lumbar spine disorders [14, 15].

As assessed by the Macnab criteria, patient satisfaction and functional outcome were high at all follow-up time points, with most patients reporting excellent or good outcomes. This underscores patients' subjective satisfaction with the surgical results and highlights the overall success of UBES in meeting patient expectations. Our results align with previous studies reporting high patient satisfaction rates following UBES [16, 17]. In Soliman's [18] prospective case series of 43 patients, outcomes based on the modified Macnab criteria were excellent in 78%, good in 17%, and poor in 5%, demonstrating high effectiveness in symptom relief; notably, the present study achieved a slightly higher rate of "Excellent" outcomes with no poor or fair results. Kim et al. [19] reported that 81% of patients experienced "Good" or "Excellent" outcomes 2 years after unilateral laminotomy with bilateral decompression using a 30° arthroscope. Similarly, Kim and Jung [20] found 51.7% "Excellent" and 41.4% "Good" outcomes 18 months after

UBE. Pao et al. [11] also supported UBE's effectiveness, with 58% "Excellent" and 35.8% "Good" results in their cohort study.

Dural tear in one patient is the only intraoperative complication. These results are comparable to the findings reported by Kim et al. [21] who observed a 3.2% incidence of dural tears in patients undergoing biportal endoscopic spinal surgery. Disc infection in two patients occurred postoperatively. Supporting data from Kpegeol et al. [22] and Chiu et al. [23] further highlight the lower disc infection rates seen with endoscopic decompression.

While our study contributes valuable insights into the long-term outcomes of UBES, several limitations should be acknowledged. The study was conducted at a single center with a relatively small sample size, limiting the generalizability of the findings. The follow-up period also precludes assessment of more long-term outcomes and recurrence rates. Future multicenter studies with larger cohorts and longer follow-up durations are warranted to confirm our findings and evaluate the durability of surgical outcomes.

Conclusion

Our study demonstrates favorable outcomes of UBES for lumbar disc prolapse after 1 year of follow-up, with significant improvements in neurological status, functional outcomes, and patient satisfaction. UBES represents a promising minimally invasive approach for treating lumbar spine disorders, offering effective symptom relief and enhancing patient quality of life.

Clinical Message

UBE is a minimally invasive spinal surgery technique offering superior visualization, minimal tissue disruption, reduced postoperative pain, and faster recovery compared to traditional methods. It is particularly effective for lumbar disc herniation and spinal stenosis, enabling precise decompression with preserved spinal stability. Clinical outcomes show significant improvement in pain, function, and patient satisfaction. However, UBE has a steep learning curve, requiring specialized training and equipment, limiting its adoption in resource-poor settings. While promising, further long-term comparative studies are needed to fully assess its benefits and potential complications, supporting broader integration into modern spine care practices.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil **Source of support:** None

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