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MICROSCOPIC UNILATERAL LAMINOTOMY FOR BILATERAL DECOMPRESSION FOR LUMBAR SPINAL STENOSIS: DOES DRAIN DIAMETER MATTER? A RETROSPECTIVE COHORT STUDY

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ABSTRACT

Objective: Microscopic unilateral laminotomy for bilateral decompression (ULBD) is performed for symptomatic lumbar spinal stenosis in selected patients who do not require fusion. It is unknown whether a larger closed-suction drain improves postoperative drainage or early clinical outcomes after ULBD. We compared 12-French (12F) and 16-French (16F) drains after ULBD.

Materials and Methods: We retrospectively analyzed 49 consecutive patients who underwent microscopic ULBD performed by a single team between May and December 2023. Patients received either a 12F (n=25) or a 16F (n=24) closed-suction drain under a uniform perioperative protocol. The primary outcome was total drain output (mL). Secondary outcomes were change in pain [Δvisual analog scale (VAS)=preoperative minus postoperative VAS] and length of stay (LOS, days). Exploratory analyses assessed associations among drainage, ΔVAS, and patient or surgical variables. Group comparisons were performed using parametric or non-parametric tests, as appropriate; multivariable linear regression was used to evaluate independent predictors.

Results: Baseline demographics and clinical variables were similar between groups. No significant differences were observed between 12F and 16F drains in total output (p=0.607), ΔVAS (p=0.935), postoperative VAS (p=0.837), or LOS (p=0.448). Prior surgery (p=1.000), anticoagulant or antiplatelet use (p=0.909), and surgical level distribution (p=0.265) did not differ between groups. Surgical extent was the only variable associated with higher drainage on univariate analysis (p<0.001). Higher preoperative VAS predicted greater ΔVAS (Pearson's r=0.604, p<0.001). In multivariable models, preoperative VAS remained the principal predictor of ΔVAS, while drain size was not an independent predictor of output or pain improvement.

Conclusion: Upsizing closed-suction drains from 12F to 16F after microscopic ULBD did not reduce pain, shorten hospitalization, or change the total output. A 12F drain appears adequate for routine ULBD; surgical extent, rather than drain diameter, drives postoperative drainage volume.

Keywords: Microscopic lumbar decompression, drainage volume, surgical drains, postoperative bleeding

INTRODUCTION

Lumbar spinal stenosis commonly necessitates surgical decompression when symptoms persist despite conservative care. Microscopic unilateral laminotomy for bilateral decompression (ULBD) is a tissue-sparing decompression technique that preserves midline structures and limits dead space relative to open laminectomy. In clinical practice, ULBD is typically selected for patients with degenerative central and/or lateral recess stenosis without radiographic instability or deformity that would otherwise mandate fusion[1,2]. Even with meticulous hemostasis, postoperative epidural or paraspinal collections remain a concern, and many surgeons place closed-suction drains as a risk-mitigation strategy[3-5].

Whether drains meaningfully improve outcomes in lumbar surgery is debated. Prior studies in open procedures have reported inconsistent effects on hematoma, infection, transfusion, and length of stay, and there is no consensus on drain selection or management[3-7]. In minimally invasive decompression, the surgical corridor and residual cavity differ substantially from open surgery, so evidence from open cohorts may not generalize[6,7]. A specific, unaddressed question is whether drain caliber matters in ULBD: a larger tube could theoretically reduce residual clot by lowering flow resistance, yet flow in narrow cavities may instead be limited by tissue

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apposition, clot viscosity, or fenestration geometry rather than lumen diameter alone[3,6,7]. As a result, upsizing may add local irritation without improving evacuation.

The present retrospective cohort study evaluates two commonly used drain diameters, 12 French (12F) and 16 French (16F), in consecutive patients undergoing standardized microscopic ULBD by the same surgical team. The primary outcome was total drain output; secondary outcomes were change in pain intensity and hospital length of stay. We additionally explored whether patient and operative variables (for example, extent of decompression) predicted drainage volume or pain improvement. Our a priori hypothesis was that larger-caliber drains would not confer a clinically meaningful advantage in the ULBD setting. By focusing on a single technique, uniform perioperative care, and clearly defined outcomes, this study aims to address a practical question that has direct implications for routine postoperative management.

MATERIALS AND METHODS

Study Design and Patient Selection

This retrospective cohort study included 49 consecutive adult patients who underwent microscopic ULBD between May 2023 and December 2023. All patients had a clinical diagnosis of lumbar spinal stenosis (neurogenic claudication and/or radiculopathy) with radiologic confirmation and had persistent symptoms despite conservative management. Patients were selected for decompression-only surgery (i.e., ULBD without fusion) based on the operating team's routine preoperative evaluation, including the absence of clinical or radiographic instability or deformity that would otherwise mandate fusion. Patients were grouped based on the diameter of the postoperative closed-suction drain placed (12F or 16F) under a uniform perioperative protocol. Patients with single-level stenosis, spinal infection, tumor, prior lumbar instrumentation, or other indications requiring fusion were excluded.

Ethical Statement

Bahçeşehir University Institutional Review Board approved this retrospective file review (approval no: 2025-15/03, date: 15.12.2025). The Declaration of Helsinki is followed during the investigation. Before being enrolled in the study, each participant signed an informed consent form that had been authorized by the institutional review board. The signed informed consent form for this study includes approval to publish clinical and medical information. The patient gave written informed consent for her case to be included in research, allowing for the release of the patient's medical records and any related photos. Upon request, a copy of the permission form is provided.

Surgical Technique, Drain Types, and Postoperative Care

All surgeries were performed using a standard bilateral decompression via a unilateral approach under an operating microscope. After midline skin incision and paramedian fascial opening, the multifidus muscle was elevated and retracted to expose the ipsilateral lamina. Using Kerrison rongeurs and a high-speed burr, a laminotomy of the cephalad and caudal hemilamina was performed in a trumpeted fashion, facilitating ligamentum flavum removal and ipsilateral decompression. The microscope was then angulated medially to perform contralateral decompression beneath the interspinous ligament. At the end of the procedure, bipolar coagulation and hemostatic gel-foam were used for hemostasis, and a closed-suction drain was placed in the surgical bed.

Two types of surgical drains were used in this study:

- Closed-suction 12F redon drains (Figure 1A, right)
- Closed-suction 16F redon drains (B-Vak Wound Drainage System, Koç Medical, İstanbul, Türkiye) (Figure 1A, left).

Drain placement and management protocols were uniformly applied across all patients. Both systems used a 400 mL collection reservoir that was maintained under negative pressure per manufacturer instructions (reservoir fully compressed after closure and re-compressed after emptying). The reservoir was kept below the level of the surgical site during hospitalization. Drains were positioned 2 cm lateral and 2 cm superior to the surgical incision on the operative side and placed subfascially. Perioperative antibiotic prophylaxis followed our institutional standard for decompression surgery (cefazolin for 24 hours postoperatively) and was not extended solely because a drain was used. Patients were encouraged to mobilize as tolerated within the first postoperative day. Patients on anticoagulant therapy prior to surgery, and/or those with limited mobility, received low molecular weight heparin (4000 U) as thromboprophylaxis. Drain removal was indicated when output dropped below 100 mL over the preceding 24 hours or by postoperative day 2, whichever criterion was met

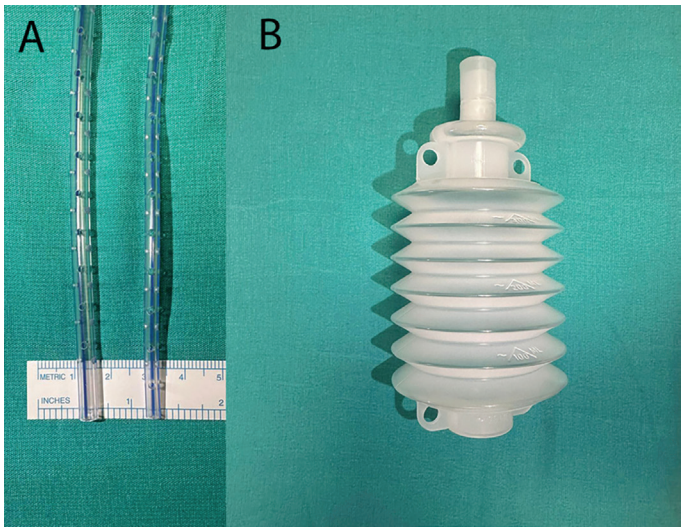

Figure 1. **(A)** The left specimen is a 16F drainage catheter, characterized by an outer diameter of 4 mm, while the right specimen is a 12F drainage catheter, featuring an outer diameter of 3 mm. **(B)** The closed drainage system is equipped with a drainage collection unit capable of accommodating a maximum volume of approximately 400 mL. 16F: 16 French, 12F: 12 French

first. Discharge was planned after mobilization and pain control criteria were met and the drain was removed, unless other medical reasons required longer observation.

Data Collection

For the study, a range of variables to evaluate the outcomes of patients undergoing lumbar surgery were collected. Demographic information included age, sex, and body mass index (BMI), while clinical parameters assessed the use of anticoagulant or antiplatelet drugs and any history of previous lumbar surgery. Surgical details focused on the number of decompressed levels and the size of the drain used. Outcomes were measured through preoperative and postoperative visual analog scale (VAS) scores, changes in VAS scores to determine pain reduction, total drain output measured in milliliters, and the length of hospital stay in days.

The preoperative VAS scores were obtained within 24 hours prior to the surgical intervention, while the postoperative VAS scores were recorded prior to the removal of the drainage. Between-group differences in change in the ΔVAS were defined as preoperative VAS minus postoperative VAS. Discharge day was counted as calendar days from the surgery date to discharge.

The primary endpoint of this study is the between-group difference in total drain output (measured in milliliters) between the 12F and 16F drainage systems. Key secondary endpoints include the ΔVAS scores and the day of discharge. Additionally, exploratory analyses will investigate potential predictors of bleeding, including age, BMI, surgical level, use of anticoagulants, and history of previous surgeries, as well as predictors of ΔVAS.

Statistical Analysis

All statistical analyses were performed using IBM SPSS Statistics version 25.0 (IBM Corp., Armonk, NY). Normality of continuous variables was assessed with the Shapiro-Wilk test. Normally distributed variables were analyzed using independent samples t-tests; non-normally distributed variables were compared using Mann-Whitney U or Kruskal-Wallis tests. Categorical data were assessed using the chi-square or Fisher's exact test where appropriate.

Correlations were analyzed using Pearson or Spearman correlation coefficients, depending on distribution. Multivariate linear regression was used to assess independent predictors of drain output and pain reduction. Statistical significance was set at $p<0.05$.

RESULTS

A total of 49 consecutive patients who underwent microscopic lumbar microdecompression were included in the analysis. Table 1 shows the overall characteristics of the whole patient population. From these operated patients, 25 patients received a 12F drain, and 24 patients received a 16F drain.

Table 1. Overall characteristics and descriptive statistics of the patient population

	Descriptive statistics
Age	68.76±2.84
Gender	
Male	20 (40.82%)
Female	29 (59.18%)
BMI	29.00±1.54
Surgical levels	
2 levels	22 (44.9%)
3 levels	19 (38.78%)
4 levels	6 (12.24%)
5 levels	2 (4.08%)
Anticoagulant/platelet use	
No	30 (61.22%)
Yes	19 (38.78%)
Previous lumbar surgery	
No	45 (91.84%)
Yes	4 (8.16%)
Surgical drain size	
12F	25 (51.02%)
16F	24 (48.98%)
Preoperative VAS score	7.96±0.57
Postoperative VAS score	2.57±0.57
Total drainage (mL)	156.73±47.5
Discharge days	1.39±0.22

BMI: Body mass index, VAS: Visual analog scale, 12F: 12 French, 16F: 16 French

Primary Outcomes - Comparison of Drain Sizes

There was no statistically significant difference between the 12F and 16F drain groups in terms of demographic characteristics and key postoperative outcomes (Table 2). Specifically, the groups were statistically similar in terms of age (p=0.289), BMI (p=0.267), preoperative pain scores (p=0.487), postoperative pain scores (p=0.837), pain reduction (ΔVAS, p=0.935), total drain output (p=0.607), and discharge day (p=0.448). The results of this study indicate that increasing the drain diameter from 12F to 16F does not offer any significant clinical advantages (Figure 2A). There were also no significant differences in rates of previous lumbar surgery (p=1.000), anticoagulant use (p=0.909) (Figure 2B), or surgical level distribution (p=0.265) between the two drain size groups. Specifically, there was no observed reduction in postoperative pain levels among patients, nor was there an increase in the postoperative drainage. Drains were maintained under negative pressure throughout hospitalization and were removed according to the prespecified criteria in all patients; no patient required drainage beyond postoperative day 2. These outcomes highlight that simply enlarging the drain size may not enhance patient recovery or outcomes, which was the main objective of our investigation.

Table 2. Comparisons between 12F and 16F drains after microscopic ULBD

	Drain size		
	12F (small size)	**16F (large size)**	**p-value**
Age	66.52±4.37	71.08±3.54	0.289
BMI	30.1±2.17	27.86±2.1	0.267
Total drainage (mL)	157.6±74.1	155.83±59.56	0.607
Discharge day	1.52±0.39	1.25±0.18	0.448
Preop VAS	8.08±0.78	7.83±0.85	0.487
Postop VAS	2.72±0.88	2.42±0.72	0.837
Δ VAS	5.36±1.06	5.42±0.88	0.935
Previous surgery			
Yes	2 (8%)	2 (8.3%)	1.000
No	23 (92%)	22 (91.7%)	
Anticoagulant/platelet use			
Yes	16 (64%)	14 (58.3%)	0.909
No	9 (36%)	10 (41.7%)	
Surgical level			
2 levels	11 (44%)	11 (45.8%)	
3 levels	12 (48%)	7 (29.2 %)	0.265
4 levels	2 (8%)	4 (16.7 %)	
5 levels	0 (0%)	2 (8.3%)	
Gender			
Male	10 (40%)	10 (41.7%)	0.906
Female	15 (60%)	14 (58.3%)	

ULBD: Unilateral laminotomy for bilateral decompression, BMI: Body mass index, VAS: Visual analog scale, 12F: 12 French, 16F: 16 French

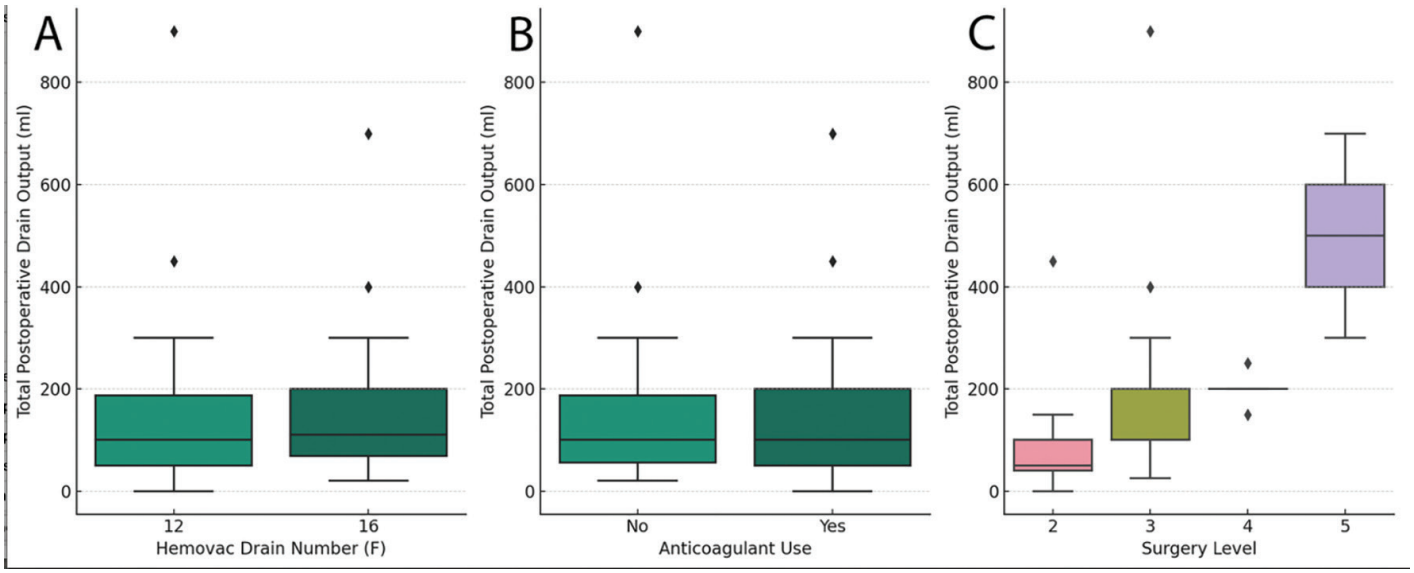

Figure 2. Total postoperative drain output in terms of **(A)** hemovac drain size, **(B)** anticoagulant use and **(C)** number of surgical level decompressed

Table 3. Association of patient/surgical factors with total drainage (mL)

	Total drainage (mL)	p-value	Post-hoc p-value
Age	156.73±47.5	0.165	-
BMI		0.382	-
Gender			
Male	168.25±83.78	0.436	-
Female	148.79±56.22		
Previous surgery			
Yes	181.25±85.09	0.246	-
No	154.56±51.02		
Anticoagulant/platelet use			
Yes	167.11±77.17	0.764	-
No	150.17±60.67		
Surgical levels			
2 levels	89.32±38.5	**0.000**	2-3: 0.321 **2-4: 0.000** 2-5: 0.868 3-4: 1.000 3-5: 0.925 4-5: 0.940
3 levels	185.0±90.14		
4 levels	200.0±25.82		
5 levels	500.0±400.0		

BMI: Body mass index

Table 4. Predictors of pain improvement (ΔVAS) after microscopic ULBD

	ΔVAS	p-value
Age	5.39±0.69	0.363
BMI		0.652
Preop VAS score		0.**000**
Draiange amount (mL)		0.100
Discharge day		0.108
Gender		
Male	4.60±1.136	0.056
Female	5.93±0.812	
Previous surgery		
Yes	7.00±0.82	0.164
No	5.24±0.72	
Anticoagulant/platelet use		
Yes	4.68±1.27	0.104
No	5.83±0.76	
Surgical levels		
2 levels	6.09±1.02	0.144
3 levels	4.42±1.18	
4 levels	6.00±0.89	
5 levels	5.00±2.00	

VAS: Visual analog scale, BMI: Body mass index

Secondary Outcomes - Predictors of Drainage Amount and Pain Reduction

Surgical level was the only variable significantly associated with drain output (Kruskal-Wallis, $p<0.001$). Post-hoc comparisons showed that patients undergoing 4-level surgeries had significantly higher drain volumes compared to those undergoing 2-level surgeries (mean difference =110.7 mL, $p<0.001$) (Figure 2C, Table 3).

When examining predictors of postoperative bleeding, univariate analysis revealed a statistically significant negative correlation with preoperative VAS scores (Spearman $\rho=-0.335$, $p=0.018$), indicating that patients with higher preoperative pain scores had lower drain outputs. However, this association did not remain statistically significant in a multivariate linear regression model adjusting for age, BMI, blood thinner use, drain size, and previous surgery (adjusted $R^2=0.051$, $p=0.227$).

Regarding predictors of pain reduction, only the preoperative pain score was significantly associated with the degree of pain reduction (Pearson's $r=0.604$, $p<0.001$). This indicates that patients experiencing higher preoperative pain experienced significantly greater pain reduction after surgery. Other variables including drain output ($p=0.100$), age ($p=0.363$), BMI ($p=0.652$), discharge day ($p=0.108$), blood thinner use ($p=0.104$), gender ($p=0.056$), previous surgery ($p=0.164$), and surgical level ($p=0.144$) were not significantly associated with pain reduction (Table 4). Additionally, there was no significant correlation between total drain output and pain reduction (Spearman $\rho=-0.232$, $p=0.108$).

No variables were found to be significantly associated with length of hospital stay in either univariate or correlation analyses.

DISCUSSION

ULBD is a widely recognized surgical modality employed to treat lumbar spinal stenosis. This technique is favored for its minimally invasive characteristics when juxtaposed with traditional decompression and posterior fusion surgeries, which often result in greater tissue disruption. Consequently, the relative risk of hematoma formation and the overall volume of intraoperative bleeding are significantly lower. Nonetheless, despite the reduced hemorrhagic volume typically associated with this procedure, the potential for mass effect from even a small hematoma collection remains a concern. This is largely attributable to the constrained anatomical space that persists postoperatively in comparison to more extensive open surgical interventions.

In recent years, the efficacy of drain placement in open surgical procedures has come under scrutiny. Evidence suggests that the routine placement of drains does not significantly reduce the incidence of epidural hematoma formation, nor does it lead to a measurable decrease in postoperative complications[3-8]. Furthermore, the introduction of drains is associated with increased rates of bleeding and necessitates higher transfusion requirements, in addition to contributing to patient discomfort during the postoperative recovery period[3,5].

Despite the growing body of research that challenges the utility of wound drainage, it continues to be standard practice among many surgeons[3-7]. This persistence exists in spinal surgical procedures, where the application of drain systems lacks a standardized protocol regarding critical factors. These factors include the choice between negative or natural drainage, as well as considerations related to the size, length, type, quantity, and positioning of the drains. The absence of a uniform guideline raises important questions about the best practices in postoperative care and the potential need for reevaluation of current protocols in surgical practice.

Previous research has demonstrated no significant correlation between drain size and outcomes in open lumbar fusion surgeries[3,5-7,9,10]. Additional studies indicate that the use of two drains, as opposed to one, may reduce failure rates associated with drain placement and lower the incidence of hematoma formation[9]. One particular investigation highlighted that when a drain was positioned 5 cm outside the surgical incision, the drainage efficacy was insufficient[11]. While these findings pertain primarily to open posterior lumbar fusion surgeries, there is a notable gap in the literature regarding ULBD procedures.

Furthermore, it is essential to consider that the placement of drains can have a significant impact on postoperative recovery. The necessity for drains tends to prolong hospital stays, and increased blood loss associated with their use may elevate the risk of surgical site infections and hemorrhagic anemia[3,5]. Thus, further research is warranted to elucidate the effects of drain placement specifically in the context of ULBD.

In this single-team cohort study on microscopic lumbar microdecompression, increasing the closed-suction drain size from 12F to 16F showed no significant impact on postoperative bleeding, pain reduction, or length of hospital stay. The only factor linked to higher drainage volumes was the extent of decompression. Additionally, preoperative pain intensity was a more reliable predictor of postoperative pain relief than either drain size or drainage volume. These findings indicate that the drainage device's size does not substantially influence the volume of postoperative drainage, which aligns with prior research on open surgical procedures[8,12].

Given that routine postoperative imaging to assess the volume of blood at the surgical site is not performed, we identified the need for surrogate markers to evaluate hematoma-related outcomes. Consequently, pain scale assessments and loss of muscle strength were selected as appropriate indicators. Specifically, an increase or lack of reduction in pain scores, along with a newly developed decrease in muscle strength, absent any apparent nerve injury during surgery, could suggest the presence of blood accumulation over the thecal sac[11].

In our patient cohort, only two patients reported no change in pain levels following surgery, both of whom were experiencing moderate to severe neuropathic pain. Notably, no loss of muscle strength was observed among the patients. Furthermore, the reduction in postoperative pain scores implies that there is no associated increase in pain related to blood collection among the analyzed patients. Additionally, we did not observe any cases of drainage obstruction during the study.

One of the notable findings from our study indicated that the reduction in postoperative pain levels is correlated with the intensity of preoperative pain experienced by patients. Specifically, a higher baseline level of pain was associated with greater analgesic relief following surgical intervention. While no direct correlation was established regarding the types or volumes of drainage employed, this outcome presents an intriguing avenue for further investigation within the context of pain management and surgical outcomes.

This study was not designed to address the broader question of drain use versus no-drain after ULBD. Drain placement is not universal, and some centers mobilize patients within hours and discharge without drains. In our practice setting during the study period, a single closed-suction drain was routinely used for multilevel ULBD to mitigate concerns about postoperative collections, with early mobilization encouraged within the first postoperative day and only standard 24-hour perioperative antibiotic prophylaxis. Accordingly, our results should be interpreted as addressing a narrower, pragmatic question: when a drain is used after microscopic ULBD, does increasing diameter from 12F to 16F provide measurable benefit? Future prospective studies incorporating a no-drain arm and standardized mobilization/discharge pathways would be required to determine whether drains are necessary in this population and to quantify any impact on rare hematoma-related outcomes.

Our study presents several limitations that could be mitigated through the implementation of larger cohort studies. This retrospective, single-center investigation is characterized by a modest sample size. Additionally, we did not routinely obtain postoperative imaging to quantify hematoma formation, and within our patient population, we observed no complications associated with hematoma development. This absence of complications restricts our ability to thoroughly evaluate the potential adverse effects related to hematoma formation. Future work should standardize drain algorithms for minimally invasive ULBD, covering indications for placement, negative vs natural pressure, exit-site/trajectory, and removal thresholds, to enable reproducible comparisons across centers[11,13-16].

Study Limitations

This study has several limitations. First, its retrospective, single-center design with a modest sample size limits statistical power and generalizability, and drain selection was not randomized, leaving the possibility of selection bias and residual confounding despite a standardized surgical technique and perioperative protocol. Second, the study did not include a no-drain control group; therefore, conclusions are restricted to comparisons between drain diameters among patients who received routine closed-suction drainage. Third, we did not routinely obtain postoperative imaging to quantify epidural/paraspinal hematoma, and no hematoma-related complications occurred in this cohort; therefore, we cannot draw conclusions regarding drain caliber and rare but clinically important hematoma outcomes. Finally, outcomes were limited to early surrogate measures and short-term hospitalization data, which may not capture clinically meaningful differences in neurologic function, patient-reported recovery trajectories, or late complications.

CONCLUSION

In this single-team cohort of microscopic ULBD, increasing drain diameter from 12F to 16F was not associated with lower postoperative pain, shorter hospitalization, or meaningfully different total drainage. Across prespecified comparisons and adjusted analyses, results were directionally consistent, and the only variable that tracked with higher drainage was greater decompression extent, while higher baseline pain predicted larger postoperative pain reduction. These findings suggest that, under standardized hemostasis and postoperative care, drain performance in ULBD is not materially improved by upsizing the lumen.

Clinically, a 12F closed-suction drain appears adequate for routine ULBD, and choice of diameter can be guided by surgeon preference and workflow rather than expectations of superior outcomes with a larger-caliber. Because this was a retrospective, single-center study with a modest sample size, prospective studies with protocolized drain management and patient-reported endpoints are warranted to confirm these observations, refine selection for atypical scenarios, and define evidence-based criteria for drain placement and removal.

Ethics

Ethics Committee Approval: Bahçeşehir University Institutional Review Board approved this retrospective file review (approval no: 2025-15/03, date: 15.12.2025).

Informed Consent: The patient gave written informed consent for her case to be included in research, allowing for the release of the patient's medical records and any related photos.

Footnotes

Authorship Contributions

Surgical and Medical Practices: M.Z.Y., D.K., Concept: B.P., Ö.E., M.Z.Y., Design: B.P., Ö.E., Data Collection or Processing: Ö.E., Y.K., Analysis or Interpretation: B.P., Ö.E., Literature Search: B.P., Writing: B.P., Ö.E., D.K.

Conflict of Interest: No conflict of interest was declared by the authors.

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