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Postoperative Outcomes and Resource Utilization Following Open vs Endoscopic Far Lateral Lumbar Discectomy

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ABSTRACT

Background: Operative approaches for far lateral disc herniation (FLDH) repair may be classified as open or minimally invasive. The present study aims to compare postoperative outcomes and resource utilization between patients undergoing open and endoscopic (one such minimally invasive approach) FLDH surgeries.

Methods: A total of 144 consecutive adult patients undergoing FLDH repair at a single, university health system over an 8-year period (2013–2020) were retrospectively reviewed. Patients were divided into 2 cohorts: "open" ($n = 92$) and "endoscopic" ($n = 52$). Logistic regression was performed to evaluate the impact of procedural type on postoperative outcomes, and resource utilization metrics were compared between cohorts using χ^2 test (for categorical variables) or t test (for continuous variables). Primary postsurgical outcomes included readmissions, reoperations, emergency department visits, and neurosurgery outpatient office visits within 90 days of the index operation. Primary resource utilization outcomes included total direct cost of the procedure and length of stay. Secondary measures included discharge disposition, operative length, and duration of follow-up.

Results: No differences were observed in adverse postoperative events. Patients undergoing open FLDH surgery were more likely to attend outpatient visits within 30 days ($P = 0.016$). Although direct operating room cost was lower ($P < 0.001$) for open procedures, length of hospital stay was longer ($P < 0.001$). Patients undergoing open surgery also demonstrated less favorable discharge dispositions, longer operative length, and greater duration of follow-up.

Conclusions: While both procedure types represent viable options for FLDH, endoscopic surgeries appear to achieve comparable clinical outcomes with decreased perioperative resource utilization.

Clinical Relevance: The present study suggests that endoscopic FLDH repairs do not lead to inferior outcomes but may decrease utilization of perioperative resources.

Level of Evidence: 3.

Lumbar Spine

Keywords: endoscopic surgery, far lateral disc herniation, lumbar spine, minimally invasive surgery, spine surgery

INTRODUCTION

Up to 10% of lumbar disc herniations are classified as far lateral disc herniations (FLDHs).[1] FLDHs occur when the disc material is displaced lateral to the intervertebral foramen, predominantly at the L3-L4 and L4-L5 levels.[2] Although conservative management of disc herniation constitutes first line care, FLDHs are inconsistently responsive to these measures, and many patients ultimately require surgery.[3] FLDH repair is more technically challenging than routine disc herniation surgeries as the incision is off-midline and transmuscular; thus, surgical approaches reveal a less familiar anatomic orientation.[4,5] Therefore, a focused evaluation of FLDH repair can inform providers and guide risk mitigation strategies.

Several operative techniques for FLDH have been described. Traditionally, "open" approaches, such as laminotomy with medial facetectomy and intertransverse discectomy, have been employed with positive clinical outcomes.[6,7] However, despite the reported successes, open approaches are not without their limitations. Laminotomy with medial facetectomy is limited by inadequate visualization of the far lateral compartment, while the intertransverse approach bears the risk for iatrogenic nerve injury during blunt dissection.[2] In contrast, minimally invasive approaches—including endoscopic, tubular, and microscopic repairs—may be employed with less tissue injury, thereby facilitating favorable clinical outcomes, reduced recovery time, and decreased overall health care utilization.[8–15]

Currently, there is no consensus regarding which approach constitutes the optimal technique. In part, this is a consequence of the limited number of studies directly comparing the open and endoscopic treatments of FLDH. Multiple reports among heterogenous lumbar disc herniation surgery populations have shown that, compared with open approaches, minimally invasive approaches are associated with shorter hospital stays, shorter operating time, less morbidity, less blood loss, and earlier return to work, with equivalent overall outcomes.[16–19] However, there exists a paucity of studies directly comparing open and minimally invasive approaches for the management of FLDH. We aim to fill this void by retrospectively reviewing our institutional experience with open and endoscopic (the minimally invasive approach utilized at our institution) FLDH repairs as they relate to adverse postsurgical events and perioperative resource utilization.

METHODS

Sample Selection

A total of 144 consecutive adult patients undergoing far lateral lumbar discectomies at a single, 1659-bed university health system in the United States over an 8-year period (2013–2020) were retrospectively enrolled. The institutional review board considered this study to be of minimal risk to patients and granted a waiver of informed consent. Patients were divided into cohorts based on procedural classification: "open" (n = 92) and "endoscopic" (n = 52). At our institution, open FLDH surgeries were performed by either an intertransverse approach or by laminotomy with medial facetectomy. All minimally invasive FLDH surgeries were performed via an endoscopic approach. Key patient characteristics and outcome data were extracted via EpiLog, a nonproprietary data acquisition software layered into the existing electronic medical record system to enable quality improvement and cost analysis projects.[20]

Primary postsurgical outcome variables included outpatient office visits within 30 days of the index FLDH repair as well as unplanned readmissions, reoperations, and emergency department (ED) visits within 30 and 90 days from the index operation. Primary resource utilization outcomes included total direct cost of the procedure (ie, the total cost of all surgical supplies and implants) and postoperative length of hospital stay. Secondary measures included discharge disposition, operative length, and duration of follow-up.

Statistical Methods

Categorical variables are reported as frequency (percentage), while continuous variables are reported with mean (SD). Patient characteristic variables and resource utilization outcomes were compared between the open and endoscopic cohorts using either χ^2 test (for categorical variables) or t test (for continuous variables). Logistic regression was executed via SAS version 9.4 (SAS Institute Inc., Cary, North Carolina) to evaluate the impact of procedural type (open vs endoscopic) on adverse postoperative outcomes, and odds ratios (OR) with 95% confidence intervals were reported to evaluate the increase/decrease in odds between procedural types. Significance for all analyses was defined as $P < 0.05$.

RESULTS

Patient Characteristics

Patients undergoing open FLDH operations were significantly younger than those undergoing endoscopic procedures (P = 0.039) and had undergone a fewer number of previous procedures ($P < 0.001$) (Table 1). No significant difference was observed between open and endoscopic cohorts for other patient characteristics, including gender, race, body mass index, and income.

Outcomes

No significant differences in adverse postoperative events—including unplanned hospital readmissions, repeat surgical interventions, or ED visits within either 30 or 90 days from the index operation—were observed (Table 2, Figure).

Patients who underwent open FLDH repair were significantly more likely to have outpatient neurosurgical office visits within 30 days of the index operation (OR = 0.40, P = 0.016).

Endoscopic FLDH operations were found to bear a significantly greater direct cost of surgery ($P < 0.001$) (Table 3). However, length of stay was longer following open procedures ($P < 0.001$). In addition, patients undergoing open FLDH surgery were more likely to stay in the hospital as inpatients had less favorable discharge dispositions, with lower rates of open patients discharged home with self-care. Operative length and duration of follow-up were both greater for open procedures than endoscopic procedures.

Table 1. Sociodemographic and health characteristics for patients who underwent surgery for far lateral lumbar disc herniation.

Variable	Open (n = 92; 63.9%)	Endoscopic (n = 52; 36.1%)	P Value
Gender, n (%)			
Men	51 (55.4%)	24 (46.2%)	0.28
Women	41 (44.6%)	28 (53.9%)	
Race, n (%)			
Black	6 (6.5%)	5 (9.6%)	0.74
White, non-Hispanic/Latino	81 (88.0%)	45 (86.5%)	
Hispanic/Latino	2 (2.2%)	0 (0%)	
All other	3 (3.3%)	2 (3.9%)	
Age, mean (SD)	60.24 (11.36)	64.35 (11.42)	**0.039**
Insurance type, n (%)			
Commercial	6 (6.5%)	4 (7.7%)	0.73
Medicare	33 (35.9%)	25 (48.1%)	
Medicaid	1 (1.1%)	1 (1.9%)	
Managed care	41 (44.6%)	18 (34.6%)	
Blue Cross	10 (1.1%)	4 (7.7%)	
Worker's compensation	1 (1.1%)	0 (0%)	
Body mass index, mean (SD)	28.37 (4.89)	28.71 (4.70)	0.68
Median household income, $, mean (SD)	78,807 (27,785)	77,356 (25,515)	0.76
Number of prior surgical interventions, mean (SD)			
Ever	0.73 (1.43)	1.56 (1.59)	**<0.001**
Within 30 d of the index operation	0.087 (0.32)	0.17 (0.38)	0.08

Note: Bolded values denote statistically significant difference ($P < 0.05$).

DISCUSSION

In this study, we present a comparison of postoperative outcomes and perioperative resource utilization among FLDH patients treated with either an open or endoscopic approach. Compared with open surgeries, endoscopic procedures were associated with shorter length of hospital stay, favorable discharge disposition, decreased surgical time, and fewer outpatient visits within 30 days of the index operation. These benefits occurred in the context of an increased direct cost of the procedure. Ultimately, no clear differences in adverse postoperative events were observed between the 2 procedure types. Our results are consistent with past comparisons demonstrating that both approaches are viable options, with similarly low incidence of adverse postoperative events.

Prior studies have shown that both endoscopic and open approaches represent safe and effective modalities for performing lumbar spine surgery to correct FLDH.[6,10,12,21] Lee et al demonstrated similar outcomes

Table 2. Postoperative outcomes for patients who underwent surgery for far lateral lumbar disc herniation.

Postoperative Outcomes	Open (n = 92)	Endoscopic (n = 52)	OR	P Value
Within 30 d of surgery				
Readmission				
Yes	4 (4.4%)	1 (1.9%)	0.57	0.56
No	88 (95.7%)	51 (98.1%)		
Reoperation				
Yes	2 (2.2%)	0 (0%)	0.35	0.50
No	90 (97.8%)	52 (100%)		
ED visit				
Yes	3 (3.3%)	3 (5.8%)	1.81	0.45
No	89 (96.7%)	49 (94.2%)		
Office visit				
Yes	42 (45.7%)	13 (25%)	0.40	**0.016**
No	50 (54.4%)	39 (75%)		
Within 30–90 d of surgery				
Readmission				
Yes	2 (2.2%)	1 (1.9%)	1.05	0.96
No	90 (97.8%)	51 (98.1%)		
Reoperation				
Yes	1 (1.1%)	1 (1.9%)	1.78	0.63
No	91 (98.9%)	51 (98.1%)		
ED visit				
Yes	2 (2.2%)	1 (1.9%)	1.05	0.96
No	90 (97.8%)	51 (98.1%)		

Abbreviation: ED, emergency department.
Note: OR <1 indicates the event is more likely for the open cohort. OR >1 indicates the event is more likely for the endoscopic cohort. Bolded values denote statistical significance ($P < 0.05$).

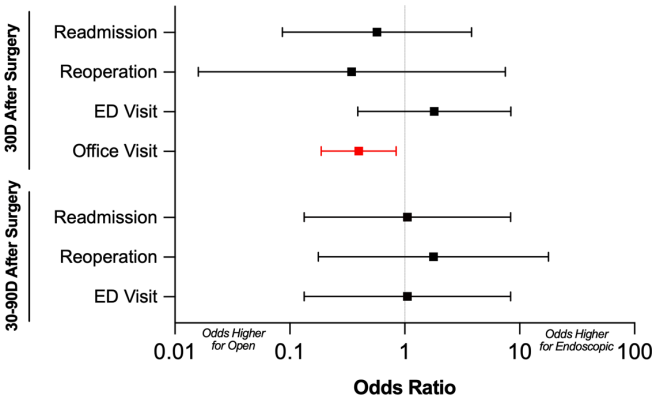

Figure. Odds ratios and 95% confidence intervals for postoperative outcomes in patients who underwent surgery for far lateral lumbar disc herniation. OR <1 indicates the event is more likely for the open cohort. OR >1 indicates the event is more likely for the endoscopic cohort. Red values denote statistical significance ($P < 0.05$). ED, emergency department.

in open and endoscopic approaches across all lumbar disc herniations.[16] Additionally, randomized controlled trials by Ruetten et al have directly compared lumbar discectomies performed via minimally invasive and open techniques; they observed that endoscopic operations had similar clinical endpoints as open surgeries but with an improved complication profile.[22,23] Furthermore, a meta-analysis by Akinduro et al found that a pooled group of minimally invasive FLDH procedures (tubular, endoscopic, and microscopic) was associated with shorter length of hospital stay and shorter surgical duration, with similar rates of surgical complications compared with open procedures.[24] The present study complements the existing literature, representing the first to directly compare open and endoscopic FLDH repairs at a single institution. Moving forward, additional randomized controlled research in FLDH-specific spine surgery populations is warranted.

Increased scar tissue may make open approaches more challenging, as dissection of scar tissue can induce a dural tear.[25,26] For patients with substantial scar tissue, endoscopic surgery for recurrent disc herniation has been employed with positive results. Hoogland et al demonstrated that 86% of patients undergoing endoscopic surgery for recurrent lumbar disc herniation reported excellent or good results at a 2-year follow-up.[25] Additionally, Hou et al reported that 96% of patients undergoing endoscopic discectomy for recurrent lumbar disc herniation achieved excellent or good results, with a 1- to 6-year follow-up period.[26] Taken together, patients with more prior surgeries may benefit greater from endoscopic FLDH repair. In our study, patients undergoing endoscopic treatment were observed to be older and underwent more prior surgeries than their open-procedure counterparts. However, the 2 cohorts did not demonstrate differences in the number of surgical procedures within 30 days of the index operation. An endoscopic approach affords multiple advantages for the medically frail, including decreased operative time, the option to eschew general anesthesia, and less invasive instrumentation, potentially explaining the observed findings. In any case, a patient's age and operative history should be taken into consideration during the perioperative patient counseling and decision-making regarding open vs endoscopic approach for surgery.

Key differences were observed in perioperative resource utilization between the open and endoscopic cohorts. Considering that endoscopic surgeries are less invasive, it is unsurprising that the endoscopic cohort had shorter length of stay, increased likelihood of outpatient status, and increased rates of discharge to home. Endoscopic surgery may be performed under local anesthesia and, by avoiding a blunt dissection, preserves local anatomy, including the lamina, facet joint, and the posterior ligament.[2,6,21] Moreover, endoscopic devices afford extremely precise maneuverability, which may further preserve local anatomy and aid postoperative recovery. Meta-analyses comparing open and endoscopic procedures for all lumbar discectomies have found that endoscopic approaches reduce

Table 3. Procedural outcomes for patients who underwent surgery for far lateral lumbar disc herniation.

Variable	Open ($n = 92$)	Endoscopic ($n = 52$)	P Value
Total direct cost of procedure, $, mean (SD)	684 (785)	1983 (438)	**<0.001**
Length of stay, h, mean (SD)	90.7 (208.9)	13.3 (27.9)	**<0.001**
Discharge disposition, *n* (%)			
Home or self-care (routine)	72 (80%)	49 (94.2%)	**0.031**
Skilled nursing facility	2 (2.2%)	0 (0%)	
Inpatient rehabilitation facility	0 (0%)	1 (1.9%)	
Discharge/transfer to home	6 (6.7%)	0 (0%)	
Home health care	10 (11.1%)	2 (3.9%)	
Patient class, *n* (%)			
Inpatient	45 (48.9%)	4 (7.7%)	**<0.001**
Outpatient	47 (51.1%)	48 (92.3%)	
Duration of surgery, min, mean (SD)	83.5 (42.6)	35.4 (13.5)	**<0.001**
Duration of follow-up, d, mean (SD)	949 (732)	506 (255)	**0.004**

Note: Bolded values denote statistically significant difference ($P < 0.05$).

complication rates and length of hospital stay.[14,17,27] Our study is the first to report these differences in postoperative recovery for FLDH.

While operating costs should not overshadow good clinical judgment at the surgeon-specific and patient-specific levels, cost containment is important to health care systems and is a factor in decision-making regarding operative technique. Here, endoscopic procedures for FLDH were associated with higher direct cost than open procedures. It should be noted that direct cost refers only to costs of performing the operation and does not include total costs inclusive of pre- and postoperative care. It remains possible that the reduction in hospital length of stay, higher likelihood of outpatient status, and increased rates of discharge home that were associated with endoscopic procedures would offset this difference in direct procedure cost. Further research should investigate the system-wide cost associated with either procedure type. Such work would be helpful to surgeons and administrators alike, as health systems increasingly rely on alternative payment methods such as bundled payments for surgical episodes.[28]

Limitations

Because this study is retrospective, it may be subject to potential data inaccuracies, incomplete medical records, and sampling bias. This study is also limited by its sample size of 144 patients. Prospective randomized studies are necessary to validate our study's conclusions. Furthermore, this study derives data from a single university-wide electronic medical record system; as such, ED visits, readmissions, and reoperations could have occurred at another health system, resulting in these outcomes being underreported. However, these patients had extensive postoperative follow-up (open: mean 949 days, endoscopic: mean 506 days), during which discrete data were captured in reference to all health care received, at each follow-up visit. As a result, it is unlikely that this limitation could have impacted the internal validity of this study in a significant manner.

Here, we aimed to capture outcomes following open and endoscopic discectomies across our broad population of FLDH surgery patients. In all patients, the disc fragments were lateral to the midpoint of the pedicle; however, the exact size and location of the lesions were not quantified. Furthermore, the present study did not intend to, and was not adequately powered to, evaluate the impact of radiographic features, presenting signs/symptoms, or surgeon experience on our primary endpoints. Prospective, larger-scale research is needed to assess the effect of these variables on outcomes and to corroborate our findings.

Finally, this study only considers the direct cost of the surgical procedure, including all surgical supplies and implants utilized during the procedure; total costs associated with surgical episodes are not reviewed. Future studies should aim to ascertain the difference in total cost accrued by these different surgical techniques, including acute and postacute care needs across the entire surgical episode.

CONCLUSION

Compared with open operations, endoscopic approaches to FLDH were associated with fewer short-term outpatient visits, shorter length of stay, outpatient status, higher discharge to home, shorter surgical duration, and higher direct cost. No clear differences in adverse postsurgical events were observed. While both procedure types represent viable treatment options for FLDH, endoscopic surgeries appear to achieve comparable clinical outcomes with decreased utilization of perioperative resources. Further research is necessary to validate these conclusions.

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Ethics Committee Approval: This study was approved by the institutional review board (IRB) at the University of Pennsylvania. IRB number for this study is: 844380. A waiver of informed consent was granted by the University of Pennsylvania IRB as this study was considered to be minimal risk to patients. All ethical guidelines and rules were followed to protect patient privacy.

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