Original Article

Lateral approach to the lumbar spine: The utility of an access surgeon

ABSTRACT

Background: Lateral lumbar interbody fusions (LLIFs) utilize a retroperitoneal approach that avoids the intraperitoneal organs and manipulation of the anterior vasculature encountered in anterior approaches to the lumbar spine. The approach was championed by spinal surgeons; however, general/vasculature surgeons may be more comfortable with the approach.

Objective: The objective of this study was to compare short-term outcomes following LLIF procedures based on whether a spine surgeon or access surgeon performed the approach.

Materials and Methods: We retrospectively identified all one- to two-level LLIFs at a tertiary care center from 2011 to 2021 for degenerative spine disease. Patients were divided into groups based on whether a spine surgeon or general surgeon performed the surgical approach. The electronic medical record was reviewed for hospital readmissions and complication rates.

Results: We identified 239 patients; of which 177 had approaches performed by spine surgeons and 62 by general surgeons. The spine surgeon group had fewer levels with posterior instrumentation (1.40 vs. 2.00; $P < 0.001$) and decompressed (0.94 vs. 1.25, $P = 0.046$); however, the two groups had a similar amount of two-level LLIFs (29.9% vs. 27.4%, $P = 0.831$). This spine surgeon approach group was found to have shorter surgeries (281 vs. 328 min, $P = 0.002$) and shorter hospital stays Length of Stay (LOS) (3.1 vs. 3.6 days, $P = 0.019$); however, these differences were largely attributed to the shorter posterior fusion construct. On regression analysis, there was no statistical difference in postoperative complication rates whether or not an access surgeon was utilized ($P = 0.226$).

Conclusion: Similar outcomes may be seen regardless of whether a spine or access surgeon performs the approach for an LLIF.

Keywords: Approach, complications, lateral lumbar interbody fusion, minimally invasive, outcomes

INTRODUCTION

With recent advances in lumbar fusion techniques, there is an increasing need for safe surgical access to the lumbar spine. Commonly, vascular or general surgeons have been involved as "access surgeons" for anterior approaches due to their expertise in the peritoneal space.[1-3] Access surgeons are most often utilized for a direct anterior approach (i.e., anterior lumbar interbody fusions [ALIFs]), in which there is a significant risk with mobilization of the great vessels as well as nonvascular complications like direct injury to the bowel or genitourinary structures.[3-8] Multiple studies have evaluated the incidence and types of complications in ALIF with and without the use of access surgeons.[4,9-12] Overall, there is varied support in the literature for general/vascular assistance

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with anterior-based approaches to the spine.[4,10,11,13-15] Other approaches to the spine utilize access surgeons less frequently but are not without their own risks. One such approach is the lateral lumbar interbody fusion (LLIF).

In contrast to the anterior approach where the spine is accessed by moving the intraperitoneal organs and iliac veins to gain access to the anterior lumbar spine, the lateral approach utilizes an entirely retroperitoneal approach and, thus, is associated with a decreased risk of vascular injury.[16-19] The approach was described and published by Ozgur *et al*. in the early 2000s as a less-invasive alternative to the conventional ALIF and was credited as a novel approach that could be safely performed without a general surgeon for access.[17,20] It allowed for interbody stabilization with indirect decompression while avoiding the major visceral/vascular risks encountered in the anterior approach to the spine.[21,22] In addition, compared to the posterior approach, LLIF offers a more extensive discectomy while enabling the preparation of a larger surface area within the disc space for intervertebral graft positioning and avoiding damage to the posterior structures.[23,24] The major structures at risk while performing an LLIF are neurologic, including the ilioinguinal and lateral femoral cutaneous nerves, as well as the femoral nerve, genitofemoral nerve, and lumbar plexus itself within the psoas musculature. This includes an estimated 4.8% risk of motor femoral nerve palsy after L4-L5 LLIFs.[18,25-30] Given the decreased risk to vascular and abdominal structures through the lateral approach, access surgeon utilization is less commonly employed.

In contrast to the anterior approach to the spine, there is sparse literature regarding access surgeon utilization and associated outcomes for LLIFs. The current study aimed to address these shortcomings by primarily evaluating postoperative complications and readmissions for patients undergoing an LLIF with and without the utilization of an access surgeon. Secondarily, we aim to compare inhospital opioid use, length of hospital stay (LOS), and surgical characteristics between groups.

MATERIALS AND METHODS

Following the Institutional Review Board Approval, we retrospectively conducted a structured query to identify all patients over 18 years of age who underwent an LLIF over 10 years from 2011 to 2021 by the current procedural terminology code 22558. All patients underwent surgical intervention at a single, tertiary urban academic center. Inclusion criteria consisted of those patients undergoing a single- or two-level LLIF. Patients who underwent surgery for nondegenerative pathologies, including trauma, infection, and malignancy were excluded. Additional exclusion criteria consisted of patients who received a concomitant interbody fusion through a different approach, prior anterior interbody fusion, and a >4 level concomitant posterior decompression or fusion. The L1-2 level was excluded due to the low sample number and anatomic proximity to the diaphragm. Patients were subsequently stratified into those who underwent LLIF with the utilization of an access surgeon and those who had a spine surgeon perform the entire surgery. Demographic data and patient characteristics were obtained and analyzed through chart review consisting of patient age, sex, race, ethnicity, body mass index (BMI), Charlson Comorbidity Index, and medical comorbidities like diabetes. Surgical information gathered included procedure (LLIF), anatomic location, operative duration, and utilization of access surgeon. Operative duration was calculated as the time in minutes from incision to closure. Additional surgical information analyzed included reported surgical blood loss in mL, utilization of intraoperative blood salvage (cell saver), and need for postoperative blood transfusion. Notably, all LLIFs performed at our institution regardless of the surgeon are performed initially in the lateral decubitus position for interbody cage insertion. Subsequently, the patient is placed prone for posterior fixation.

Cohorts were primarily analyzed for differences in 90-day complications, additional surgeries, and hospital readmissions. Postoperative data were gathered through chart review and encompassed 90 days postoperatively as defined by the Centers for Medicare and Medicaid Services for major procedures. Complications were recorded if they required medical/surgical intervention (Clavien–Dindo grade III and IV) and/or were approach related. Secondarily, patients were evaluated for the duration of surgery, LOS, and inhospital morphine milliequivalents (MMEs) utilized postoperatively.

Data were compared using the independent *t*-tests or Mann–Whitney tests for continuous variables and Chi-squared or Fisher's exact tests for categorical variables. Multivariable regression analysis was performed to identify factors independently associated with postoperative complications, LOS, operative duration, and estimated blood loss (EBL) after an LLIF. $P < 0.05$ was deemed significant, and all statistical analyses were done using RStudio (version 4.1.2, Vienna, Austria).

RESULTS

Demographic information

In total, 1536 patients were identified by our query, and 239 unique patients undergoing LLIF were identified following operative note review with the remainder of patients having undergone an ALIF. One hundred and seventy-seven (74.1%) patients underwent an LLIF without the utilization of an access surgeon, while the remaining 62 (25.9%) patients underwent an LLIF with an access surgeon. Patients who underwent LLIF with the orthopedic surgeon alone were significantly older compared to those in which an access surgeon was involved (63.9 ± 9.03 vs. 60.5 ± 10.7, $P = 0.016$). There were no significant differences in medical comorbidities such as BMI (30.4 ± 6.07 vs. 30.1 ± 6.41, $P = 0.658$), Charlson Comorbidity Index (2.77 ± 1.81 vs. 2.37 ± 1.45, $P = 0.191$), or presence of diabetes (25.4% vs. 16.1%, $P = 0.186$) between the two groups [Table 1]. In addition, there was no significant difference in other demographic characteristics such as sex, race, or ethnicity between the two groups.

Table 1: Demographics

	Spine surgeon (n=177), n (%)	Access surgeon (n=62), n (%)	P
Age	63.9 (9.93)	60.5 (10.7)	0.016
Sex			
Female	91 (51.4)	37 (59.7)	0.330
Male	86 (48.6)	25 (40.3)	
Race			
White	149 (84.2)	56 (90.3)	0.088
Black	21 (11.9)	2 (3.23)	
Other	7 (3.95)	4 (6.45)	
Ethnicity			
Non-Hispanic	173 (97.7)	59 (95.2)	0.380
Hispanic	4 (2.26)	3 (4.84)	
BMI	30.4 (6.07)	30.1 (6.41)	0.658
CCI	2.77 (1.81)	2.37 (1.45)	0.191
Diabetes			
No	132 (74.6)	52 (83.9)	0.186
Yes	45 (25.4)	10 (16.1)	

Bolded text signifies a significant P (<0.05). BMI - Body mass index; CCI - Charlson Comorbidity Index

Surgical data

There were no significant differences in the number of levels fused with lateral interbody cages ($P = 0.831$) between the two cohorts [Table 2]. However, there was a significant difference in the number of levels decompressed and fused posteriorly with the spine surgeon group averaging less levels decompressed (0.94 ± 1.05 vs. 1.24 ± 1.13, $P = 0.046$) and fused (1.40 ± 0.97 vs. 2.00 ± 1.16, $P < 0.001$). In addition, the operative duration was significantly longer in the access surgeon group by an average of 47 min (328 ± 101 vs. 281 ± 110, $P = 0.002$). EBL was significantly higher in operative cases where an access surgeon was utilized (456 ± 484 mL vs. 285 ± 358 mL, $P < 0.001$). This did not result in a significant difference in the need for postoperative transfusion (8.70% vs. 3.48%, $P = 0.227$); however, there was an increased utilization of intraoperative cell salvage in patients in the access surgeon group (56.5% vs. 20.9%, $P < 0.001$).

Inhospital course

The length of hospital stay was significantly different between the cohorts with the access surgeon cohort having a longer LOS (3.59 ± 1.62 days vs. 3.13 ± 1.92 days, $P = 0.019$). Postoperative inhospital narcotic consumption was lower in patients who had a spine surgeon perform the entire procedure (238 ± 183 MME vs. 334 ± 197 MME, $P = 0.001$). However, this difference was not significant when adjusted for LOS (81.3 MME/day vs. 99.1 MME/day, $P = 0.157$) [Table 3].

Postoperative data

During the 90-day postoperative period, there were no differences in patients requiring additional surgery (2.26% vs. 4.84%, $P = 0.380$) or readmissions among the two groups (2.82% vs. 4.84% $P = 0.431$). Additional surgeries included four incision and drainage procedures, one revision decompression, one interbody removal, and one additional posterior fusion for spondylolisthesis. The

Table 2: Surgical information

	Spine surgeon (n=177), n (%)	Access surgeon (n=62), n (%)	P
Number of levels of LLIF			
1	124 (70.1)	45 (72.6)	0.831
2	53 (29.9)	17 (27.4)	
Number of levels fused posteriorly	1.40 (0.97)	2.00 (1.16)	**<0.001**
Number of levels decompressed	0.94 (1.05)	1.24 (1.13)	**0.046**
Operative duration (min)	281 (110)	328 (101)	**0.002**
EBL (mL)	285 (358)	456 (484)	**<0.001**
Transfusion			
No	111 (96.5)	42 (91.3)	0.227
Yes	4 (3.48)	4 (8.70)	
Cell saver			
No	91 (79.1)	20 (43.5)	**<0.001**
Yes	24 (20.9)	26 (56.5)	

Bolded text signifies a significant P (<0.05). LLIF - Lateral lumbar interbody fusion; EBL - Estimated blood loss spine surgeon approach group had a lower postoperative complication rate (5.08% vs. 12.9%, $P = 0.048$). Postoperative complications included one death, three infections, seven visits to the emergency department (six for pain control and one for postoperative hypotension), two acute kidney injuries, one interbody dislodgement, one ileus, and one deep venous thrombosis. One patient experienced both an acute kidney injury and a deep venous thrombosis postoperatively [Table 4].

Multivariate regression analysis

The presence of an access surgeon was not associated with postoperative complications (odds ratio [OR]: 1.97; confidence interval [CI]: 0.64–5.92; $P = 0.226$), LOS (effect size: 0.25, CI:-0.26–0.75, $P = 0.338$), operative duration (effect size: 14, CI:-16–45, $P = 0.362$), or EBL (effect size: 40, CI:-76–156, $P = 0.503$). Patients with longer fusion constructs posteriorly were independently more likely to have a postoperative complication (OR = 1.92; CI = 1.18–3.15; $P = 0.008$), increased LOS (effect size: 0.39, CI: 0.16–0.62, $P = 0.001$), increased operative duration (effect size: 58, CI: 44–76, $P < 0.001$), and more EBL (effect size: 206, CI: 154–257, $P < 0.001$). The number of levels decompressed posteriorly was also independently associated with increased operative duration (effect size: 25, CI: 12–38, $P < 0.001$) and increased EBL (effect size: 51, CI: 2–100, $P = 0.043$), but not postoperative complications ($P = 0.543$) or LOS ($P = 0.296$) [Table 5].

Table 3: Inhospital course

	Spine surgeon (*n*=177)	Access surgeon (*n*=62)	*P*
Length of stay	3.13 (1.92)	3.59 (1.62)	**0.019**
MME in hospital	238 (183)	334 (197)	**0.001**
MME/day	81.3 (45.1)	99.1 (60.6)	0.157

Bolded text signifies a significant *P* (<0.05). MME - Morphine milliequivalent

Table 4: 90-day postoperative complications

	Spine surgeon (*n*=177), *n* (%)	Access surgeon (*n*=62), *n* (%)	*P*
Additional surgery			
No	173 (97.7)	59 (95.2)	0.380
Yes	4 (2.26)	3 (4.84)	
Chest tube			
No	177 (100)	61 (98.4)	0.259
Yes	0	1 (1.61)	
Readmission			
No	172 (97.2)	59 (95.2)	0.431
Yes	5 (2.82)	3 (4.84)	
Complication			
No	168 (94.9)	54 (87.1)	**0.048**
Yes	9 (5.08)	8 (12.9)	

Bolded text signifies a significant *P* (<0.05)

DISCUSSION

Previous literature regarding the utility of access surgeons has focused on the anterior approach to the lumbar spine. The risk profile of LLIF is significantly different from other lumbar spine surgical approaches and as such, understanding the utility of a spinal access surgeon cannot be gleaned from the data on other approaches to the anterior lumbar spine. We report in 239 patients that the use of an access surgeon does not impact inhospital or postoperative outcomes for patients undergoing LLIFs.

Although the lateral approach to the lumbar spine has demonstrated certain benefits compared to the traditional posterior approach, it also comes with its own set of unique risks. Studies have suggested that the lateral approach to the lumbar spine for fusion can shorten the LOS, reduce intraoperative blood loss, and decrease the risk of vascular/nerve injury.[17,23,31,32] However, a significant risk with the lateral approach is the potential morbidity associated with dissection about the psoas musculature that can result in postoperative hip flexion pain or femoral nerve palsy.[30,33,34] More specifically, when utilizing the lateral approach, there is an increased risk to vital neurologic structures, including the lumbar plexus and lumbar nerve roots.[35] As the surgeon moves from cranial to caudal (i.e., L1-2 to L4-5), the psoas musculature and the intimately related lumbar plexus follow a more ventral trajectory posing an increasingly greater risk of injury.[30] To mitigate the risk of lumbar plexus injury, intraoperative neuromonitoring is commonly utilized. Despite this, the rates of sensory deficit in the form of anterior thigh numbness and motor weakness (decreased hip flexion strength) are reported in 9.6% and 3.2% of patients, respectively, after an 18-month follow-up from LLIF.[36]

Table 5: Multivariate regression analysis

Variable	Postoperative complications			Length of stay			Operative duration			EBL		
	OR	CI	*P*	Effect size	CI	*P*	Effect size	CI	*P*	Effect size	CI	*P*
Access surgeon	1.97	0.64–5.92	0.226	0.25	−0.26–0.76	0.338	14	−16–45	0.362	40	−76–156	0.503
Levels fused posteriorly	1.92	1.18–3.15	**0.008**	0.39	0.16–0.62	**0.001**	58	44–76	**<0.001**	206	154–257	**<0.001**
Levels decompressed posteriorly	1.16	0.70–1.86	0.543	0.11	−0.10–0.33	0.296	25	12–38	**<0.001**	51	2–100	**0.043**

Length of stay is represented by days, length of surgery is represented by minutes, and EBL is represented by mm. Bolded text signifies a significant *P* (<0.05). OR - Odds ratio; CI - Confidence interval; EBL - Estimated blood loss

In addition to anterior thigh numbness and decreased hip flexion strength, the lateral approach can also affect other vital abdominal structures. One of the major goals in the development of the lateral approach to the lumbar spine was to mitigate risk to vascular structures that are commonly encountered during the anterior approach to the lumbar spine. A recent meta-analysis demonstrated the rates of aortic injury and common iliac lacerations during LLIF to be 0.12% and 0.25%, respectively.[37] This contrasts the published rates of vascular injury associated with ALIF, which range from 1.9% to 24%.[2,5,7] The decreased rate of vascular injury reported in LLIF can be partially attributed to the lateral positioning utilized, which results in the critical vascular structures moving away from the surgical corridor.[38] Despite the overall decreased risk of vascular injury reported during LLIF, if it does occur, repairing it may be difficult due to the patient's lateral decubitus position.[38-41] Other approach-related complications associated with the lateral approach include bowel injuries, ureteral injuries, and seromas.[21] Although the retroperitoneal anatomy is not one that spine surgeons often encounter, we found no difference in approach-related complications, such as the instances of bowel, vascular, or ureteral injury. Thus, the addition of an access surgeon does not appear to change outcomes when performing the retroperitoneal approach of an LLIF.

However, like most novel orthopedic procedures, there is a learning curve to perform LLIF that must be considered. In one study, it was shown that complications such as iliopsoas and quadriceps weakness decrease as surgeons obtain more experience with the surgery.[42] Other studies have echoed this sentiment stating that disadvantages of the LLIF include the learning curve associated with new surgical techniques and the involvement of a regional anatomy unfamiliar to most spine surgeons.[30] Multiple recent studies have shown a temporally related decrease in postoperative neurologic complications with increased time performing LLIFs. One such study demonstrated a proportional trend for decreasing anterior thigh pain over 6 years.[43] Similarly, Le *et al*. observed a learning curve with a reduction in the incidence of postoperative thigh numbness during 3 years of performing LLIF (from 26.1% to 10.7%).[44] However, given that the approach has been utilized for over 20 years and there has been an exponential rise in its utilization and incorporation into training programs, spine surgeon exposure and level of comfort with this approach are likely improving.

Several of the secondary outcomes in this study were found to be significantly different between the two groups; however, these were likely due to confounding factors. The operative duration in the access surgeon group was nearly one hour longer with a statistically significant difference of 47 min/case (281.0 vs. 328.0 min, $P = 0.002$). This difference is likely attributed to larger surgeries performed in the access surgeon group, and this hypothesis is supported by our regression analysis suggesting that each additional level fused and decompressed posteriorly was associated with an increase in the procedure length by over one hour. Importantly, complications after surgical intervention of the spine directly correlate with operative duration. Regarding LLIFs, Bendersky *et al*. previously recommended that psoas retraction be limited to 20–30 min per operative level.[23,29] Specifically, they noted that a retraction time less than this decreased postoperative neurologic complications. Ultimately, the effect an access surgeon has on operative duration has yet to be fully elucidated in the literature; however, our study suggests that their impact is negligible for LLIFs.[45] Similarly, EBL was shown to be significantly greater with an access surgeon (285 mL vs. 456 mL, $P < 0.001$); however, the most likely reason for this difference is in the greater number of levels fused and decompressed posteriorly in the access surgeon cohort as seen on multiple regression. Another explanation for this significant difference is that "cell saver" or intraoperative cell salvage was more likely to be used in cases with an access surgeon. Therefore, there were more objective data to estimate intraoperative blood loss compared to operative cases where a cell saver was not used. However, most importantly, despite the greater reported blood loss in the access surgeon cohort, this did not result in a significant difference in transfusion rates between the two groups.

Although we found that postoperative LOS may be longer in the access surgeon group, this may also be due to confounding factors. Postoperative LOS was significantly longer by 0.5 days in the access surgeon group (3.1 days vs. 3.6 days; $P = 0.019$). However, the utilization of an access surgeon was not independently associated with increased LOS on regression analysis. Our LOS is consistent with other studies, which report similar lengths of hospital stay following an LLIF (3.16 days for inpatient cases and 3.3 days for cases that include a posterior spinal fusion).[46,47] Moreover, although we found that patients with access surgeons consumed a greater number of MMEs (238 vs. 334 MME; $P = 0.001$) during their hospital stay, when examining the MME/day, the amounts were not statistically different (81.3 vs. 99.1 MME/day; $P = 0.157$).

This study is not without limitations. First, it is retrospective in nature and has inherent weaknesses due to this method of evaluation with incomplete/incorrect documentation and unknown selection bias in potentially missed patients. In addition, this study incorporated several spine surgeons with extensive experience performing LLIF. All spine surgeons performing these operations had undergone training in the lateral approach and completed a spinal surgery fellowship. As such, this cohort may not be generalizable to a cohort of surgeons with less experience. In addition, all spinal surgeons at our institution perform the lateral approach in the lateral decubitus position and then transition to a prone position for posterior instrumentation. The results of this study may not be generalizable to surgeons who do not transition to a prone position for the latter portion of the surgical intervention. Moreover, the differences in the baseline and surgical characteristics between the two groups confound the results on short-term outcomes. We attempt to control for this difference with a multivariate regression analysis; however, the size of the cohort limits the number of variables that can be controlled for through this analysis.

CONCLUSION

To date, there is limited evaluation on whether an access surgeon is beneficial when performing a lateral lumbar approach to the spine for LLIF. Our study demonstrates that similar results may be obtained with and without utilizing an access surgeon with the lateral approach to the lumbar spine for LLIF procedures. This study supports the notion that lateral access surgery to the lumbar spine can be performed safely by spinal surgeons and access surgeons. Further study is needed to understand the utility of access surgeons in revision cases and its potential benefit.

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