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Dynamic Posture-Related Preoperative Pain as a Single Clinical Criterion in Patient Selection for Extreme Lateral Interbody Fusion Without Direct Decompression

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Abstract

Study Design: Prospective cohort study.

Objectives: Evidence on predicting the success of indirect decompression via extreme lateral interbody fusion (XLIF) is scarce. The authors investigated if patients who could achieve a pain-free position preoperatively would derive clinical benefit from XLIF without direct decompression.

Methods: Data from 50 consecutive patients who underwent XLIF with and without direct decompression by a single surgeon from January 2014 to August 2017 was collected. Primary outcome is the rate of failure of patients who underwent XLIF without direct decompression, characterized by persistence of pain postoperatively that required reoperations within 6 months postoperatively. Secondary outcomes are clinical outcomes and patient-reported quality of life outcome data, including visual analogue scale for leg (VASL) and back (VASB) pain, Oswetry Disability Index (ODI), and Physical Component Score (PCS) and Mental Component Score (MCS) of SF-12, for up to 2 years postoperatively.

Results: One patient with preoperative dynamic posture-related pain who underwent XLIF without direct decompression subsequently had a reoperation due to persisting pain. Statistically significant improvement was achieved across all patient reported outcomes ($P < .05$): improvement of 68% for VASL, 61% for VASB, 50% for ODI, 33% for PCS, and 11% for MCS of SF-12 at last follow-up. Six patients had thigh symptoms that resolved.

Conclusion: The simple clinical criterion based on postural pain status preoperatively may help clinicians in patient selection for indirect decompression of XLIF without the need for direct decompression. Further studies with larger cohorts are warranted to establish the validity of the algorithm.

Keywords

back pain, lumbar interbody fusion, radiculopathy, spinal decompression, spondylolisthesis, extreme lateral interbody fusion, XLIF

Introduction

Conventionally, when stabilization has been indicated for degenerative lumbar spinal conditions, patients were offered posterior open decompressive surgery with instrumented fusion. However, this requires extensive dissection of paraspinal musculature and supporting ligamentous structures and may require prolonged recovery.[1] Minimally invasive approaches for instrumented fusion have been gaining momentum in recent years as alternatives to traditional open posterior

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approaches, with the aim of minimizing surgical trauma, blood loss, dural tears, and reduced hospital stay.[2] One such approach, extreme lateral interbody fusion (XLIF; NuVasive Inc, San Diego, CA), first described by Ozgur, is gaining favor due to less overall complications compared with other fusion techniques while achieving favorable clinical and radiological outcomes.[3-6]

The mechanics of XLIF seek to restore foraminal and disc height, thus indirectly decompressing neural elements and relieving patients of their neurogenic claudication or radiculopathy. A lateral transpsoas approach to insert an interbody cage implant spanning the large surface area of dense apophyseal ring promotes strong support and fusion while preserving the posterior elements. Due to the direct lateral access to the disc space, a much larger cage footprint is used compared with the smaller cages that must be used when circumventing the neural elements via a posterior approach. This approach has been associated with shorter recovery time and lower blood loss and infection rates.[3,6] Due to the intimate relationship of the psoas muscle in this approach, most common complications are thigh-related symptoms (including anterior thigh pain, numbness or paresthesia, or weakness), reported to range between 4% and 31%.[3,6-9]

However, indirect decompression is not always sufficient and direct decompression is required in some cases.[7,8] Returning patients for a delayed decompression procedure require an additional anesthetic and perioperative risk, and cost for the additional hospital admission and length of stay. A method for predicting, a priori, that an indirect decompression will be successful would be invaluable.

There is a paucity of studies in the current literature that can guide spine surgeons in selecting patient groups that would benefit most from indirect decompression via XLIF alone. The studies that exist generally rely on various radiological factors, such as locked facets, severe central canal stenosis, or osteoporosis, as predictors of indirect decompression failure.[8-13]

Neurogenic claudication symptoms are typically posture-related; symptoms are aggravated when the spine is extended (in upright stance) but eased when spine is flexed (sitting or lying supine).[14] The theory behind the syndrome is that the exacerbation results from dynamic stenosis, such as in degenerative spondylolisthesis, which causes posture-related compression. Typically, patients experience relief by spine flexion, when there is indirect decompression of the neural elements at the stenotic motion segment.

We hypothesize that patients with stenosis who are able to achieve a pain-free position preoperatively would achieve the clinical benefit by indirect decompression from XLIF, while those who are unable to achieve a pain-free position would require a planned single-stage XLIF and supplementary direct decompression. The XLIF would stabilize the segment and the patient would remain pain free irrespective of postoperative posture.

The aim of this study is to assess this hypothesis in our series of patients who underwent XLIF, particularly focusing on early postoperative outcomes and the rate of delayed supplemental decompressive surgery.

Methods

Study Design

After approval from the institutional review board, prospective cohort data was collected from 50 consecutive patients who underwent XLIF by a single surgeon (senior author) from January 2014 to August 2017. The indications for XLIF surgery are single or multilevel lumbar degenerative diseases that are symptomatic with neurogenic claudication who have failed at least 6 weeks of conservative measures including physical therapy, analgesics, and epidural injections.

Patient Sample and Selection

After failing medical treatment, patients with radiologically confirmed lumbar spinal pathologies requiring XLIF were carefully reviewed by the senior author for posture-related symptomatology: if patients with neurogenic claudication or radicular leg pain were able to achieve relief by sitting or lying, XLIF without posterior decompressive surgery was offered; XLIF with planned posterior decompressive surgery, under the same anesthetic, was offered to patients who had persisting pain despite change in posture. Patients with other preexisting neurological conditions such as arachnoiditis that may contribute to the lower extremity symptoms are excluded from the study: there was one such patient.

With patients' consent, baseline patient demographic, comorbidities, surgical indication, previous surgery, ability to achieve pain-free position, treatment details (XLIF with or without posterior decompression; supplemental lateral or posterior fixation), complications including revision surgery, and clinical outcome data were collected.

Outcomes

The primary outcome of this study was further unplanned revision surgery at index level less within 6 months post-XLIF. Secondary outcomes included patient-reported outcomes including visual analog scale for leg (VASL) and back (VASB) pain, disability scores via Oswestry Disability Index (ODI), quality of life scores with SF-12 Physical and Mental Component Scores (PCS and MCS) were collected preoperatively and subsequently at standard postoperative time points through at least 6 months of follow-up (up to 1 year postoperatively). Patient-reported outcomes were collected via electronic surveys completed by patients using the survey function on Redcap (Research Electronic Data capture) electronic data capture tools (Vanderbilt University) or phone surveys in patients with no electronic access.[15] Operative data, postoperative symptoms, and complication data were also collected. In our study, patients who failed indirect decompression and required an

Table 1. Data of Baseline Demographic, Inpatient Admission, and Discharge Destination.

Baseline Data of Total Cases, N = 50	Indirect Decompression via XLIF, n = 42	XLIF and Direct Decompression, n = 8
Age, mean (range)	64 (36-80)	66 (38-82)
Female, n (%)	25 (60%)	4 (50%)
Private sector (n = 29), n (%)	25 (60%)	4 (50%)
Mean hospital stay in days (range)	3 (1-6)	6 (3-14)
Discharge destinations to rehabilitation facility, n (%)	11 (26%)	3 (38%)

Abbreviation: XLIF, extreme lateral interbody fusion.

additional second-stage posterior decompressive surgery were those with minimal subjective or objective improvement (ie, debilitating/persisting radicular leg pain postoperatively or less than 20% improvement in VAS) within 6 months post-XLIF.

Surgical Technique

The XLIF procedure is a mini-open, 90-degree off-midline, retroperitoneal transpsoas approach for disc space access with the patient in the lateral decubitus position.[6] Under fluoroscopic guidance, an off-midline incision was made with subsequent serial dilation over the disk space through a retroperitoneal approach. Exposure was achieved with an expandable split-blade retractor, with blunt dissection through psoas muscle by the dilator under intraoperative neuromonitoring guidance throughout. Once the desired intervertebral disc was identified, diskectomy and annulotomy were performed with rongeurs followed by end plate preparation and graft implantation. Supplemental internal fixation was applied at the surgeon's discretion and under the same anesthetic. Direct decompression was performed for patient groups who could not achieve any pain-free position at baseline.

Statistical Analyses

T tests and χ^2/Fisher exact tests were performed using GraphPad Prism 7.00 (GraphPad Software, La Jolla, CA; www.graphpad.com) to determine changes from pre- to postoperative clinical outcome scores, and differences between XLIF alone and XLIF with direct decompression group. A univariate logistic regression was conducted, and we reported the adjusted odds or hazard ratios and their subsequent 95% confidence intervals. Level of statistical significance was defined at $P < .05$.

Results

Patient demographics, baseline characteristics, radiographic features, and treatment indication are included in Tables 1 and 2.

All patients were followed-up in clinical reviews and complication, morbidity, and reoperation data collected. During the study period, 50 patients were treated at total of 66 spinal levels, including 37 single-level cases and 11 double-level cases: 42 with indirect decompression via XLIF and 8 with XLIF and direct decompression. Twenty-five patients from the former group and 4 patients from the latter group were treated in private sector and their patient reported outcomes (VAS for

Table 2. Clinical, Operative, and Radiological Data.

Data of Total Cases, N = 50	Indirect Decompression via XLIF, n = 42	XLIF and Direct Decompression, n = 8	Odds Ratio	95% Confidence Interval	*P*
Comorbidities					
Rheumatoid arthritis	4 (10%)	1 (13%)	1.36	0.13-14.01	.8
Diabetes	3 (7%)	1 (13%)	1.86	0.17-20.51	.61
Smoker	7 (17%)	0 (0%)	NA	NA	.8
Surgical factors					
Previous surgery	10 (24%)	4 (50%)	3.2	0.67-15.19	.13
Single level	34 (81%)	2 (25%)	0.08	0.01-0.46	.001
Supplemental fixation					
Screws	31 (74%)	7 (88%)	2.48	0.27-22.53	.41
Plate	7 (17%)	1 (13%)	0.71	0.08-6.76	.77
Standalone	5 (12%)	0 (0%)	NA	NA	.58
Indications					
Spondylolisthesis	28 (67%)	3 (38%)	0.3	0.06-1.44	.12
Adjacent segment disease	4 (10%)	1 (13%)	1.36	0.13-14.02	.80
Scoliosis	9 (21%)	4 (50%)	3.67	0.76-17.62	.091
Foraminal stenosis	15 (36%)	1 (13%)	0.26	0.03-2.29	.20
Sagittal imbalance	0 (0%)	1 (13%)	NA	NA	.16
Radiological factors					
Locked facets	4 (10%)	2 (25%)	3.17	0.47-21.24	.22
Severe central canal/lateral recess stenosis	19 (45%)	3 (38%)	0.73	0.15-3.44	.69

Abbreviations: XLIF, extreme lateral interbody fusion; NA, not available.

Table 3. Patient-Reported Outcome Scores of All Patients With Follow-up Surveys (n = 29).

	All Patients (n = 29)						
	Preoperative Mean Score ± SD	3-Month Postoperative Mean Score ± SD	Change From Preoperative to 3 months ± SE	*P*	Last Follow-up[a] Mean Score ± SD	Change From Preoperative to Last Follow-up	*P*
VASL	7.9 ± 1.7	2.3 ± 0.5	−5.6 ± 2.8	<.0001	2.5 ± 2.8	−5.4 ± 3.0	<.0001
VASB	7.7 ± 2.3	3.2 ± 2.2	−4.4 ± 2.8	<.0001	3.0 ± 2.7	−4.7 ± 3.0	<.0001
ODI	24.3 ± 7.1	14.0 ± 9.6	−10.4 ± 9.6	<.0001	12.1 ± 8.3	−12.2 ± 8.3	<.0001
PCS	32.3 ± 7.4	42.0 ± 8.8	9.7 ± 8.3	<.0001	43.0 ± 9.7	10.8 ± 9.0	<.0001
MCS	46.0 ± 9.1	50.9 ± 7.6	4.9 ± 9.2	.0076	51.2 ± 7.5	5.3 ± 7.2	.0005

Abbreviations: VASL, visual analogue scale for worst leg pain; VASB, visual analogue scale for back pain; ODI, Oswestry Disability Index; PCS, Physical Component Score of SF-12; MCS, Mental Component Score of SF-12; SD, standard deviation.
[a]Last follow-up refers to the most recent outcome data for the patient (range = 6-24 months).

Table 4. Patient-Reported Outcome Scores of Patients Who Underwent Indirect Decompression XLIF Alone With Follow-up Surveys (n = 25)

	XLIF Alone (n = 25)						
	Preoperative Score ± SD	3-Month Postoperative Mean Score ± SD	Change From Preoperative to 3 Months ± SD	*P*	Last Follow-up Mean[a] Score ± SD	Change From Preoperative to Last Follow-up	*P*
VASL	7.9 ± 1.7	2.2 ± 2.5	−5.7 ± 2.9	<.0001	2.4 ± 2.8	−5.5 ± 3.2	<.0001
VASB	7.5 ± 2.4	3.1 ± 2.2	−4.4 ± 2.9	<.0001	2.9 ± 2.8	−4.6 ± 3.1	<.0001
ODI	24.3 ± 7.2	13.4 ± 8.9	−11.0 ± 9.9	<.0001	12.1 ± 8.6	−12.2 ± 8.5	<.0001
PCS	32.5 ± 7.5	42.3 ± 9.3	9.8 ± 8.2	<.0001	42.9 ± 10.3	10.4 ± 9.3	<.0001
MCS	46.0 ± 8.8	50.5 ± 7.9	4.5 ± 8.3	.0126	50.9 ± 7.8	4.9 ± 7.2	.0022

Abbreviations: VASL, visual analogue scale for worst leg pain; VASB, visual analogue scale for back pain; ODI, Oswestry Disability Index; PCS, Physical Component Score of SF-12; MCS, Mental Component Score of SF-12; SD, standard deviation.
[a]Last follow up refers to the most recent outcome data for the patient (range = 6-24 months).

leg and back pain, ODI, PCS, MCS) were prospectively collected via follow-up surveys on Redcap. There was a significant higher rate of single-level surgery in the group of patients with indirect decompression via XLIF; however, no patients who had multilevel surgery required subsequent decompression. Thirteen patients had spinal surgeries to the lumbar region prior to XLIF (Table 2). The most common level treated was L4-L5 level. Hospital length of stay is significantly longer in patients with XLIF and direct decompressive procedure at an average of 6 days (range of 3-14 days) compared with 3 days (range of 1-6 days; $P < .0001$) among patients who had XLIF without direct decompression. Fourteen patients were discharged to rehabilitation facilities while the others were discharged home following their hospital inpatient stays.

Out of all 42 patients who underwent XLIF without direct decompression, one patient required revision, while none of the 8 patients who underwent XLIF and direct decompressive procedures required a revision procedure. A summary of clinical results in terms of all patient-reported outcomes is provided in Tables 3 and 4 and Figures 1 to 3. All 29 patients with data available for patient-reported outcomes, when compared with baseline, experienced statistically significant improvement in all clinical measures (VASL, VASB, ODI, PCS, MCS) with $P < .05$ at 3 months and at last follow-up (Table 3). From preoperative to last follow up, average worst leg pain improved by 68% from 7.9/10 to 2.5/10 ($P < .0001$), while back pain improved by 61% from 7.7/10 to 3.0/10 ($P < .0001$). Mean disability based on ODI also had a significant reduction from baseline of 24.3% to 12.1% with a 50% improvement ($P < .0001$). In terms of quality-of-life outcome measures, based on SF-12, on average, PCS improved from 32.3 to 43.0 at last follow up (33% improvement; $P < .0001$) and MCS from 46.0 to 51.2 at last follow up (11% improvement; $P = .0005$). Statistically significant improvement is also seen in the patient-reported outcomes in those who had XLIF without direct decompressive procedures, with $P < .0001$ for all patient-reported measures (VASL and VASV, ODI, and PCS) at all follow-up time points except for MCS, with $P = .0126$ at 3 months and $P = .0022$ at last follow-up (Table 4).

The one patient who required a reoperation was a 70-year-old female with rheumatoid arthritis and prior lumbar laminectomy surgery 22 years ago in another institution, who presented with right-sided neurogenic claudication (VASL 9/10; VASB 8/10) for over 6 months. There were no neurological deficits on examination. This was due to an unstable degenerative spondylolisthesis and right bony foraminal stenosis. The patient underwent an L4/L5 XLIF. The patient improved for a few weeks, but represented with a recurrent right L4 radiculopathy,

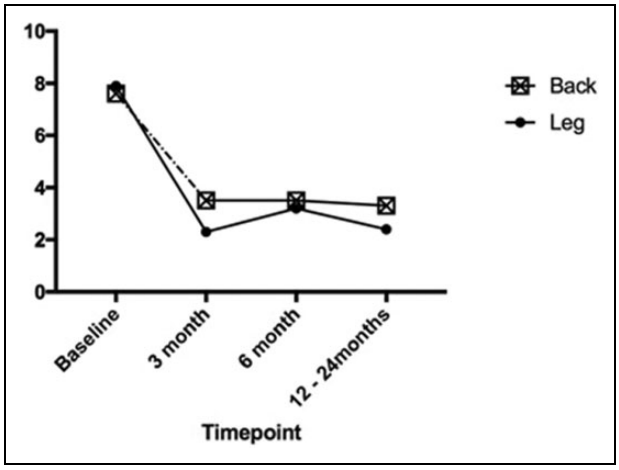

Figure 1. Mean Visual Analogue Score (VAS) of worst leg pain and worst back pain.

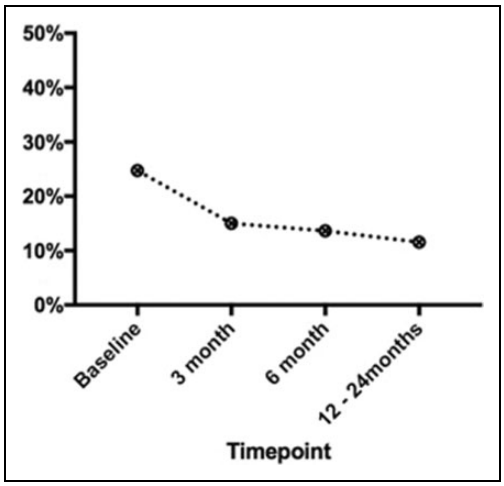

Figure 2. Mean Oswestry Disability Index (ODI) of patients.

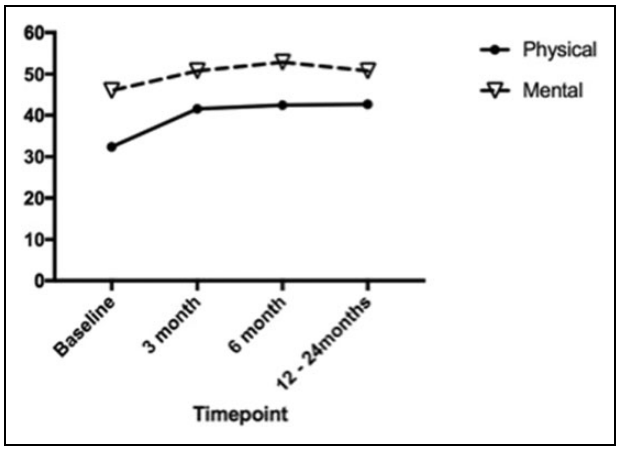

Figure 3. Quality-of-life outcomes: SF-12 mean physical and mental component scores.

Table 5. Thigh Symptoms in the Postoperative Period.

Postoperative Thigh Symptoms	Number of Patients (n = 50)	Resolution/Course
Thigh numbness/ dysesthesia	6	100% resolved over 6 months postoperatively
Hip flexion weakness	2	100% resolved over 6 months postoperatively

Table 6. Intraoperative and Postoperative Complications.

Complication	Number of Patients (n = 50)	Resolution/Course
Intraoperative		
Dural tear	2	One patient was repaired with dural graft One patient was repaired primarily; subsequently developed cerebellar hemorrhage (see below) None of them developed pseudomeningocele
Postoperative		
Incisional hernia	2	Subsequent primary repair with mesh of incisional hernia
Urinary retention	1	Resolved prior to discharge
Remote cerebellar hemorrhage day 1 postoperative	1	Resolved spontaneously with no further surgeries required and no focal neurological deficits
Hypotension requiring inotropes	1	Admitted into intensive care unit for 3 days and discharged to ward and subsequently rehabilitation
Mechanical fall resulting in undisplaced endplate fracture at screw bone interface at L2 vertebral level	1	Fusion achieved with no further surgical intervention
Mechanical fall resulting in undisplaced fracture of L4 and sacrum diagnosed on bone scans	1	Readmitted into rehabilitation with no further surgical intervention

with worsening pain when upright. Imaging revealed subsidence of the cage and a pseudoarthrosis at L4/L5. Five months post-XLIF, the patient underwent an L4/L5 transforaminal decompression of right L4 nerve root, which was found encased in calcified degenerative material intraoperatively. The patient had significant improvement of her radiculopathy.

Complication data is outlined in Table 5 and Table 6. We noted 2 cases (4%) of intraoperative dural tears in patients with XLIF and supplemental direct decompression, which were repaired primarily and with dural graft. One of the 2 patients

developed cerebellar hemorrhage on day 1 postoperatively, confirmed on computed tomography scan of the brain. This resolved without further intervention. The postoperative local complication rate was 20% (10 patients), with 2 cases of hip flexion weakness (4%) and 6 cases (12%) of thigh numbness and dysesthesia, all of which resolved over 1 month postoperatively. Another 2 patients (4%) developed an incisional hernia over the wound and required subsequent repair with mesh. In terms of overall general complications postoperatively, we observed one patient requiring intensive care unit admission for inotropes due to hypotension, one instance of cerebellar hemorrhage (related to the dural tear, as above), and one instance of urinary retention, both of which were managed conservatively and resolved without any deficits on discharge. Two patients, each with single-level L2/L3 XLIF without direct decompression, had mechanical falls postoperatively—one with undisplaced L2 vertebral endplate fracture at the screw-bone interface and another with undisplaced fracture of L4 and sacrum. Both patients did not require revision surgery and fusion was achieved on follow-up.

Discussion

A successful XLIF restores the vertebral disc height, unbuckles the thickened ligamentum flavum, and distracts the tensioned posterior longitudinal ligament, subsequently increasing the area of the epidural space and decompressing the neural elements indirectly, with clinical and radiological improvement of disc height, canal area, foraminal area, and height as reported in several studies that compare results to ALIFs (anterior lumbar interbody fusion) and TLIFs (transforaminal lumbar interbody fusion).[3-5,8,16,17] Several previously published studies have shown significant improvements across patient-reported outcomes (VAS pain scores, ODI, SF-36), which are further supported by comparable improvement in our cohort of patients.[4,7,18-22]

In the recent systematic review by Lang et al, at least a quarter of patients had unplanned direct decompression with XLIF; however, many other studies did not report clear clinical indications and timing of posterior decompression.[7,8,23] To our knowledge, this study represents the first attempt at evaluating the presence of preoperative pain with lying or standing as the single clinical criterion, rather than radiographic criteria, to predict the successful adequate indirect decompression in XLIF.

The mechanism of indirect decompression in XLIF is similar to the relief of dynamic stenosis with spine flexion in a seated or supine position that is typical for patients with neurogenic claudication. Therefore, the dynamic disc distraction and ligamentotaxis achieved with XLIF can be replicated transiently by spine flexion with sitting or supine position, due to the increased interlaminar space, with unbuckling of ligamentum flavum and movement of superior facets in caudal-posterior direction.[24]

Not all patients can achieve relief even in the seated or supine position, implying the more advanced degenerative disease process due to development of osteophytes that creates a fixed bony impingement, reducing the amount of spinal motion and thus the amount of neural decompression achieved with simple spinal flexion or interbody fusion.[9,25] Indeed, in the series of patients with lumbar spinal stenosis by Ganz et al, direct decompressive laminectomy was successful in achieving relief of pain in 95% of those with preoperative neurogenic claudicant pain with a postural component, but was successful only in half of those with constant preoperative pain not changed by posture.[24]

The general findings of the present study suggest that if the patients are able to achieve dynamic symptom relief in a sitting or lying position, they may benefit from XLIF without requiring direct decompression. Conversely, the persistence of pain despite dynamic spine flexion acts as the predictor for advanced bony degenerative disease that would only benefit from a planned direct decompressive procedure. Indeed, in the current study, we highlighted that patients with direct decompression required longer hospital stay than those with XLIF.

A few studies suggested osteoporosis as a clinical predictor of XLIF failure due to risk of subsidence and poor fusion.[10,11] Radiologically, lateral recess stenosis has been cited as the common factor in cases of failed XLIF in recent literature. Wang et al demonstrated that presence of bony lateral recess stenosis on preoperative imaging was a predictor for unsuccessful indirect decompression by XLIF in a study in which 9 of 16 patients with radiographic bony stenosis required revision surgery for persistent symptoms.[12] Similarly, another study demonstrated bony lateral recess stenosis to be the reason for unplanned second-stage direct decompressive procedure after XLIF in 3 out of the 11 cases.[13] The algorithm developed by Gabel et al to select patients best suited for indirect decompression from XLIF included absence of bony lateral recess stenosis as one of the predictors for successful decompression in their series of 28 patients.[10] Lang et al proposed that severe central canal stenosis to be predictive of failure of XLIF indirect decompression.[8] Although some groups initially considered severe facet arthropathy or locked facets to negatively impact on the indirect decompression of XLIF,[9-11] the outcome of XLIF was shown to be independent of facet arthropathy, regardless of grade in more recent studies.[12,26] We found that locked facets and severe central or lateral recess stenosis did not affect outcome.

The rate of posterior decompressions after XLIF differed greatly between studies, ranging up to 60% of cases in study by Kim et al.[7] Oliveira et al reported 2 of 21 patients (9.5%) required posterior decompression after XLIF due to persistent symptoms.[9] In the current study, in patients treated using our clinical algorithm, unplanned second-stage decompression was performed in 1 of 42 patients (2.3%) who had posture related pain. Although it is tempting to cite previous lumbar spinal surgeries as a common factor in failing our clinical algorithm, 13 other patients with prior lumbar spine surgery in our series did not require second-stage decompressive procedure on follow-up. The patient who failed our clinical algorithm experienced subsidence of her cage, which may have been due to

breaching of the endplate during the index procedure. This resulted in loss of indirect decompression and the need for the second procedure.

In the study by Sembrano et al, in which patients with prior lumbar fusion surgery were excluded, all 29 patients who underwent XLIF did not require direct decompression or revision procedures. However, it is unclear if patients with previous lumbar nonfusion surgeries were included in the study population.[4] In their study of 600 XLIF cases, Rodgers et al noted a significantly increased rate of complications in the group of patients with prior spinal surgery.[27] The patient who underwent L4/L5 XLIF in Case 4 in Oliveira et al had prior surgery and required a second-stage direct decompression.[9] We believe that prior lumbar surgery is a potential risk factor for failure of the XLIF's indirect decompression and should be taken into account during decision making and the informed consent process.

Thigh dysaesthesia and/or numbness and hip flexor weakness are well reported in the postoperative course after XLIF, with varying rates in different studies, ranging from 0.2% to 31% for hip flexor weakness, 4.4% to 18% for thigh numbness, and 5% to 21% for thigh dysesthesia, as concluded by the recent review by Lang et al, with symptom resolution in >90% of cases by 12 months after surgery.[8,23,27] In the present study this occurred in 15% patients but resolved completely. Postoperative hip flexion weakness is noted to be more common in patients with XLIF at lower lumber levels, especially at L4-L5 level due to possible traction on lumbar plexus or the psoas muscle itself during the lateral approach. One of the 2 patients with hip flexion weakness in the current series had XLIF performed at L2/L3 level, the other patient had surgery at the L4/L5 level; both patients had resolution of their weakness.

Interestingly, one of the 2 patients in our series with dural tears developed a cerebellar hemorrhage day 1 postoperatively. The patient did not develop any residual neurological deficits or wound complications and was discharged home after rehabilitation. Remote cerebellar hemorrhage after spinal surgery complicated by dural tears, although extremely rare, has been reported, with some cases suffering from residual neurological deficits. It is theorized to be due to the sudden cerebrospinal fluid drainage from dural tear causing subsequent downward displacement of the cerebellum and stretching of the bridging cerebellar veins that can cause hemorrhage or venous infarction.[28-33]

The limitations of the study include baseline differences between the groups with higher rate of smoking, comorbidities, and spondylolisthesis in the XLIF-only group, but this is most likely due to the disproportionately lower number in the group of patients who underwent a direct decompressive procedure. Although the small sample size of patients who underwent XLIF with supplemental direct decompression was a limitation of the study, the focus of this report is not assessing the effect of direct decompression on patients but rather investigating the postoperative clinical progress of patients with dynamic postural-related pain who underwent indirect decompression via XLIF. In particular, this study focused at looking at the failures of this algorithm, especially residual pain and reoperation. The other limitation was that not all patient-reported outcomes were recorded due to limited financial and staffing resources in the public institution. This may open up the potential of selection bias. However, this was a consecutive single surgeon series and all patients in both the public and private sectors received similar care and had similar clinic follow-up otherwise.

Conclusion

A successful XLIF is able to provide significant symptom improvement as evidenced by improvement in clinical outcome scores across different domains as demonstrated in the current cohort. These results corroborate with prior reports of XLIF. Using the simple clinical algorithm based on postural pain status preoperatively may be helpful to clinicians in selecting candidates suitable for indirect decompression of XLIF without the need for direct decompression and its associated risks and increased length of stay. Further studies with larger cohort are warranted to establish the validity of the above-mentioned clinical algorithm.

Declaration of Conflicting Interests

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