Original Article

Complications in Extreme Lateral Interbody Fusion (XLIF®): A Retrospective Study in Siriraj Hospital

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Background: Extreme Lateral Interbody Fusion (XLIF®) is a well-known transpsoas approach technique that confers advantages including excellent visualization, easy access to the lumbar disc, accommodation for a large anterior graft, restoration of disk height and lumbar alignment, and indirect decompression. However, no study in Thailand has investigated early postoperative complications after spinal fusion with XLIF surgery.

Objective: To determine the early postoperative complication rates among Thai patients that underwent spinal fusion with XLIF procedure.

Materials and Methods: The present study was a retrospective chart review to evaluate perioperative and early postoperative complications in patients that underwent spinal interbody fusion with XLIF procedure and were followed-up for a minimum of three months at the Department of Orthopedic Surgery, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand between 2015 and 2019.

Results: One hundred eighteen patients, including 82 females and 36 males, with a mean age of 64.2 years and 165 levels, that were operated upon, were included. Eighty patients (67.8%) underwent one-level fusion, 29 (24.6%) had two-level fusion, and 9 (7.6%) underwent three-level fusion. Immediate postoperative complications occurred in 66 patients (55.9%), consisting of eight (6.7%) with medical complications, 57 (48.3%) with surgical complications, and one (0.8%) with combined medical and surgical complications. Postoperative complications were resolved within three months after surgery in 48 patients. Forty-one patients (34.7%) had postoperative proximal lower limb neuropathy. Only 10 patients (24.4%) still had neuropathy at the 3-month follow-up, but it did not affect their function.

Conclusion: Postoperative proximal limb neuropathy, including thigh numbness, pain, or hip flexor weakness, had a high prevalence in the present study despite intraoperative neurophysiologic monitoring; however, most cases resolved by the 3-month follow-up. Patient education about potential nerve irritation complication is recommended, and meticulous preoperative radiographic assessment and careful step-by-step intraoperative surgical approach may reduce the rates of these postoperative complications.

Keywords: Extreme lateral interbody fusion; Complications; Neuropathy; Postoperative

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Minimal invasive surgery with lumbar interbody fusion (MIS-LIF) has become an effective and increasingly used procedure in spinal surgery. Posterior spinal musculature can increase postoperative back pain and cause extensive intraoperative blood loss. There are many new minimal invasive methods of interbody fusion that were designed to avoid disruption of the posterior spinal musculature. These MIS techniques can also accelerate recovery and reduce the duration of hospitalization. MIS-LIF technique is a good treatment option for patients with spinal lesions, especially those with single-level spinal pathology, because it delivers increased stability after decompression or correction due to spinal stenosis, degenerative scoliosis, trauma, infections, and neoplasms. Minimally invasive surgical techniques can be performed during MIS-LIF and include anterior lumbar interbody fusion (ALIF), direct lateral lumbar interbody fusion (DLIF), oblique lateral lumbar interbody fusion (OLIF), and minimal invasive transforaminal lumbar interbody fusion (MIS-TLIF)[1]. Each technique has its own advantages and disadvantages. Extreme Lateral Interbody Fusion (XLIF®) is the trade name for DLIF from NuVasive, Inc. of San Diego, California. The approach used for the XLIF technique is via the transpsoas muscle to the lumbar spine, and this approach was first reported by Pimenta et al[2,3]. This approach has the advantages of excellent visualization, easy access to the lumbar disc, accommodation for a large anterior graft, restoration

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of disk height and lumbar alignment, and indirect decompression of neural element[4]. However, this technique requires dissection of the psoas muscle, which increases the risk of iatrogenic lumbar plexus injury[5]. The disadvantages of this technique include postoperative proximal lower limb neuropathy, such as thigh numbness, pain, or hip flexor weakness, as well as other complications related to the structures around the vertebral body[6-8]. The largest study of postoperative complications after XLIF was reported by Rodgers et al in 2011. They reviewed the charts of 600 patients from a single center, and they found an overall complication rate of 6.2%, and a reoperation rate of 1.8%[9]. No previous study has investigated the early postoperative complication rate after spinal fusion with XLIF technique in Thailand. Accordingly, the aim of the present study was to determine the early postoperative complication rate among Thai patients underwent spinal fusion with XLIF procedure at Siriraj Hospital, Thailand's largest national tertiary referral center.

Materials and Methods

Subjects

After receiving approval from the Institutional Review Board of the Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand (COA no. si 229/2020), patients that underwent spinal fusion with XLIF procedure at one or more levels between 2015 and 2019 were identified and enrolled. All cases were operated upon and followed-up by only one orthopedic surgeon (Sutipornpalangkul W). Operative notes, anesthesia records, discharge summaries, and clinical progression notes were accessed from the present study institutional electronic medical record database.

Early postoperative complications were defined as any abnormal clinical events that occurred within the first 12 weeks after surgery. Patient age, gender, pathologic diagnosis, number of levels fused, estimated blood loss (EBL), surgical time, length of hospital stay (LOS), clinical outcome, and postoperative complications were recorded. Postoperative complications were categorized as surgical or medical complications.

Surgical techniques

An intraoperative nerve monitoring system (NIMS) was used to monitor all patients that underwent XLIF procedure (XLIF®; NuVasive Inc., San Diego, CA, USA)[2]. First, the patient was placed in the left lateral decubitus position, and the targeted disc level was rechecked under fluoroscopic imaging. One or two incisions were made according to the number of levels to be fused. The authors used a mini open approach via the retroperitoneal transpsoas muscle to access the mid-axillary line of the disc space. An electromyography (EMG) probe was used to check the border of the safe area for a dilator tube to the spinal disc, and an expandable retractor was used to protect the nerve structures of the lumbar plexus. After a recheck using the EMG probe, the discectomy and vertebral endplate preparations were performed in a step-by-step fashion. The authors used a polyether ether ketone (PEEK) implant (CoRoent®; NuVasive, Inc.) with bone morphologic protein 2 (rhBMP-2) (Infuse®; Medtronic, Inc., Memphis, TN, USA) or iliac bone graft packed into XLIF PEEK implants. The patient was then moved into the prone position so that percutaneous spinal fixation with pedicle screw and rod system could be performed.

Statistical analysis

Data were described as mean plus or minus standard deviation (SD) for continuous data with normal distribution, and as number and percentage for categorical data. Analyses of variance (ANOVA) test were used to assess for statistically significant differences among three or more independent data groups. Kruskal-Wallis test was used for non-parametric data. All analyses were performed using PASW Statistics, version 18.0 (SPSS Inc., Chicago, IL, USA). A p-value of less than 0.05 was considered statistically significant.

Results

One hundred eighteen patients treated by XLIF procedures were enrolled in the present study. There were 36 males and 82 females, and the average age was 64.2±10.9 years with a range of 19 to 87. Demographic data, pathologic diagnosis, mean body mass index (BMI), levels of fusion, and numbers of levels of fusion are shown in Table 1. Most patients were diagnosed as spondylolisthesis (52 patients), followed by spinal stenosis (42 patients), adjacent segment disease (8 patients), TB spondylodiscitis (7 patients), degenerative scoliosis (4 patients), and degenerative disc disease (5 patients). The total number of levels treated by XLIF were 165 levels. The L4 to 5 level was the most common level in the present study (63.6%), and most cases were one-level operation (67.8%) (Table 1).

The mean estimated blood loss (EBL) was 118.8±131.7 mL for one-level XLIF, 194±121.2 mL

Table 1. Demographic and clinical characteristics of patients (n=118)

Characteristics	n (%)
Age (years); mean±SD	64.2±10.9
Sex	
Male	36 (30.5)
Female	82 (69.5)
Diagnosis	
Spinal stenosis	42 (35.6)
Spondylolisthesis	52 (44.1)
Adjacent segment disease	8 (6.8)
TB spondylodiscitis	7 (5.9)
Degenerative scoliosis	4 (3.4)
Degenerative disc disease	5 (4.2)
Body mass index (kg/m^2); mean±SD	24.9±1.8
Level of surgery (n=165)	
L2-3	11 (6.7)
L3-4	43 (26.1)
L4-5	105 (63.6)
L5-S1	6 (3.6)
Levels per operation (n=118)	
One level	80 (67.8)
Two levels	29 (24.6)
Three levels	9 (7.6)

SD=standard deviation; TB=tuberculosis; L=lumbar; S=sacral

for two levels, and 320±207.3 mL for three levels. The mean operative time, including posterior spinal fixation, was 176.7±53.0 minutes for one level, 248.6±72.9 minutes for two levels, and 298.9±87.3 minutes for three levels. The mean LOS was 6.5±5.6 days for a one-level operation, 9.2±11.0 days for two levels, and 7.0±1.8 days for three levels. There was significantly less EBL, shorter operative time, and shorter LOS between one-level XLIF and two- or three-level XLIF (Table 2).

Immediate postoperative complications occurred in 66 patients (55.9%) consisting of eight (6.7%) medical complications, 57 (48.3%) surgical complications, and one (0.8%) patient with combined medical and surgical complications. The eight medical complication patients comprised two patients (1.6%) with deep vein thrombosis, two patients (1.6%) with bowel ileus, one patient (0.8%) each with urinary retention, acute myocardial infarction, symptomatic hyponatremia, and pneumonia. The 57 patients (48.3%) with surgical complications included 41 patients (34.7%) with proximal lower limb neuropathy, seven patients (5.9%) with inadequate decompression, five patients (4.2%) with postoperative back pain, two patients (1.6%) each with pedicle screw penetration injury and deep surgical site infection (psoas abscess), and one patient (0.8%) each with superficial surgical site infection, surgical wound hematoma, surgical wound dehiscence, and postoperative foot drop. There was one patient with both proximal lower limb neuropathy and urinary tract infection. There was no statistically significant difference between the number of levels operated upon and postoperative medical or surgical complications (Table 3).

Most complications were resolved within three months after surgery. However, 18 patients (15.2%) had complications that persisted longer than three months. In the present study, severe complications were reported in 20 patients (16.9%), as follow 1) permanent proximal neuropathy in 10 patients (8.5%) including six patients with ipsilateral proximal neuropathy and four patients with contralateral proximal neuropathy, 2) inadequate decompression that required further decompression in three patients (2.5%), 3) severe medical problems in four patients (3.4%) including two deep vein thrombosis, one non-ST-segment myocardial infarction, and one pneumonia, 4) screw penetration injury that required reoperation in one patient (0.8%), 5) deep surgical site infection that required debridement in one patient (0.8%), and 6) postoperative foot drop in one patient (0.8%).

The 41 cases of postoperative proximal lower limb neuropathy could be categorized into three subgroups,

Table 2. Mean estimated blood loss, operative time, and length of hospital stay by number of levels fused

Number of interbody levels fused	Estimated blood loss (mL); mean±SD	Operative time (minutes); mean±SD	Length of hospital stay (days); mean±SD
XLIF 1 level (n=80)	118.8±131.7	176.7±53.0	6.5±5.6
XLIF 2 levels (n=29)	194.0±121.2	248.6±72.9	9.2±11.0
XLIF 3 levels (n=9)	320.0±207.3	298.9±87.3	7.0±1.8
p-value	<0.001	<0.001	0.018

XLIF=extreme lateral interbody fusion; SD=standard deviation

Kruskal-Wallis test was used, a p<0.05 indicates statistical significance

Table 3. Complications after XLIF by number of levels fused

Patients with complications (n=66)	Medical complications (n=8); n (%)	Surgical complications (n=57); n (%)	Medical & surgical complications (n=1); n (%)
XLIF 1 level (n=40)	4 (10.0)	35 (87.5)	1 (2.5)
XLIF 2 levels (n=20)	2 (10.0)	18 (90.0)	0 (0.0)
XLIF 3 levels (n=6)	2 (33.3)	4 (66.7)	0 (0.0)
p-value	0.171		

XLIF=extreme lateral interbody fusion

A p<0.05 indicates statistical significance

Table 4. Postoperative proximal limb neuropathy complications by number of levels fused

Neuropathy patients (n=41)	Ipsilateral proximal limb neuropathy; n (%)	Contralateral proximal limb neuropathy; n (%)	Bilateral proximal limb neuropathy; n (%)
XLIF 1 level (n=26)	17 (65.4)	8 (30.8)	1 (3.8)
XLIF 2 levels (n=12)	9 (75.0)	2 (16.7)	1 (8.3)
XLIF 3 levels (n=3)	2 (66.7)	1 (33.3)	0 (0.0)
p-value	0.802		

XLIF=extreme lateral interbody fusion

A p<0.05 indicates statistical significance

with 28 patients (68.3%) with ipsilateral proximal neuropathy, 11 patients (26.8%) with contralateral proximal neuropathy, and two patients (4.9%) with bilateral proximal neuropathy. The present study did not find significant association between postoperative proximal lower limb neuropathy and either the number of levels fused (Table 4) or the level of XLIF operation (data not shown).

At the 3-month follow-up, 10 (24.4%) of 41 patients still had persistent postoperative proximal lower limb neuropathy including six patients with ipsilateral and four patients with contralateral proximal neuropathy, but their functions were not adversely affected.

Concerning reoperation, five patients (4.2%) required reoperation within three months of follow-up including one patient (0.8%) for pedicle screw revision, three patients (2.5%) for decompressive laminectomy, and one patient (0.8%) for debridement. Early adjacent segment disease was detected in five patients (4.2%) within three months after surgery including two with adjacent disc protrusion and three with adjacent vertebral compression fracture. All these patients were treated conservatively, except the patient with vertebral compression fracture who underwent vertebroplasty.

Discussion

The present study showed a high (55%) prevalence of postoperative complications following XLIF surgery, and this rate is much higher than the rates reported from other studies[9,10]. In addition, the most common surgical complication in the present study was postoperative proximal limb neuropathy (34.7%), which was similar to the finding reported by Cummock et al[7]. However, by the 3-month follow-up, complication in 75.6% of these patients was spontaneously resolved. No patients required reoperation to correct proximal limb neuropathy symptoms. Rodger et al reported an overall postoperative complication rate of only 6.2% among 600 XLIF patients[9]. However, their study did not include postoperative proximal limb neuropathy complications, including thigh numbness and hip flexor weakness. Many previous studies reported symptoms of proximal limb neuropathy to be common postoperative findings after direct lateral interbody fusion using the transpsoas approach, with an overall incidence ranging between 19% and 67%[7,11]. Moreover, most of those cases (50 to 84%) resolved by six months, and 90% resolved by one year. However, these patients experienced disturbance of their daily life activities for six months to one year after operation, so the authors considered proximal limb neuropathy to be a surgical complication. Thigh numbness and hip flexor weakness could have many causes, such as direct injury to the psoas belly muscle, direct injury to the ilioinguinal nerve, subcostal

nerve, hypogastric nerve, and genitofemoral nerve. In cases where neuromonitoring were not sufficient for avoiding injury to sensory nerves to avoid complications, surgeons should employ a surgical approach that facilitates clear visualization and gentle mobilizations.

In the present study, 11 (26.8%) of 41 patients had contralateral proximal limb neuropathy. This rate is higher than that reported by Papanastassiou et al (6.25%, 2 of all 32 patients)[12]. They attributed the causes of contralateral proximal limb neuropathy to far lateral disk herniation, displacement of an endplate fragment, and lateral overhang of interbody spacer.

Multiple-level XLIF procedures increased operative time, the likelihood of femoral nerve injury or psoas muscle injury, and the risk of postoperative hematoma and muscle ischemia[7]. In the present study, there was no significant association between postoperative proximal lower limb neuropathy and the number of levels fused during XLIF procedures (p=0.802), which is consistent with the findings of Cummock et al[7].

In the present study, the authors also could not demonstrate a statistically significant relationship between postoperative proximal lower limb neuropathy and the level of the spine operated upon (p=0.38) (data not shown). Many studies reported significant association between proximal lower limb neuropathy and XLIF at the L4-5 level because the femoral nerve is more prone to injury at this level than at other levels during XLIF operation[7,10]. The femoral nerve tends to lie closer to the disc at the L4 to 5 level than to the cephalad interbody level, and the XLIF procedure was reported to be less than ideal for management at the L5 to S1 level[5]. Injury to the femoral nerve was caused by retractor blade compression or traction during the intervertebral disc approach, and the injury could not be detected by the neuromonitoring system.

The reoperation rate in the present study was 4.2%, and most were due to inadequate decompression (60%). In general, XLIF by indirect decompression technique and stabilization using PEEK and instrumentation is a good option in patients who have mild to moderate severity of central and primary foraminal spinal stenosis. Pimenta et al reported an increase in central canal and foraminal height of more than 30 to 50% from XLIF procedures[3]. Preoperative magnetic resonance imaging (MRI) can help the surgeon distinguish severe cases of central and primary foraminal stenosis for which XLIF would be inappropriate.

The present study had nine patients with postoperative medical complications, and all those patients were treated in the hospital and recovered prior to discharge. The authors' 7.6% rate of postoperative medical complications was higher than the 3.9% rate reported by Rodger et al[9]. In addition, the present study had no major complications, such as vascular injury or bowel injury, liked previous study[6]. This may be the result of careful preoperative MRI review before XLIF, and the mini-open technique that improves visualization of these vital organs.

The main limitation of the present study is its retrospective design. Other limitations include a relatively small sample size compared to other studies, and the fact that the present data were collected from only one center. Lastly, since only one surgeon (Sutipornpalangkul S) operated on all study patients, there would have been a learning curve between the first and the last XLIF case. This factor could have influenced factors like EBL, operative time, and surgical complications. The strength of the present study is that it is the first study in Thailand to evaluate postoperative complications after XLIF procedure.

Conclusion

Postoperative proximal limb neuropathy, including thigh numbness, pain, or hip flexor weakness, had a high prevalence in the present study, despite intraoperative neurophysiologic monitoring, however, most cases resolved by the 3-month follow-up. Patient education about potential nerve irritation complication is recommended, and meticulous preoperative radiographic assessment and careful step-by-step intraoperative surgical approach may reduce the rates of these postoperative complications.

What is already known on this topic?

There are many reports on complication in XLIF surgery. Most of them showed low prevalence of complications.

What this study adds?

This study reported high rate of complications, which was different from other reports. This is also the first report on complications of XLIF surgery done in Thai patients.

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Conflict of interest

The authors declare no personal or professional conflicts of interest, and no financial support from the companies that produce or distribute the drugs, devices, or materials described in this report.

References

1. Mobbs RJ, Phan K, Malham G, Seex K, Rao PJ. Lumbar interbody fusion: techniques, indications and comparison of interbody fusion options including PLIF, TLIF, MI-TLIF, OLIF/ATP, LLIF and ALIF. J Spine Surg 2015;1:2-18.
2. Ozgur BM, Aryan HE, Pimenta L, Taylor WR. Extreme Lateral Interbody Fusion (XLIF): a novel surgical technique for anterior lumbar interbody fusion. Spine J 2006;6:435-43.
3. Pimenta L. Less-invasive lateral lumbar interbody fusion (XLIF) surgical technique: video lecture. Eur Spine J 2015;24 Suppl 3:441-2.
4. Kwon B, Kim DH. Lateral lumbar interbody fusion: indications, outcomes, and complications. J Am Acad Orthop Surg 2016;24:96-105.
5. Davis TT, Bae HW, Mok JM, Rasouli A, Delamarter RB. Lumbar plexus anatomy within the psoas muscle: implications for the transpsoas lateral approach to the L4-L5 disc. J Bone Joint Surg Am 2011;93:1482-7.
6. Epstein NE. Non-neurological major complications of extreme lateral and related lumbar interbody fusion techniques. Surg Neurol Int 2016;7:S656-s9.
7. Cummock MD, Vanni S, Levi AD, Yu Y, Wang MY. An analysis of postoperative thigh symptoms after minimally invasive transpsoas lumbar interbody fusion. J Neurosurg Spine 2011;15:11-8.
8. Epstein NE. Review of risks and complications of Extreme Lateral Interbody Fusion (XLIF). Surg Neurol Int 2019;10:237.
9. Rodgers WB, Gerber EJ, Patterson J. Intraoperative and early postoperative complications in extreme lateral interbody fusion: an analysis of 600 cases. Spine (Phila Pa 1976) 2011;36:26-32.
10. Grimm BD, Leas DP, Poletti SC, Johnson DR, 2nd. Postoperative complications within the first year after extreme lateral interbody fusion: Experience of the first 108 patients. Clin Spine Surg 2016;29:E151-6.
11. Moller DJ, Slimack NP, Acosta FL Jr, Koski TR, Fessler RG, Liu JC. Minimally invasive lateral lumbar interbody fusion and transpsoas approach-related morbidity. Neurosurg Focus 2011;31:E4.
12. Papanastassiou ID, Eleraky M, Vrionis FD. Contralateral femoral nerve compression: An unrecognized complication after extreme lateral interbody fusion (XLIF). J Clin Neurosci 2011;18:149-51.