High neurological complication rates for extreme lateral lumbar interbody fusion and related techniques: A review of safety concerns

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Received: 12 June 16   Accepted: 14 June 16   Published: 22 September 16

Abstract

**Background:** There are frequent reports of lumbosacral plexus and other neurological injuries occurring with extreme lateral interbody fusions (XLIF) and other related lateral lumbar techniques.

**Methods:** This review focuses on the new neurological deficits (e.g. lumbosacral plexus, root injuries) that occur following minimally invasive surgery (MIS) XLIF and other related lateral lumbar techniques.

**Results:** A review of multiple articles revealed the following ranges of new postoperative neurological complications for XLIF procedures: plexus injuries 13.28%; sensory deficits 0–75% (permanent in 62.5%); motor deficits 0.7–33.6%; anterior thigh pain 12.5–25%. Of interest, in a study by Lykissas et al., the frequency of long-term neural injury following lateral lumbar interbody fusion (LLIF) with BMP-2 (72 patients) was much higher than for LLIF performed with autograft/allograft (72 patients). The addition of bone morphogenetic protein led to persistent sensory deficits in 29 vs. 20 without BMP; persistent motor deficits in 35 with vs. 17 without BMP; and persistent anterior thigh/groin pain in 8 with vs. 0 without BMP. They should also have noted the unacceptably high incidence of neural injury occurring with LLIF alone without BMP.

**Conclusion:** This review highlights the high risk of neural injury (up to 75% for sensory, 33.6% for motor, and an overall plexus injury rate of 13.28%) utilizing the XLIF and other similar lateral lumbar approaches. With such extensive neurological injuries, is the XLIF really safe, and should it still be performed?

**Key Words:** Comparison with other lateral interbody methods, extreme lateral interbody fusion, minimally invasive surgery, neurological complications, open surgery

INTRODUCTION

This review focuses on the frequency of neural injuries resulting from extreme lumbar interbody fusion (XLIF) or similar lateral procedures (e.g., direct lumbar interbody fusion (DLIF) and lateral lumbar interbody fusion (LLIF)). The multiple studies analyzed cited the following ranges of new postoperative neurological complications attributed to XLIF: new sensory deficits 0–75% (permanent 62.5%), new motor deficits 0.7–33.6%, new anterior thigh pain 12.5–25%,
and a plexus injury rate of 13.28%. Because it is well-known that the transpsoas approach places the lumbosacral plexus at risk, some authors even concluded these frequent deficits should not be considered “complications,” as they were simply “anticipated” consequences of the procedure. Here, we emphasize the unacceptably high rate of neurological injuries attributed to XLIF and related lateral lumbar procedures, and question whether, with this safety record, it should still be performed?

**HIGH FREQUENCY OF NEW NEUROLOGICAL INJURIES WITH XLIF AND RELATED LATERAL LUMBAR PROCEDURES**

Multiple authors have reported a high frequency of neurological injuries, including anterior thigh pain, contralateral femoral nerve palsies, new sensory/motor root deficits, and lumbar plexopathies attributed to XLIF and other lateral lumbar procedures. In 2011, Sharma et al. evaluated the 1-year outcomes of 43 LLIF addressing degenerative disc disease (DDD), degenerative spondylolisthesis (DS), or scoliosis; 25% of the patients experienced new postoperative anterior thigh pain [Table 1].[10] Further, in 2011, Papanastassiou et al. observed 2 (6.25%) new contralateral femoral nerve root injuries occurring out of a series of 32 XLIF procedures [Table 1].[10] One of the latter injuries was attributed to the contralateral displacement of an endplate fragment due to “overzealous endplate removal and breaking of the osteophytes in the opposite corner of the intervertebral disc”; the second was due to a failure to pay close attention to cage placement, which extended into the opposite foramen.[10] In 2013, Ahmadian et al. reviewed 18 studies involving 2310 patients undergoing XLIF; 304 (13.2%) patients exhibited plexus injuries, while root injuries led to motor (0.7–33.6%) and sensory (0–75%) deficits.[1] Of interest, here the authors concluded neural complications for XLIF procedures were being underreported. In 2014, Hrabalek et al. analyzed the complication rates for minimally invasive (MIS) anterior lumbar interbody fusions (ALIF) (20 patients) vs. MIS XLIF (88 patients) addressing T12-L5 level pathology [Table 1].[7] MIS ALIF complications included post-sympathectomy syndrome (19 patients; 15.8%) and 35 minor intra/postoperative complications (32 patients; 26.6%). For XLIFs, 26 complications occurred in 22 patients (25%); one transient L5 root injury (1.1%) and 20 of 25 root/plexus injuries involving transient left groin/anterior thigh pain (11 patients; 12.5%) or numbness (9 patient; 10.2%). Formica et al., in 2014, evaluated the complications of 39 consecutive XLIF performed for degenerative or post-traumatic lumbar pathology over an average postoperative interval of 16 months; 10 (26%) patients exhibited “mild, transient” motor quadriceps deficits that completely resolved [Table 1].[5] Khajavi et al. in 2015 further assessed the outcomes for 160 patients (197 levels) undergoing MIS XLIF for degenerative lumbar disease [Table 1].[8] Patients experienced anterolateral thigh/groin sensory deficits (14%) and iliopsoas weakness (9%); notably, they considered these “minor complications.” In a retrospective cohort analysis of the neurological sequelae of 120 XLIF and DLIF, Cheng et al., in 2015, found that 31 (25.8%) patients experienced one or more adverse event (AEs).[2] Twenty-two patients (18.3%) experienced 24 neurological AEs; 15 (12.5%) complained of anterior/lateral thigh dysesthesias, and there were 6 (5.0%) instances of radiculopathy and 3 (2.5%) cases of postoperative weakness. Interestingly, AEs occurred more frequently following DLIF (28%) vs. XLIF (14.2%). In 2016, Epstein commented on the much higher frequency of root/plexus injuries occurring with MIS XLIF (23.8%) vs. ALIF (15.8%) reported in the Spine Patient Outcomes Research Trial by Desai et al.[3,4] Interestingly, these numbers far exceeded those quoted for open discectomy (0.13% to 0.25%), open laminectomy/stenosis with/without fusion (0%), and open laminectomy/stenosis/degenerative spondylolisthesis with/without fusion (2%). Performing a retrospective review of outcomes 1 year following 108 XLIF, Grimm et al. (2016) found a 23% complication rate (25 complications); 21 (19.4%) involved thigh pain paresthesias, whereas the remaining 4 (3.7%) addressed a vertebral body fracture, a contralateral root injury, quadriceps weakness, and residual stenosis; notably 3 patients required additional surgery.[6] Interestingly, the authors also commented that some patients experienced severe femoral nerve palsies despite the use of intraoperative neurophysiological monitoring (IONM). Certainly, the overall high frequencies of neural/plexus injuries occurring with XLIF and related lateral lumbar procedures should lead to questions regarding the safety of these procedures and whether they should be continued.

**EXTREME LATERAL INTERBODY FUSION COMPLICATIONS INCREASED WITH THE ADDITION OF BONE MORPHOGENETIC PROTEIN-2**

The study by Lykissas et al. in 2014 critically pointed out the potential direct damage of rhMP-2 to the lumbosacral plexus when utilized for LLIF [Table 1].[9] The authors recognized that bone morphogenetic proteins-2 (BMP-2) contributed to neurological deficits when used for ALIF or transformaminal lumbar interbody fusion (TLIF), however, questioned in their 6-year retrospective series, whether it would have similar adverse effects (e.g., lumbosacral plexus injuries and/or pain) following LLIF. The study included two clinically comparable controlled cohort LLIF populations; 72 LLIF utilized BMP-2 vs. 72 LLIF performed with autograft/allograft. They documented that rhBMP-2 combined with LLIF directly damaged the lumbosacral plexus uniformly in
| Author Reference Year | Study | Data for Study | Complications (COMP) | Complications (COMP) | Complications (COMP) |
|-----------------------|-------|----------------|----------------------|----------------------|----------------------|
| Tormenti (12) 2010    | 8 XLIF TLIF/PS Adult TLS | Versus 4 TLIF/PS Adult TLS | COMP: 1 TLIF/PS 1 Revision | XLIF/TLIF/PS COMP: 1 bowel perforation 2 (25%) motor root *1 remained | XLIF/TLIF/PS COMP: 6 (75%) sensory root (5 or 62.5% not resolved) 10.5 months |
| Papanastassiou (10) 2011 | 2 Femoral Nerve Injuries (contralateral) | 32 XLIF levels | COMP: 1 extensive end plate removal | COMP: 1 cage too foraminal (opposite) | COMP: 2/32 XLIF (6.25%) Femoral Nerve (opposite) |
| Sharma (11) 2011 | 43 LLIF | For DDD DS | For New onset scoliosis | COMP: 25% anterior thigh pain; Resolved | COMP: 25% anterior thigh pain; |
| Ahmadian (1) 2013 | XLIF 18 Studies 2310 Patients | COMP: 304 (13.2%) Plexus injuries | Nerve root 0-3.4% (motor 0.7-33.6%), sensory (0-75%) | Injuries underreported with MIS XLIF | COMP: Plexus 13.2% Motor up to 33.6% Sensory up to 75% |
| Lykissas (9) 2014 | 72 LLIF with BMP 72 LLF with autograft/allograft | COMP: Long-Term: Sensory 29 BMP (40.3%) 20 no BMP (27.8%) | Motor deficit 35 BMP (48.6%) 17 no BMP 23.6% Anterior thigh pain 8 with BMP (11.1%) 0 without (0%) | Direct injury of BMP-2 to lumbosacral plexus Also direct injury LS plexus with LLIF alone | COMP: Sensory + BMP 40.3% – BMP 27.8% Motor + BMP 48.6% – BMP 23.6% |
| Formica (5) 2014 | 39 XLIF Trauma Degenerative Lumbar | Assessment ODI VAS X-rays | XLIF Followed average 16 months | Improvement VAS Back 6.08 Leg 2.77 ODI 38 | COMP: 10 (26%) Transient Quadriceps weakness -regression |
| Hrabalek (7) 2014 | MIS ALIF (120 patients) MIS XLIF (88 patients) | Disc Herniations T12-L5 Other Pathology | COMP: ALIF Sympathectomy syndrome 19 (15.8%) Minor 32 (26.6%) | COMP: XLIF L5 root (1.1%) 20/25 Root or plexus | COMP: MIS ALIF 11 (12.5%) Transient groin/anterior thigh pain 9 numbness (10.2%) |
| Cheng (2) 2015 | 120 Patients DLIF XLIF | 31 AE (25.8%) 22 (18.3%) Neurological AE | COMP: 15 (12.5%) thigh dysesthesias | COMP: 6 (5%) radiculopathy 3 (2.5%) weakness | COMP: More AE with DLIF (28%) vs. XLIF (14.2%) |
| Khajavi (8) 2015 | 160 (197 levels) XLIF For DS DDD, ASD Postoperative | Average age 61 Followed average19 months | No symptomatic pseudoarthrosis No implant/ instrument failures | COMP: 1 (0.6%) major complication 12 minor complications | COMP: Anterolateral groin pain 14% Hip flexor weakness 9% |
| Grimm (6) 2016 | 108 XLIF | COMP: Major (3.7%) 1 Vertebral fracture 1 Opposite root injury | COMP: Major 1 Dense quadriceps paresis 1 Persistent stenosis (3 Reoperations) | COMP: Minor 19.4% Thigh Pain Paresthesias (Resolved) | COMP: Major complications: 3.7% Minor 19.4% |

Contd...
the long-term; sensory deficits occurred in 29 fused with rhBMP-2 vs. 20 without; motor deficits in 35 fused with rhBMP-2 vs. 17 without; and anterior thigh/groin pain in 8 fused with rhBMP-2 vs. 0 without. In addition, careful reassessment of the extremely high rate of neurological injury occurring secondary to the LLIF procedures alone, even with intraoperative neural monitoring, should lead to reconsideration of whether these procedures should still be offered to patients [Table 1].

COMBINING EXTREME LATERAL INTERBODY FUSION WITH OTHER PROCEDURES FOR ADULT SCOLIOSIS

XLIF procedures combined with additional procedures to address adult scoliosis increased the complication rates [Table 1]. To address adult degenerative thoracolumbar scoliosis, Tormenti et al. in 2010, compared the efficacy of performing 8 XLIF, TLIF, and pedicle screw fixation procedures versus 4 TLIF/pedicle screw procedures alone [Table 1]. Of the 8 patients undergoing XLIF/TLIF/pedicle screws, 1 sustained an intraoperative bowel injury requiring a colon resection, 2 (25%) developed new motor radiculopathies (1 resolved; 1 continued at 3 months), whereas 6 (75%) exhibited new thigh paresthesias (note 5 of 6 persisted at 10.5 postoperative months). Of the 4 undergoing TLIF/pedicle screw fixation, 1 required revision of the instrumentation. The authors rightfully concluded the combined procedures carried “significant risks that require further evaluation and proper informed consent.” However, how many surgeons inform their patients prior to XLIF with/without other procedures that they have such a substantial risk of sustaining new postoperative neurological deficits? Let us conclude it is very unlikely because it would certainly curtail the number of XLIF being performed.

CONCLUSION

This review focused on the high frequency of neural injuries resulting from XLIF and related lateral lumbar interbody procedures. New neurological injuries included sensory deficits in 0–75% of cases (permanent 62.5%), motor deficits in 0.7–33.6% of patients, anterior thigh pain in 12.5–25%, and a 13.28% plexus injury rate. When is the neurological injury rate for XLIF and its related procedures considered unacceptable? And when do we question why, with this safety record, it should still be performed?

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

REFERENCES

1. Ahmadian A, Deukmedjian AR, Abel N, Dakwar E, Uribe JS. Analysis of lumbar plexopathies and nerve injury after lateral retroperitoneal transpsoas approach: Diagnostic standardization. J Neurosurg Spine 2013;18:289-97.
2. Cheng I, Briseño MR, Arrigo RT, Bains N, Ravi S, Tran A. Outcomes of Two Different Techniques Using the Lateral Approach for Lumbar Interbody Arthrodesis. Global Spine J 2015;5:308-14.
3. Epstein NE. More nerve root injuries occur with minimally invasive lumbar surgery, especially extreme lateral interbody fusion: A review. Surg Neurol Int 2016;7(Suppl 3):S83-95.
4. Epstein NE. More nerve root injuries occur with minimally invasive lumbar surgery: Let’s tell someone. Surg Neurol Int 2016;7(Suppl 3):S96-S101.
5. Formica M, Berjano P, Cavagnaro L, Zanirato A, Piazzolla A, Formica C. Extreme lateral approach to the spine in degenerative and post traumatic lumbar diseases: Selection process, results and complications. Eur Spine J 2014;23(Suppl 6):S684-92.
6. 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.
7. Hrabalek L, Adamus M, Gryga A, Wanek T, Tucek P. A comparison of complication rate between anterior and lateral approaches to the lumbar spine. Biomed Pap Med Fak Univ Palacky OloMOuk Czech Repub 2014;158:127-32.
8. Khajavi K, Shen A, Lagina M, Hutchison A. Comparison of clinical outcomes following minimally invasive lateral interbody fusion stratified by preoperative diagnosis. Eur Spine J 2015;24(Suppl 3):S322-30.
9. Lykissas MG, Aichmair A, Sama AA, Hughes AP, Lebl DR, Cammisa FP, et al. Nerve injury and recovery after lateral lumbar interbody fusion with and without bone morphogenetic protein-2 augmentation: A cohort-controlled study. Spine J 2014;14:217-24.
10. Papastassiou 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.
11. Sharma AK, Kepler CK, Girardi FP, Cammisa FP, Huang RC, Sama AA. Lateral lumbar interbody fusion: Clinical and radiographic outcomes at 1 year: A preliminary report. J Spinal Disord Tech 2011;24:242-50.
12. Tormenti MJ, Maserei MB, Bonfield CM, Okonkwo DO, Kanter AS. Complications and radiographic correction in adult scoliosis following combined transpsoas extreme lateral interbody fusion and posterior pedicle screw instrumentation. Neurosurg Focus 2010;28:E7.