



## LATERAL LUMBAR INTERBODY FUSION

Dr. Majesh Pratap Malla\* and Dr. She Yuan Ju

*Department of Orthopaedics, Clinical Medical College of Yangtze University, Jingzhou Central Hospital Jingzhou,  
Hubei Province, PR China*

### ABSTRACT

Lateral lumbar Interbody Fusion (LLIF) is a relatively new, minimally invasive technique for interbody fusion. This approach provides an alternative to anterior lumbar interbody fusion with instrumentation, posterior lumbar interbody fusion, and transforaminal lumbar interbody fusion for anterior column support. Lateral lumbar interbody fusion has been used successfully to treat common degenerative spinal conditions such as spinal instability, stenosis, scoliosis, and degenerative disk disease. LLIF is minimally invasive, safe, better structural support from the apophyseal ring, potential for coronal plane deformity correction, and indirect decompression, which have made this technique popular. Favorable long-term outcomes and a reduced risk of visceral/vascular injuries, incidental dural tears, and perioperative infections have been reported. However, approach-related complications such as motor and sensory deficits remain a concern. LLIF can be a safe procedure used for a variety of indications.

**Keywords:** Lateral Lumbar Interbody Fusion, minimally invasive , degenerative spinal conditions

## INTRODUCTION

Lateral lumbar interbody fusion (LLIF) is a relatively new, minimally invasive technique for interbody fusion. The modern LLIF technique was described in 2006 by Ozgur et al [1]. In 2003, Bertagnoli et al. described the so-called AnteroLateral transPsoatic Approach (ALPA) as a new technique for implanting prosthetic disc-nucleus devices [2]. The relative simplicity of the technique and potential reduction in surgical morbidity, compared with those of open anterior surgery, have generated great interest and rapid acceptance among surgeons experienced in the technique. The technique has also demonstrated widespread appeal among patients. LLIF is suitable for conditions that require access to the interbody disc space from T12/L1 to L4/5. This technique is not suitable for the L5/S1 level, due to the location of the iliac crest that obstructs lateral access. Furthermore, at more caudal levels of the lumbar spine, the lumbar plexus courses more anteriorly and the iliac vessels course more laterally, which increases risk of injury via a lateral approach. The indications for this technique include adult lumbar scoliosis, central and foraminal stenosis, spondylolisthesis, adjacent segment degeneration, pseudarthrosis, and total disc arthroplasty conversion. This approach can also be used for anterior corpectomy [1, 3]. LLIF is useful for revision spine surgeries requiring dissection through scar tissue that is adherent to the dura and neural structures. LLIF shows good results in elderly patients with degenerative scoliosis and significant comorbidities because it indirectly decompresses central and foraminal stenosis and corrects regional and global coronal and sagittal balance. This technique is relatively contraindicated if a patient has a low lying L4–L5 disc space, infection, or those with high grade spondylolisthesis due to the location of the lumbar plexus.

## DISCUSSION

### Indications and Contraindications of LLIF:

The indications of LLIF are the same as the other methods of Lumbar spine interbody fusion but this method focuses on the conditions localized to L1 to L5 levels. Degenerative spinal conditions like spinal stenosis, degenerative scoliosis, spondylolisthesis, degenerative disc diseases are the major indications of this procedure. Contraindications to LLIF include severe osteoporosis, active infection, history of serious retroperitoneal infection or disease such as diverticulitis, and previous retroperitoneal dissection or injury.

### Surgical Technique:

The patient is placed on lateral decubitus position after induction of general anaesthesia. A right lateral position is mostly preferred to avoid the risk of injury to Inferior Venacava but left lateral position is also used whenever more direct access to target level or levels is required. Since the lateral position is inherently more unstable than supine or prone position, the patient is secured to table using straps or heavy adhesive tapes. The surgical field should be prepared as widely as possible. Vascular injuries are rare, but in the event that one occurs, the incision can be quickly and readily lengthened for vascular repair [4]. Intraoperative fluoroscopy is used to estimate the operative segment.

A mini-open technique that permits direct visualization of the retroperitoneal space, psoas muscle, and the neural structures as well as digital palpation of the target disc is utilized. An oblique incision is made beginning at the anterior, inferior corner of the caudal vertebral body and directed towards the posterior, superior corner of the cephalad vertebral body. The subcutaneous tissue layer is dissected, and the abdominal muscles are split in line with their fibers to minimize injury to the abdominal nerves. The iliohypogastric and the ilioinguinal nerves, which lie between the internal oblique and the transverses abdominis, are protected. The retroperitoneal space is accessed with gentle sweeping of the peritoneum from posterior to anterior with large sponge sticks to expose the psoas muscle. A transpsoatic dissection is done ventral to the exiting roots. The position of the lumbar plexus is confirmed with neuromonitoring. Retraction is maintained using table-mounted self retaining systems or hand-held renal vein retractors. A single Kirschner (K)-wire is introduced half way into the disc space and its position is confirmed on fluoroscopy. We prefer to position the K-wire in the anterior half of the disc space to allow the implant to be prolordotic. A discectomy is performed using pituitary rongeurs, curettes, and paddle shavers. A Cobb elevator is passed along both endplates to the contralateral side using fluoroscopic guidance, which allows for release of the contralateral annulus. The implant is sized by sequential trials and the position is verified on fluoroscopy. Overstuffing of the disc space should be avoided, as it can result in implant subsidence and fracture of the endplate. Numerous graft options exist to fill the cage. The implant is positioned to span the vertebral body and rest on the apophyseal ring. The implant can be left as a stand-alone or a supplemental screw or plate can be fixed depending on the surgeon's preference and the clinical scenario.

The exposure is irrigated, and the retractors are removed. No drain is required. The transversalis and internal and external obliques are gently closed in layers in an interrupted fashion. The subcuticular layer is sutured with 3-0 monocryl. The anterior fusion can be supplemented by either posterior percutaneous or open pedicle fixation. Fusion is assessed at follow up based on the presence of bridging bone across the disc space and lack of instability across the disc space.

### **Complications:**

Despite the many advantages of the technique, LLIF has its unique set of approach-related complications.

### **Hip Flexion Weakness:**

Hip flexion weakness is very common postoperatively and considered a result of trauma to the psoas muscle during the approach and is probably not related to direct nerve injury. Tomeh et al. reported the results of a prospective multicenter study with 102 patients undergoing LLIF at L3-4 and/or L4-5. In their study, 27.5% of patients experienced postoperative hip flexion weakness, with a grade 4/5 in the majority of cases. The weakness was transient and typically resolved in the first 2 weeks after surgery [5]. Lee et al. evaluated hip flexion strength prospectively with a dynamometer. Similarly, in this study, the authors found hip flexion weakness in the immediate postoperative phase that returned almost to baseline within 2 weeks [6].

### **Neurologic:**

In the largest series to date evaluating potential neurologic complications following LLIF, Lykissas et al [7] reported the incidences of post-operative thigh pain, sensory deficits, and motor deficits in 451 patients (919 operated levels). Complication rates were studied at three time points: immediate postoperative, at most recent followup (range, 6 to 53 months), and in only those patients available at a minimum 18-month follow-up (n = 87). A relatively high rate of potential neurologic issues were reported in the immediate postoperative period, with a 39% incidence of early thigh pain, 38% incidence of early sensory deficit, and 24% incidence of early extremity weakness. These rates decreased to a still notable 9.6% rate of sensory deficit (mostly anterior thigh numbness) and 3.2% rate of ongoing ipsilateral lower extremity (mostly hip flexion) weakness in the group with a minimum 18-months follow-up. Multivariate analysis of the immediate postoperative period suggested that higher rates of complications were observed at the L4-5 level, but this difference was not observed at longer follow-up. These high rates of postoperative complications were of obvious concern to surgeons performing LLIF and have limited more widespread early adoption. [8] Recent reports have demonstrated a notable learning curve that markedly affects the rate of observed complications as well as much lower complication rates among patients treated later in surgical series. Le et al [9] reported on 71 consecutive patients over a 3-year period. They found that the incidence of immediate postoperative anterior thigh numbness decreased by 60% during that time period (from approximately 26% to approximately 11%) (Figure 4). In this series, 92.3% of patients with thigh pain had resolution by 3 months postoperatively. Similarly, Aichmar et al [10] reported on 293 patients treated over a 6-year period in one institution. They analyzed sensory deficits, motor deficits, and thigh pain in three subgroups representing early, middle, and late time periods during their series. The authors found that sensory deficits decreased markedly across the three time periods. Motor deficits also decreased over time, but this trend was not statistically significant, possibly because of low sample size.

### **Vascular:**

Vascular injuries are perhaps the most feared complication of LLIF. Vascular repair in the lateral position would prove to be difficult, at best, because of minimal access and unfamiliar positioning even for the experienced vascular surgeon. Although these complications have turned out to be uncommon, they can be serious and life-threatening. [4]

### **Subsidence:**

Complications related to vertebral endplate fractures and subsidence have also been reported [11, 12]. Brier- Jones et al. [13] reported four cases of coronal plane and compression fractures of the vertebral body in non-osteoporotic individuals. They concluded that endplate breach, instrumentation, cage movement, and subsidence were contributing factors. We treated two cases of atraumatic vertebral body fracture seen 6 weeks postoperatively [14]. These patients had osteoporosis and received supplemental fixation in the form of screws and/or a lateral plate. As a result, we attempt to avoid placing a screw adjacent to the endplate to

prevent a stress riser when using lateral fixation. In addition, we are very cautious when utilizing these implants in a stand-alone fashion in elderly patients.

## CONCLUSION

In the past years, the rate of LLIF procedures performed has increased. LLIF is used for a wide array of indications and can be performed as a standalone procedure or as part of a circumferential fusion. In review of the literature, most authors agree that the placement of a wide interbody cage spanning the dense apophyseal ring and avoiding dissection through the spinal canal or neural foramina are the major advantages of this technique, resulting in good clinical outcomes. Approach-related neurologic deficits, however, remain a concern. In summary, LLIF can be a safe and versatile procedure in patients indicated for anterior fusion with the use of a proper surgical technique.

## REFERENCES

1. Ozgur, B.M., et al., Extreme Lateral Interbody Fusion (XLIF): a novel surgical technique for anterior lumbar interbody fusion. *Spine J*, 2006. 6(4): p. 435-43.
2. Bertagnoli, R. and R.J. Vazquez, The Anterolateral Transpsoatic Approach (ALPA): a new technique for implanting prosthetic disc-nucleus devices. *J Spinal Disord Tech*, 2003. 16(4): p. 398-404.
3. Isaacs, R.E., et al., A prospective, nonrandomized, multicenter evaluation of extreme lateral interbody fusion for the treatment of adult degenerative scoliosis: perioperative outcomes and complications. *Spine (Phila Pa 1976)*, 2010. 35(26 Suppl): p. S322-30.
4. Aichmair, A., et al., Aortic perforation during lateral lumbar interbody fusion. *J Spinal Disord Tech*, 2015. 28(2): p. 71-5.
5. Tohmeh, A.G., W.B. Rodgers, and M.D. Peterson, Dynamically evoked, discrete-threshold electromyography in the extreme lateral interbody fusion approach. *J Neurosurg Spine*, 2011. 14(1): p. 31-7.
6. Lee, Y.P., et al., Evaluation of hip flexion strength following lateral lumbar interbody fusion. *Spine J*, 2013. 13(10): p. 1259-62.
7. Lykissas, M.G., et al., Nerve injury after lateral lumbar interbody fusion: a review of 919 treated levels with identification of risk factors. *Spine J*, 2014. 14(5): p. 749-58.
8. Moller, D.J., et al., Minimally invasive lateral lumbar interbody fusion and transpsoas approach-related morbidity. *Neurosurg Focus*, 2011. 31(4): p. E4.
9. Le, T.V., et al., Postoperative lumbar plexus injury after lumbar retroperitoneal transpsoas minimally invasive lateral interbody fusion. *Spine (Phila Pa 1976)*, 2013. 38(1): p. E13-20.
10. Aichmair, A., et al., An institutional six-year trend analysis of the neurological outcome after lateral lumbar interbody fusion: a 6-year trend analysis of a single institution. *Spine (Phila Pa 1976)*, 2013. 38(23): p. E1483-90.

11. Sharma, A.K., et al., Lateral lumbar interbody fusion: clinical and radiographic outcomes at 1 year: a preliminary report. *J Spinal Disord Tech*, 2011. 24(4): p. 242-50.
12. Karikari, I.O., et al., Minimally invasive lumbar interbody fusion in patients older than 70 years of age: analysis of peri- and postoperative complications. *Neurosurgery*, 2011. 68(4): p. 897-902; discussion 902.
13. Brier-Jones, J.E., et al., Vertebral body fractures after transpsoas interbody fusion procedures. *Spine J*, 2011. 11(11): p. 1068-72.
14. Smith, W.D. and C.F. Huntington, Letter to the editor regarding: Dua K, Kepler CK, Huang RC, Marchenko A. Vertebral body fracture after anterolateral instrumentation and interbody fusion in two osteoporotic patients. *Spine J* 2010;10:e11-5. *Spine J*, 2011. 11(2): p. 166-7; author reply 167.