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HOW I DO IT - SPINE

Extreme lateral interbody fusion (XLIF®): how I do it

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Abstract

Background First introduced by Pimenta et al. in 2001, the extreme lateral interbody fusion (XLIF®) approach is a safe and effective alternative to anterior or posterior approaches to lumbar fusion, avoiding the large anterior vessels and posterior structures including the paraspinous muscles, facet joint complexes and tension bands.

Method The authors provide a detailed description of the surgically relevant anatomy focusing on the close relationship among the lumbar plexus, psoas muscle and lateral spinal column. The surgical technique is detailed step by step, stressing how to avoid complications. A video clip of an XLIF is provided, and important perioperative considerations are listed in detail.

Conclusion The XLIF® approach is a safe procedure allowing an approach to the lateral lumbar spine. Nevertheless, the surgeon's knowledge of anatomical landmarks, response to visual and tactile cues, and intraoperative decision-making skills remain of paramount importance.

Key Points

- *Correct lateral positioning with an orthogonal orientation of the corresponding lumbar vertebral body is of key importance.*
- *Subsequent table repositioning for every level is advised in multilevel cases.*
- *Posterior structures including the paraspinous muscles, facet joint complexes and tension bands are mostly preserved.*
- *Meticulous preoperative planning of the psoas docking point, considering all level-specific vascular and neuronal elements, is of paramount importance.*
- *In general, concavity is recommended for the selection of the approach side.*
- *A careful endplate and contralateral preparation and release are mandatory in order to allow bony fusion and maximum indirect foraminal decompression.*
- *Using a perioperative dexamethasone bolus seems to be effective at the L4/5 level to reduce postoperative plexopathy.*
- *Overdistraction should be avoided in order to prevent cage subsidence.*
- *A major disadvantage is the relatively high, but mostly only transient, incidence of psoas weakness as well as hip-groin-thigh pain, dysaesthesia and/or numbness.*
- *Major advantages include indirect neurological decompression, minimal blood loss, shorter operation times, decreased overall infection rates and more surface for bony fusion.*

Keywords Extreme lateral interbody fusion, XLIF® · Minimally invasive spine surgery · Directional neuromonitoring

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Relevant surgical anatomy

The surgical pathway for an extreme lateral interbody fusion (XLIF®) approach consists of three parts: (1) lateral flank, (2) retroperitoneal and (3) transpsoas. The first part includes the passage through the obliquus externus and internus abdominis as well as the transversus abdominis muscle in a blunt parallel muscle fiber-splitting technique [2]. During the second part, the important structures include the subcostal, iliohypogastric, ilioinguinal and lateral femoral cutaneous nerves (Table 1 and Fig. 1) [2, 3]. Additionally, attention has to be paid to the course of the genitofemoral nerve, supplying sensory innervation to the femoral triangle and the cremaster muscle in males and the skin of the mons pubis and labia majora in females. The third part requires understanding of the lumbar plexus, which migrates from a dorsal to ventral location from the L1-2 down through the L4-5 disc space (Fig. 1) [5].

Description of the surgical technique

The patient is placed in a lateral decubitus position with the iliac crest directly over the table break after electrode installation for triggered EMG neuromonitoring. The patient is fixed with adhesive tape (over the thoracic and subaxillar area and pelvis) around the table. Overbreaking of the table is contraindicated in order to avoid too much tension of the psoas muscle. After re-adjustment of the table in order to obtain aligned spinous processes and endplates, the patient is fixed securely. After a 4-cm skin incision, a blunt dissection is performed until the superficial fascia of the obliquus externus is exposed. The fascia is opened followed by a blunt muscle-splitting technique through the three muscle layers. Once the last muscle layer has been opened, epidural fat is seen and felt manually. In the lateral position gravity clears most of the abdominal content away from the field. Any remaining peritoneum or fat is gently dissected from the lateral surface of the psoas in an anterior direction.

Passage through the psoas is made by directional, continuously triggered EMG neuromonitoring on dilators. This “neuromapping” around the dilator is a crucial safety element. If the dilatator is in such a safe zone, a K-wire is inserted into the disc through the dilator, and its position is confirmed with biplanar fluoroscopy. The self-retaining retractor is subsequently introduced over the third dilatator and fixed to the table. After visual inspection and neuromonitoring control, the intradiscal shim is introduced through the posterior blade in order to stabilize the self-retaining retractor.

Thereafter, a classic discectomy is performed consisting of first detaching the disc from the endplates with a Cobb elevator

Table 1 Summary of nerves [1]

Nerve	Roots	Muscles innervated
Subcostal	Th12	Rectus abdominis, external oblique
Iliohypogastric	Th12-L1	Transverse abdominis, internal oblique
Ilioinguinal	L1	Transverse abdominis, internal oblique
Lateral femoral cutaneous	L2-L3	-

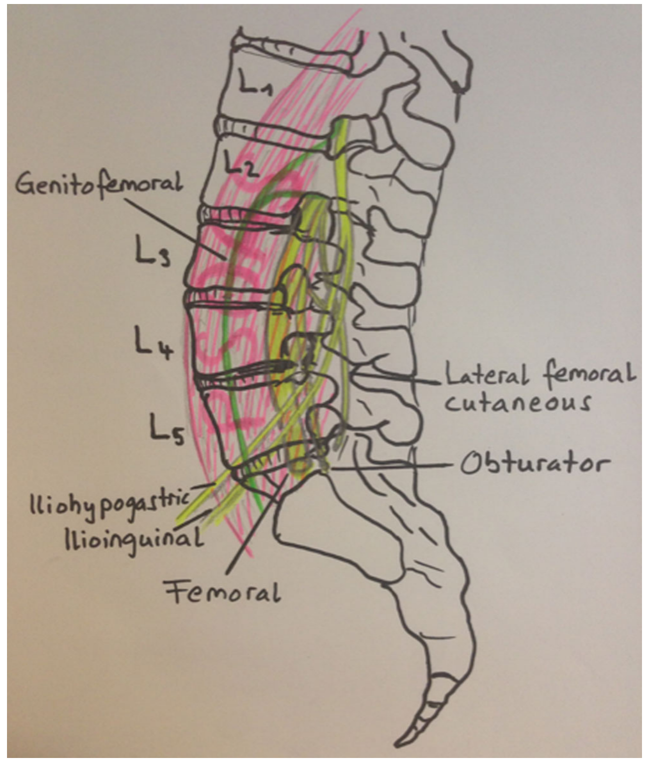

Fig. 1 Schematic drawing of the lumbar plexus from the lateral view. © by the authors

followed by contralateral annulus release. After choosing a definitive cage with the trials, and while the scrub nurse prepares the definitive implant with graft material, final endplate preparation is made with non-aggressive instruments. An appropriate lateral-to-lateral cage length should be chosen in order to give full coverage of the disc space. After cage implantation, the surgical site is thoroughly irrigated. Distraction from the self-retaining retractor is released, and the retractor is removed slowly under visual control for any bleeding. Thereafter, a final anteroposterior and lateral fluoroscopy control is obtained to ensure proper positioning of the cage.

The table is returned to the neutral position, and the fascia over the external oblique is closed with single sutures, followed by subcutaneous single sutures and a final resorbable intradermal running suture. A sterile dressing is applied, and afterwards, uni- or bilateral percutaneous pedicle-screw fixation in the same position, or in the prone position, is performed in the usual manner.

Indications

Some possible indications are single or multilevel degenerative disc disease, adult scoliosis, grade 1 to 2 spondylolisthesis, lumbar spondylosis with instability, lumbar stenosis, adjacent segment disease, trauma, disc replacement revision surgery, pseudoarthrosis, tumor, infections and eventually thoracic disc

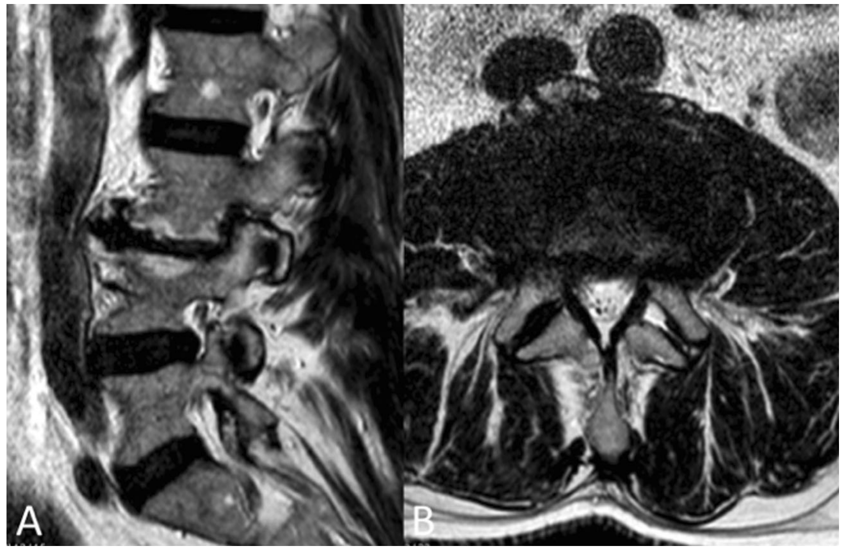

Fig. 2 Preoperative lumbar MRI, (**a**) sagittal and **b**) axial, showing a right-sided L3 foraminal stenosis

herniation (Figs. 2 and 3) [1]. The authors perceive the superiority of this approach in: (1) revision cases as it allows for a new, virgin access corridor, (2) osteoporosis patients because of the reduced risk of cage subsidence associated with large-footprint cages, (3) foraminal stenosis cases as restoration of the disc height permits indirect decompression (Figs. 4 and 5) and (4) de novo scoliosis cases as the large, laterally placed cages permit coronal and some sagittal realignment of the spine.

Limitations

The XLIF® approach is limited to levels from T6 down to L4-L5. Venous anatomical variants and a teardrop-shaped psoas with an anteriorly located plexus can preclude the approach to L4-L5. Extreme osteoporosis is a relative contraindication for any interbody cage technique because of an increased risk of peroperative endplate violation or postoperative cage subsidence. Although the dimension of indirect decompression can be extensive, as shown in Figs. 4 and 5, the XLIF technique has a limitation in case of severe central stenosis without spondylolisthesis. In these cases, a subsequent "classic" decompression might be mandatory in order to guarantee sufficient neuronal decompression.

How to avoid complications

A thorough radiological preoperative assessment of the lumbar spine with meticulous planning of the approach side and the psoas docking station point, considering all level-specific vascular and neuronal elements, is essential. Similarly, a

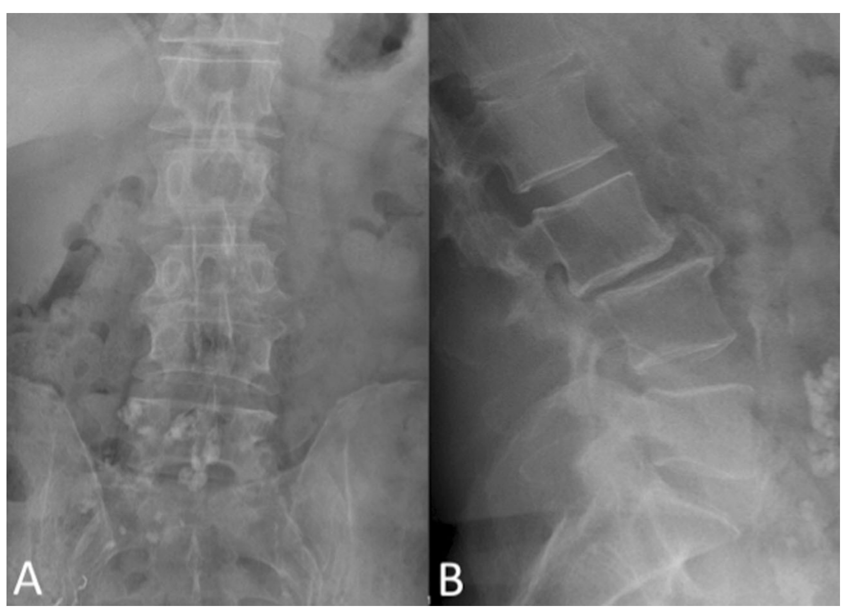

Fig. 3 Preoperative conventional images, (**a**) coronal and (**b**) lateral, showing degenerative L3/4 disc disease with a retrolisthesis and foraminal stenosis

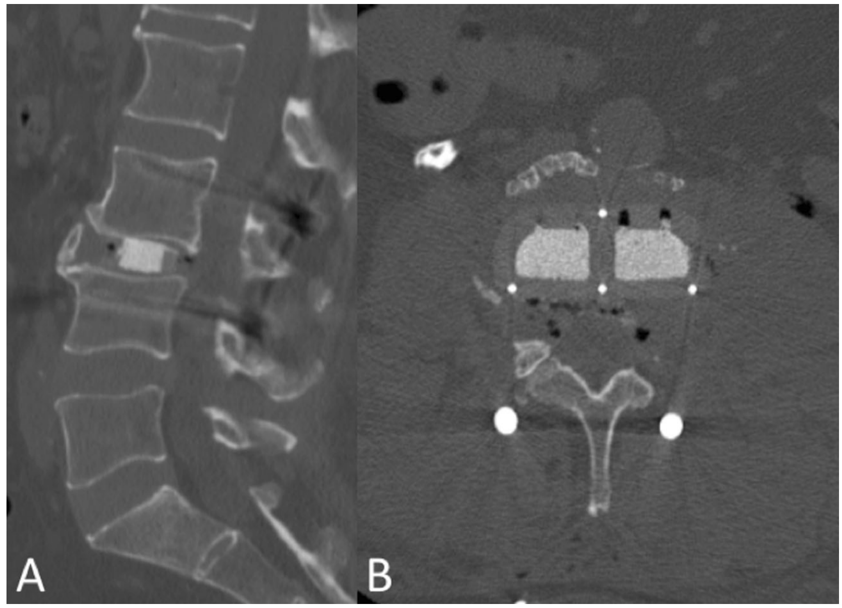

Fig. 4 Postoperative lumbar CT scanner, (**a**) sagittal and (**b**) axial, showing the XLIF cage in place, a complete reduction of the retrolisthesis and an open L3 foramen on the right side (indirect decompression)

correct lateral positioning with an exactly aligned orthogonal orientation of the corresponding lumbar vertebral body prior to the skin incision is important. Furthermore, a sophisticated directional triggered EMG is crucial to minimize the risk of lumbar plexus injury.

Specific perioperative considerations

After the procedure, the authors' preference is allowing for bed rest for the day of surgery. The next day, patients are allowed to stand up, walk and sit with the assistance of a physiotherapist, after instructions on avoidance of trunk flexion and torsion and after adequate postoperative imaging has been obtained (radiographs or CT scan). A standing biplanar full spine x-ray is obtained before the discharge and at 6 weeks after surgery. The length of stay for these procedures may vary depending on resource availability, the patient's condition and expectations, and even preoperative patient instructions. Return to work is recommended after approximately 6 weeks to 2 months, according to the workload intensity.

Specific information to give the patient about surgery and potential risks

Patients should be informed about the surgical pathway. They should sign an information form where the type and site of

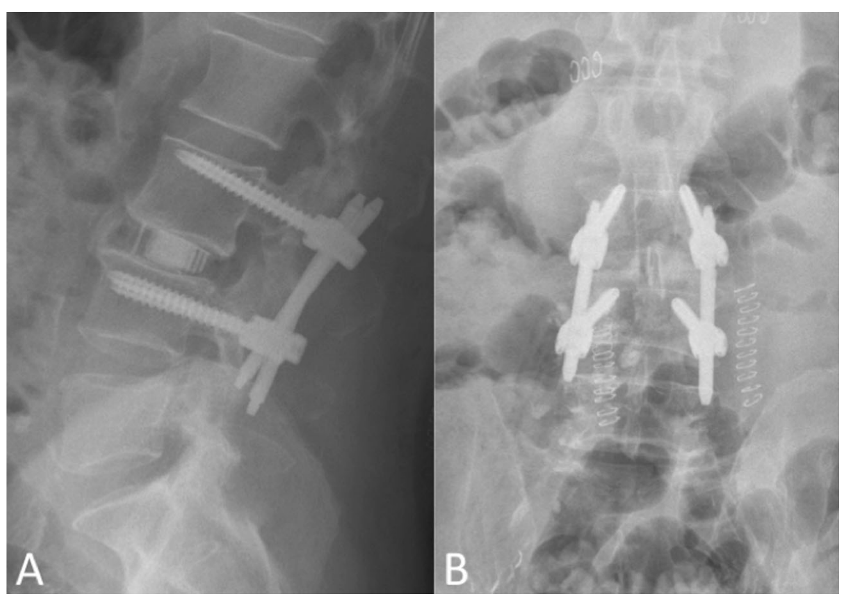

Fig. 5 Postoperative conventional X-rays, (**a**) lateral and (**b**) coronal, with posterior bilateral percutaneous fixation

surgery, most common side effects, complications and surgical expectations are detailed. Patients should also be aware of possible general and specific complications. General complications include deep or superficial infections and hematoma at the surgical site. The most frequent side effect of the XLIF® approach is postoperative "thigh" symptoms, with a relatively high overall incidence of an average of one of five patients (0.7–62.7 % according to the literature) [4]. These so-called thigh symptoms include thigh paraesthesia, thigh numbness and motor weakness affecting hip flexion. However, the patient has to be informed that most of these sensory and/or motor deficits are transient and recover with a 50 % recovery rate at 3 months and 90 % recovery rate after 1 year.

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