29 Pre-psoas Approaches for Thoracolumbar Interbody Fusion

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Learning Objectives/Key Points

- Understand the relevant anatomy associated with the antepsoas approach
- Understand the key benefits of the antepsoas approach compared to ALIF and LLIF
- Overview of surgical technique

29.1 Background

Degenerative pathologies of the lumbar spine are common and can include degenerative disk disease, spinal stenosis, spondylolisthesis, or deformity. Regardless of the etiology, compression of neurologic structures can result in radiculopathy, claudication, and pain. When non-operative treatment modalities fail, the mainstay of surgical treatment options involve decompression with or without fusion of the involved spinal levels [1]. Interbody arthrodesis techniques are a useful method to achieve fusion, indirectly decompress neurologic structures, and correct deformity in the coronal and sagittal plane [2]. The most common approaches to interbody fusion of the lumbar spine can be categorized into posterior approaches that traverse the paraspinal musculature and anterior muscle-sparing approaches. Posterior approaches include posterior lumbar interbody fusion (PLIF) and transforaminal lumbar interbody fusion (TLIF). Anterior approaches include anterior lumbar interbody fusion (ALIF), lateral lumbar interbody fusion (LLIF), and most recently antepsoas (ATP) lumbar interbody fusion, also known as oblique lumbar interbody fusion (OLIF) (Fig. 29.1) [2, 3].

The increasing popularity of minimally invasive surgery (MIS) has led to an increased interest in anterior interbody fusion techniques [4]. Traditionally, the ALIF approach has been associated with risk of vascular injury, ileus, and retrograde ejaculation [2, 3]. LLIF approach was introduced in 2006 to allow avoidance of the great vessels, but the drawbacks include injury to the lumbar plexus and inability to reliably access the L4–5 and L5–S1 disc spaces [2, 5]. Moreover, due to location of the lumbosacral plexus within the psoas muscle, neuromonitoring is required during LLIF procedures [6]. The ATP/OLIF approach to lumbar spine is a laterally based muscle-sparing approach to the lumbar spine that combines the benefits of ALIF and LLIF. It allows retroperitoneal approach to the lumbar spine through an oblique corridor, simultaneously avoiding retraction of the great vessels while also avoiding traversing the psoas and lumbar plexus.

A primary benefit of approaching the spine anterior to the psoas is that the risk of injury to the femoral nerve and genitofemoral nerves are drastically decreased. The psoas is able to be retracted posteriorly gently, especially at L2/3 and L4–5. Furthermore, direct nerve neuromonitoring may not be required with surgical experience.

Key Point
The antepsoas approach to the lumbar spine is an MIS approach that combines the benefits of ALIF and LLIF by traversing the corridor between the great vessels and the psoas major.

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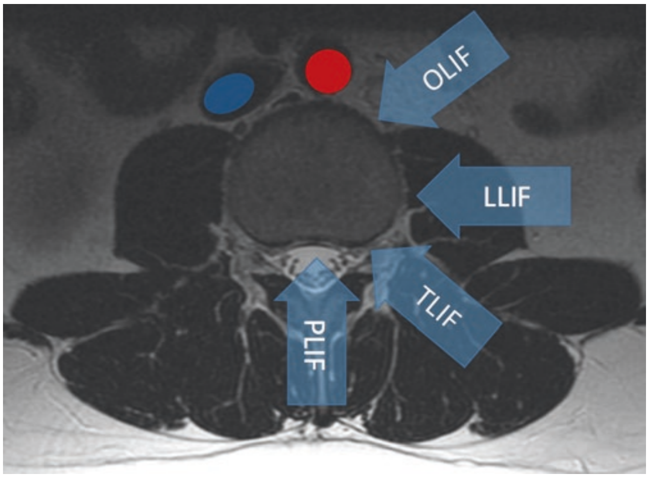

Fig. 29.1 Surgical approaches to the lumbar spine

29.2 Anatomy

While most surgeons are familiar with the traditional posterior approach to the lumbar spine, it is important to understand the unique anatomic structures at risk when performing lateral and antepsoas approaches to the lumbar spine.

At the most superficial level, the surgical corridor is framed in the cephalad direction by the 12th rib and caudally by the iliac crest. The iliac crest is typically at the level of the L4–5 disc and can often limit access to L4–5 during LLIF (Fig. 29.2), requiring "jack-knifing" of the operating table. The ATP/OLIF approach takes advantage of the caudal slope of the iliac crest in the anterior direction and allows reliable access to the L4–5 disc space without needing to break the operating table.

When starting the approach, the three abdominal wall muscles, the external oblique, internal oblique, and transversus abdominis, are encountered. Due to their segmental innervation, denervation typically does not occur with blunt dissection or electrocautery [7].

Similar to other anterior approaches, the ATP/OLIF approach traverses the retroperitoneal plane to gain access to the lumbar spine. A significant advantage of ATP/OLIF over ALIF is the lateral patient positioning, which allows the peritoneal contents and great vessels drop away from the surgical field with gravity [8]. The ureter is attached loosely to the peritoneum and usually falls away along with the peritoneal contents, but care should be taken to ensure it is out of the surgical field, especially at the distal levels [9].

The posterior aspect of the surgical corridor is marked by the psoas major. The sympathetic chain lies between the vertebral body and the psoas muscle. The genitofemoral nerve lies on the anteromedial aspect of the psoas muscle. The lumbosacral plexus courses through the psoas muscle in a posterior to anterior direction from L1 to L5 [10]. In comparison to the LLIF, the ATP/OLIF approach does not traverse the psoas muscle and lumbosacral plexus, and thus neuromonitoring is not required.

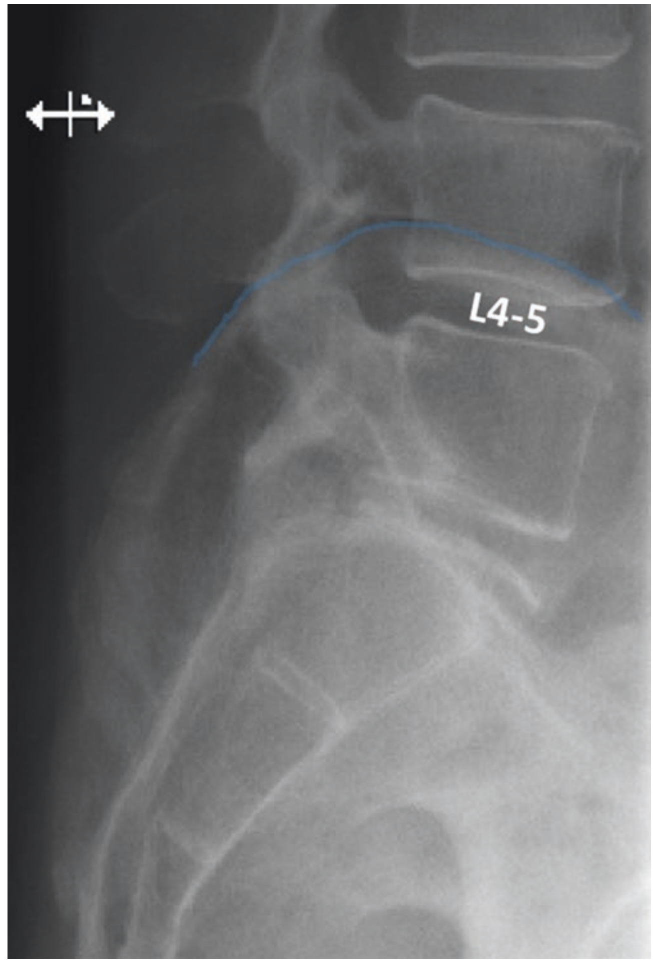

Fig. 29.2 Patient with high-riding iliac crest

The anterior border of the surgical corridor consists of the great vessels. When approaching from the left side, the aorta is encountered first, while on the right the vena cava is encountered first. Left-sided approaches are generally preferred because the aorta is less easily torn during retraction.

Based on MRI studies, the corridor available to access the interspace is 16 mm at L2–3, 14 mm at L3–4, 10 mm at L4–5, and 10 mm at L5–S1 [11]. Mild psoas retraction can be performed to enlarge the interval, but there is a "psoas sling" at L3/4 that has to be released in order to mobilize this level.

> **Key Point**
> A key advantage of the antepsoas approach over an ALIF approach is the lateral positioning, which allows the abdominal contents to fall away from the surgical corridor with gravity. The lateral position also facilitates single-position 360-degree fusion, in which an antepsoas approach for interbody fusion is combined with MIS posterior pedicle screw instrumentation.

29.3 Surgical Technique

1. Preoperative planning
   (a) Study axial MRI to identify common iliac vessels and determine laterality of approach.
   (b) Generally a left-sided approach will be used.
2. Positioning
   (a) Place the patient in right lateral decubitus position on a radiolucent table with bony prominences padded (Fig. 29.3).
   (b) Ensure patient positioned anteriorly on table so as peritoneal contents fall forward.
   (c) Ensure patient is taped securely to prevent rotation during surgery.
   (d) The surgeon position is anterior to the patient.
   (e) Tilt the table in slight Trendelenburg.
   (f) No breaking of the table is necessary.
   (g) Ensure true AP and lateral fluoroscopic images of the lumbar spine are attainable.
   (h) Allow for 270-degree prep if percutaneous robotic or navigated posterior instrumentation is planned (Fig. 29.4).
3. Fluoroscopic localization
   (a) Mark the iliac crest, 12th rib, and anterior superior iliac spine.
   (b) Identify and mark the relevant disc spaces under fluoroscopy.
   (c) For L2–L5

Fig. 29.3 Right lateral decubitus positioning with bean bag

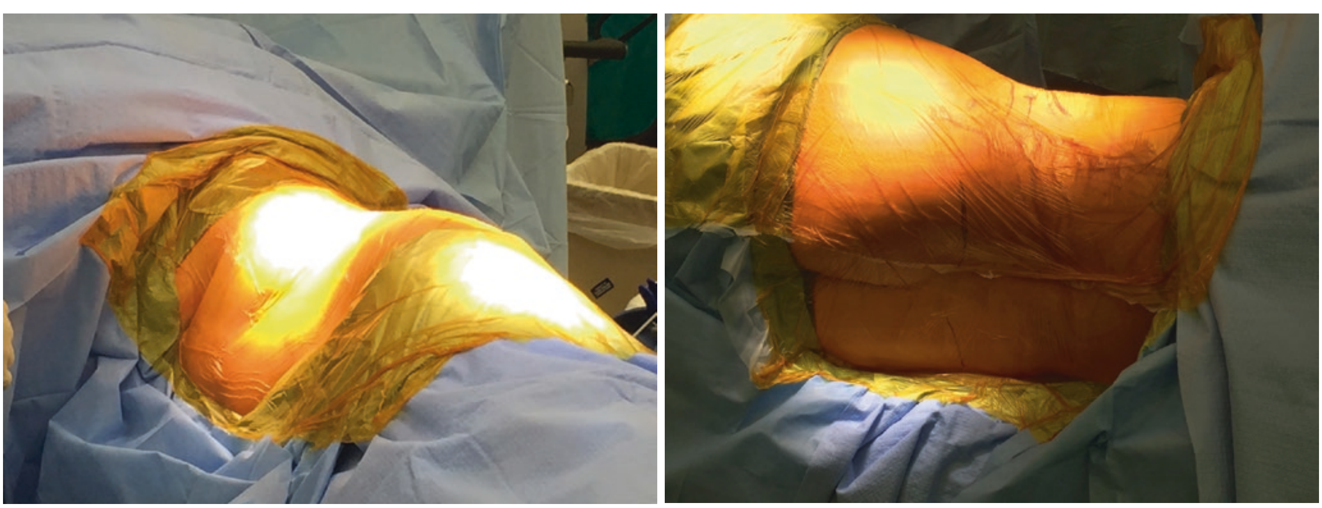

Fig. 29.4 A 270-degree prep for posterior instrumentation

(i) Mark a longitudinal incision 6 cm anterior to the midportion of the disc space. Separate incisions may be necessary if greater than two levels are approached (Fig. 29.5).

(d) For L5/S1

(i) Extend a line from the L5–S1 disc space 2 inches past ASIS.

(ii) Draw a second horizontal line from the center of the disc space straight down to the table.

(iii) The incision will be a 6 cm longitudinal incision connecting these two lines, two fingerbreadths anterior to the ASIS (Fig. 29.6).

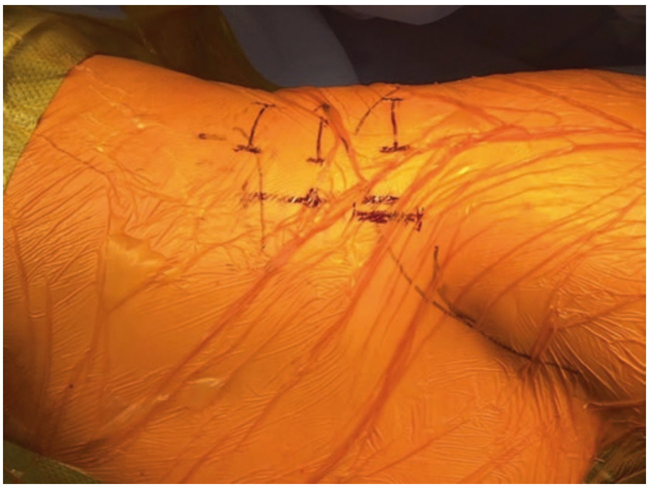

Fig. 29.5 Skin marking showing 12th rib; iliac crest; L2–3, L3–4, and L4–5 discs; and two planned skin incisions

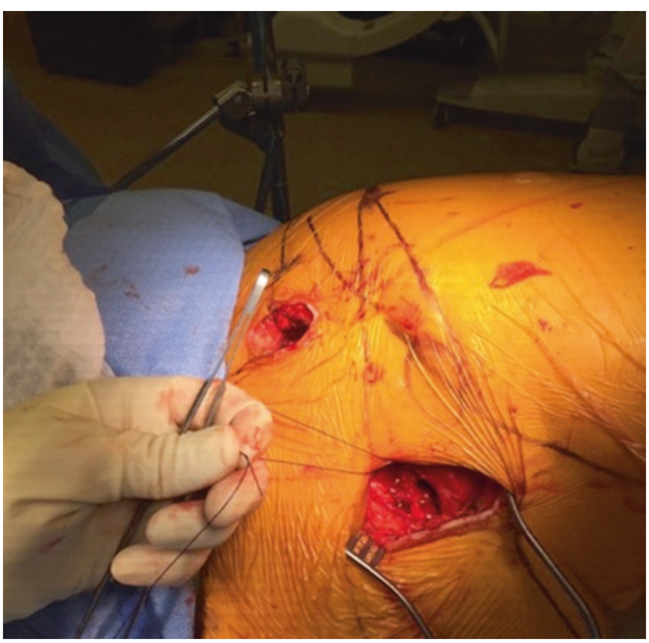

Fig. 29.6 The skin incisions for L4–5 and L5–S1 approaches

4. Approach retroperitoneal space
   (a) Bluntly dissect external oblique, internal oblique, transversus abdominis, and transversalis fascia (Fig. 29.7).
   (b) Preserve iliohypogastric and ilioinguinal nerves, which may cross the field at the L4–5 level between the internal oblique and transversus abdominis [12].
5. Approach disc space
   (a) Handheld retractors are used to gain initial access to disc space.
   (b) For L2–L5
      (i) Palpate psoas and then move finger anterior to palpate the spine through the oblique corridor.
      (ii) With a finger on the spine and protecting the great vessels ventrally, slide smallest dilator onto disc space dorsally.
      (iii) Confirm radiographically that the position of the dilator is 30–40% from the front of the disc.
      (iv) Sequentially dilate with tubular retractors (Fig. 29.8).
      (v) Perform gentle lateral retraction on psoas to increase exposure.

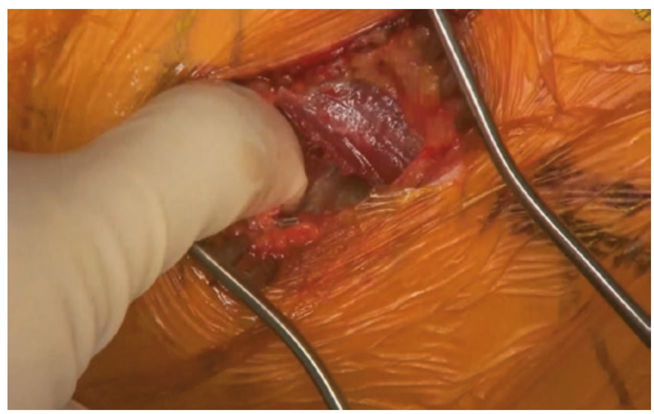

Fig. 29.7 Blunt dissection of abdominal wall musculature

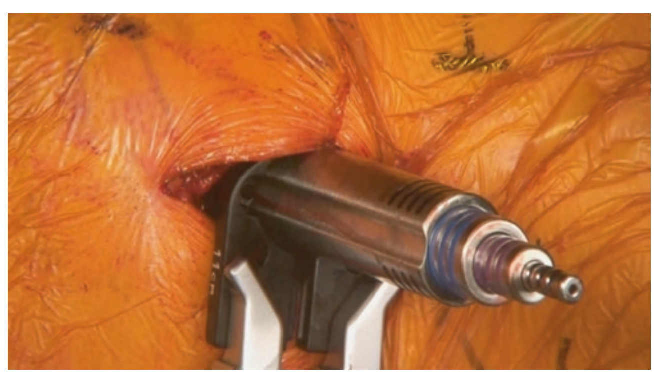

Fig. 29.8 Sequential dilation with tubular retractors

   (c) For L5/S1
      (i) Palpate inner table of ileum with palm up.
      (ii) Sweep finger laterally to palpate psoas sling and iliac artery.
      (iii) Identify common iliac vessels.
      (iv) Use bipolar cautery to cauterize sacral vessel.
      (v) Mobilize adventitial layer on anterior disc space prior to mobilizing common iliac vessels.
      (vi) Ligation of iliolumbar vein may be necessary to mobilize vessels.
      (vii) Secure table-mounted retractors.
6. Disc preparation
   (a) Mark midline of disc space and confirm radiographically (Fig. 29.9).
   (b) Perform annulotomy.
   (c) Perform discectomy and prepare disc space sequentially using disc shavers, pituitary rongeurs, straight and curved curettes, and Kerrison rongeurs (Fig. 29.10).
   (d) Do not use shaver for implant sizing as this may lead to endplate violation.
   (e) Denude endplates of cartilage and to reveal bleeding bony surfaces, without compromising the integrity of the endplate.
   (f) The ALL can be released if significant lumbar lordosis is needed. At L5–S1, the ALL is released as part of the approach.
7. Graft sizing and placement
   (a) Trail implant.
   (b) Check implant sizing fluoroscopically. Interbody cage should extend to the apophyseal ring on both sides to prevent graft subsidence.
   (c) Our preference is to fill the cage with rhBMP2 and demineralized bone fiber or iliac crest bone graft.
   (d) Place final implant (Fig. 29.11).
   (e) Obtain final films (Fig. 29.12).
8. Wound closure
   (a) Close abdominal wall musculature in layers.

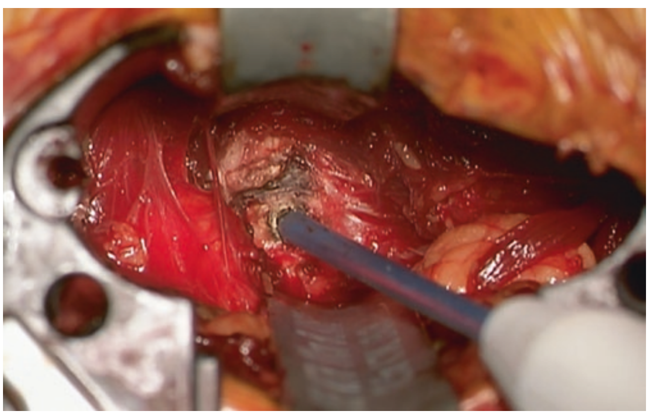

Fig. 29.9 Midportion of disc space is marked with bovie tip and confirmed radiographically

29.4 Results

The early clinical results of the OLIF approach to lumbar interbody fusion are promising, with low blood loss, low rate of neurologic and vascular complications, and high fusion rates. However, most studies consist of small case series with short-term follow-up [13].

In 1997, Mayer described the OLIF approach and reported on initial results in 20 patients who underwent OLIF between L2 and L5 with iliac crest autograft. Mean operating time was 111 minutes; mean blood loss was 67.8 mL at the fusion site. No complications were reported [14].

Fig. 29.10 Discectomy with disc shaver

Fig. 29.11 Insertion of lordotic cage packed with rhBMP2 and demineralized bone fiber

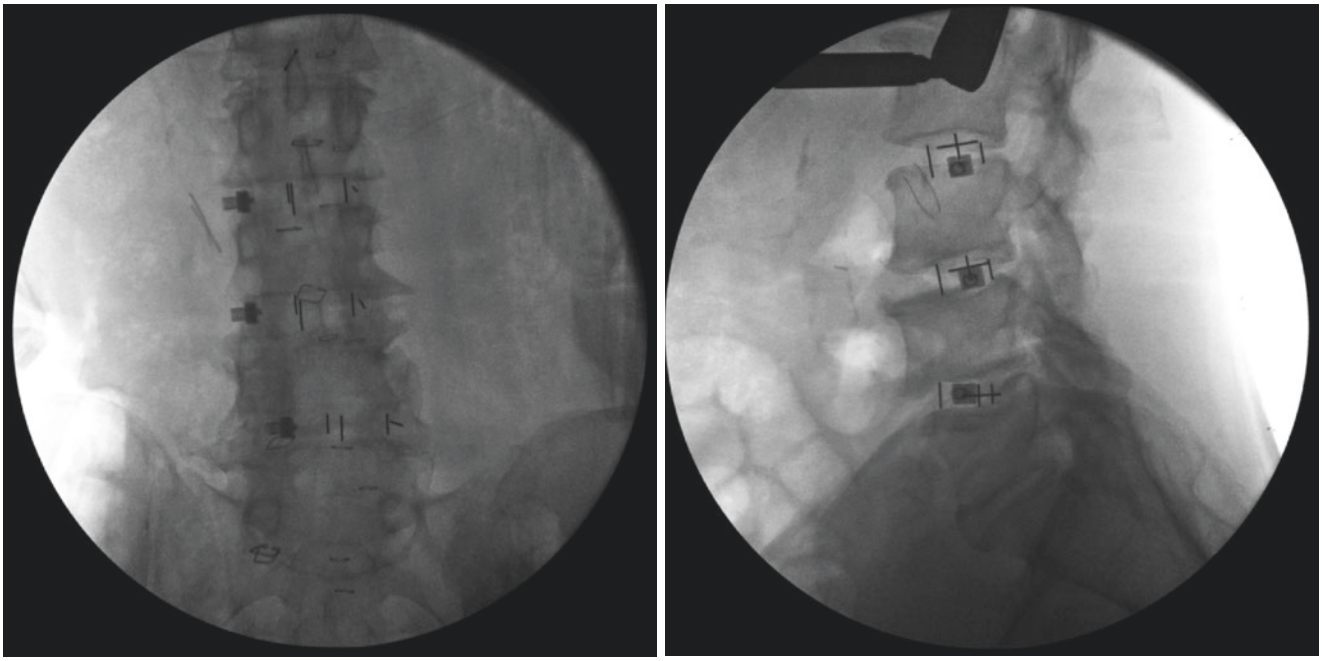

Fig. 29.12 Final fluoroscopic films showing restoration of disc height and segmental lordosis

In 2012, Silvestre et al. reported results on 179 patients who underwent OLIF between L1 and S1. Postoperative complications included three sympathetic chain injuries, two neurologic deficits, two transient paresthesias, three venous lacerations, one case of ileus, and one peritoneal laceration [15].

Mehren et al. reported on inpatient complications of 812 patients who underwent left-sided OLIF between L1 and L5. There were three vascular complications (0.37%), three neurologic complications (0.37%), no abdominal injuries, and no urologic injuries. All three vascular injuries were at L4–5 level, and two of the three neurologic injuries were at the L4–5 level [16].

Woods et al. reported minimum 6-month results on 137 patients and 340 fusion levels. Most common complications were subsidence (4.4%), ileus (2.9%), and vascular injury (2.9%). Ileus and vascular injuries were only seen in cases involving L5–S1. 97.9% of levels were fused at 6 months [9].

Key Point
Early clinical studies demonstrate that the antepsoas approach results in low blood loss and low rate of neurologic and vascular complications.

29.5 Summary

The ATP approach to the lumbar interbody fusion is a useful technique that combines the benefits of ALIF and LLIF. This approach allows anterior access to the entire lumbar spine in a single lateral position, facilitates placement of a large interbody cage, and traverses a corridor that avoids the great vessels and lumbar plexus.

29.6 Pearls and Pitfalls

- Pearls
  - Understand preoperative sagittal alignment and surgical goals.
  - Choose approach based on patient pathology and surgeon experience—multiple approaches to lumbar spine available.
  - Maximize correction through interbody space.
  - Interbody graft should contact apophyseal ring bilaterally to prevent subsidence.
- Pitfalls
  - Overaggressive retraction on psoas
  - Endplate violation with disc shaver

Summary

The antepsoas approach to lumbar interbody fusion is an effective technique for the treatment of degenerative lumbar pathology. It is a useful technique that combines the benefits of ALIF and LLIF. This approach allows anterior access to the entire lumbar spine in a single lateral position, facilitates placement of a large interbody cage, and traverses a corridor that avoids the great vessels and lumbar plexus.

Similar to other MIS techniques, the learning curve for the antepsoas approach is significant. However, the early clinical results of the antepsoas approach to lumbar interbody fusion are promising, with low blood loss, low rates of neurologic and vascular complications, and high fusion rates.

Quiz Questions

1. *What nerve descends over the surface of the psoas major muscle?*
   (a) Obturator nerve
   (b) Genitofemoral nerve
   (c) Ilioinguinal nerve
   (d) Pudendal nerve
   (e) Sciatic nerve
2. *What are the advantages of OLIF over LLIF?*
   (a) Single position for L2–S1
   (b) No need to "jack-knife" operating table
   (c) Decreased risk for neurologic complications associated with lumbar plexus
   (d) May obviate the need for neuromonitoring
   (e) All of the above

Answers

1. b
2. e

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