

The Oblique Anterolateral Approach to the Lumbar Spine Provides Access to the Lumbar Spine With Few Early Complications

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Abstract

Background During the last 20 years several less-invasive anterior approaches to the lumbar spine have become standard, including the extreme lateral transpsoas approach. Although it is associated with a lower risk of vascular injury compared with anterior midline approaches, neuromonitoring is considered mandatory to avoid neurologic complications. Interestingly, despite neuromonitoring, the reported risk of neurologic deficits with the extreme lateral transpsoas approach is greater than observed with other anterior approaches. An alternative lateral, oblique, psoas-sparing approach, recently named the oblique lumbar interbody fusion, uses the anatomic pathway between the abdominal vessels anteriorly and the lumbar plexus laterally

to decrease the risk of neurologic and vascular injury; however, as yet, little on this new approach has been reported.

Questions/purposes We asked: what proportion of patients experienced (1) perioperative complications (overall complications), (2) vascular complications, and (3) neurologic complications after less-invasive anterior lumbar interbody fusion through the oblique lumbar interbody approach at one high-volume center?

Methods We performed a chart review of intra- and perioperative complications of all patients who had undergone minimally invasive anterior lumbar interbody fusion through a lateral psoas-sparing approach from L1 to L5 during a 12-year period (1998–2010). During the study period, the oblique, psoas-sparing approach was the preferred approach of the participating surgeons in this study, and it was performed in 812 patients, all of whom are studied here, and all of whom have complete data for assessment of the short-term (inpatient-only) complications that we studied. In general, we performed this approach whenever possible, although it generally was avoided when a patient previously had undergone an open retro- or transperitoneal abdominal procedure, or previous implantation of hernia mesh in the abdomen. During the study period, posterior fusion techniques were used in an additional 573 patients instead of the oblique lumbar interbody fusion when we needed to decompress the spinal canal beyond what is possible through the anterior approach. In case of spinal stenosis calling for fusion in combination with a high disc space, severe endplate irregularity, or severe biomechanical instability, we combined posterior decompression with oblique lumbar interbody fusion in 367 patients. Complications were evaluated by an independent observer who was not involved in the decision-making process, the operative procedure, nor the

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Each author certifies that his or her institution has approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained. This work was performed in the Schön Klinik München Harlaching, Munich, Germany.

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postoperative care by reviewing the inpatient records and operative notes.

Results A total of 3.7% (30/812) of patients who underwent the oblique lumbar interbody fusion experienced a complication intraoperatively or during the hospital stay. During the early postoperative period there were two superficial (0.24%) and three deep (0.37%) wound infections and five superficial (0.62%) and six deep (0.86%) hematomas. There were no abdominal injuries or urologic injuries. The percentage of vascular complications was 0.37% (n = 3). The percentage of neurologic complications was 0.37% (n = 3).

Conclusions The risk of vascular complications after oblique lumbar interbody fusion seems to be lower compared with reported risk for anterior midline approaches, and the risk of neurologic complications after oblique lumbar interbody fusion seems to be lower than what has been reported with the extreme lateral transposas approach; however, we caution readers that head-to-head studies will need to be performed to confirm our very preliminary comparisons and results with the oblique psoas-sparing approach. Similarly, future studies will need to evaluate this approach in terms of later-presenting complications, such as infection and pseudarthrosis formation, which could not be assessed using this inpatient-only approach. Nevertheless, with the results of this study the oblique psoas-sparing approach can be described as a less-invasive alternative for anterior lumbar fusion surgery from L1 to L5 with a low risk of vascular and neurologic damage and without costly intraoperative neuromonitoring tools.

Level of Evidence Level IV, therapeutic study.

Introduction

Anterior lumbar interbody fusion was introduced by Carpener in 1932 [9], and since then has been modified and refined by numerous authors for various surgical indications [8, 10, 17, 21, 27, 35, 45]. Regardless of the approach used to achieve anterior lumbar interbody fusion (anterior midline, pararectal, anterolateral, retroperitoneal, transperitoneal, or others), a major challenge is management of the retroperitoneal blood vessels. For medicolegal reasons in some countries, an “access surgeon” is commonly used even for experienced surgeons to perform this approach [6, 13, 14]. To overcome this problem and to turn an anterior lumbar interbody fusion procedure into a less-invasive procedure, an anterolateral, minimally invasive approach was introduced by Mayer in 1997 [28]. This muscle-splitting lateral approach exposes the disc space obliquely anterior to the psoas muscle. It later was modified by McAfee et al. [30] and Ozgur et al. [38] into a transmuscular, psoas-splitting access, which has become

more popular recently as the extreme lateral transposas approach for interbody fusion technique. Although the disc space can be reached from a strictly lateral direction, this approach risks neurologic injuries while dissecting the psoas muscle [4]. This is why neuromonitoring is considered mandatory [38, 40]. However, even with neuromonitoring there is a high risk of approach-related neurologic and muscular complications. The risk of postoperative hip flexor and quadriceps weakness, which are considered to be approach-related muscular trauma, range between 20% and 36%, whereas sensory deficits and anterior thigh pain range between 25% and 75% and 23% and 60%, respectively [15, 20, 25, 33, 43, 46].

Davis et al. [11], in a cadaveric study, described the retroperitoneal oblique corridor to the L2 to S1 intervertebral discs. They concluded that use of this oblique corridor, anterior to the psoas muscle, may avoid many of the anatomic structure-associated complications with the anterior or transposas approaches. However, studies on intra- and perioperative complications of the oblique psoas-sparing approach have been based on small cohorts of patients undergoing surgery for different indications [36, 37, 42]. Silvestre et al. [44] reported the results of 179 patients who underwent oblique lumbar interbody fusion, but a single-center series focusing on inpatient complications has not been reported to our knowledge.

We therefore asked: What proportion of patients experienced (1) perioperative complications (overall complications), (2) vascular complications, and (3) neurologic complications after less-invasive anterior lumbar interbody fusion through the oblique psoas-sparing approach without neurologic monitoring at one high-volume center?

Patients and Methods

We conducted a chart review of patients who had undergone minimally invasive anterior lumbar interbody fusion through an oblique anterolateral approach from L1 to L5 during a 12-year period (1998–2010) at a single center.

During the study period, the oblique psoas-sparing approach was the preferred approach of the participating surgeons in this study, and it was performed in 812 patients (317 females, 495 males) with a median age of 63 years (range, 16–88 years), all of whom are included here, and all of whom have complete data for assessment of the short-term (inpatient-only) complications. In general, we performed this approach whenever possible, although it typically was avoided when a patient previously had undergone an open retro- or transperitoneal abdominal procedure or previous implantation of hernia mesh in the abdomen. During the study period, posterior fusion

techniques were used in an additional 573 patients instead of oblique lumbar interbody fusion when we needed to decompress the spinal canal beyond what is possible through the anterior approach. In case of spinal stenosis calling for fusion in combination with a high disc space, severe endplate irregularity, or severe biomechanical instability, we combined posterior decompression with oblique lumbar interbody fusion in 367 patients. During this time, the oblique psoas-sparing approach was the preferred approach in patients with infections, revisions, and vertebral-body fractures undergoing vertebral body replacements, which we believe represented the highest-risk situations for vascular injuries.

The patients' records were reviewed by an independent research fellow (CZ) for patient demographics, diagnosis, comorbidities, type of operative procedure, levels of surgery, operating time, and intra- and postoperative complications related to the access surgery. A vascular complication was defined as any violation of the large abdominal vessels, including the vena cava, iliac veins, ascending lumbar vein, and the aorta or iliac arteries. A neurologic complication was defined as any obvious violation of a nerve structure or a new postoperative neurologic finding such as muscle weakness or sensory deficit which could not be explained by the posterior surgery.

Degenerative disc disease and translational instabilities represent the predominant indications that led to surgery (86%). In 61 patients (8%) an infection and in 39 patients a fracture of a lumbar vertebra (5%) had led to surgery. The remaining patients included those with failed back surgery syndrome (1%, nine of 812) and with tumors (0.4%, three of 812). The operative technique was highly standardized, and based on the original technique as described by Mayer in 1997 [28]. The access to the lumbar spine was performed by a spinal surgeon without the assistance of a vascular surgeon.

Surgical Technique

The patient is placed in a right-sided lateral decubitus position that is slightly tilted backward depending on the target level [31] to get adequate access to the physiologic corridor between the psoas muscle and the vena cava anteriorly (Fig. 1). Under fluoroscopic control the center of the disc is marked on the skin. A 4-cm skin incision is centered in projection of the target segment and was made parallel to the external oblique muscle fibers. The external and internal oblique muscle and the transverse abdominal muscle are dissected along the direction of their fibers in a blunt muscle-splitting technique. The retroperitoneal space

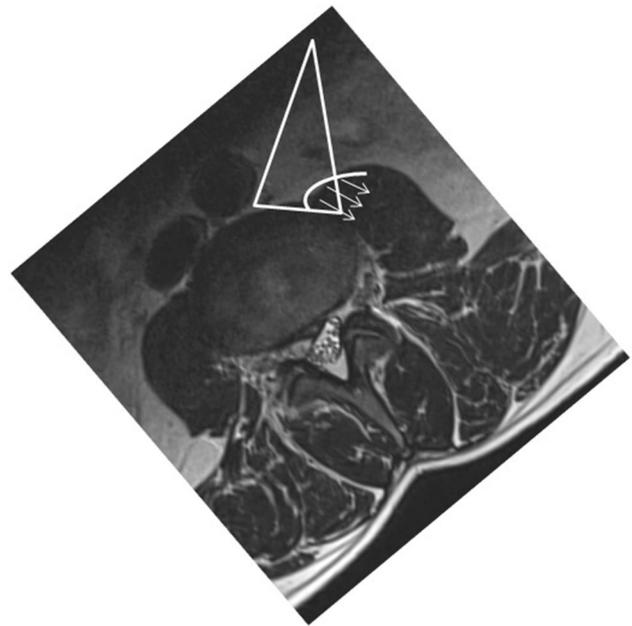


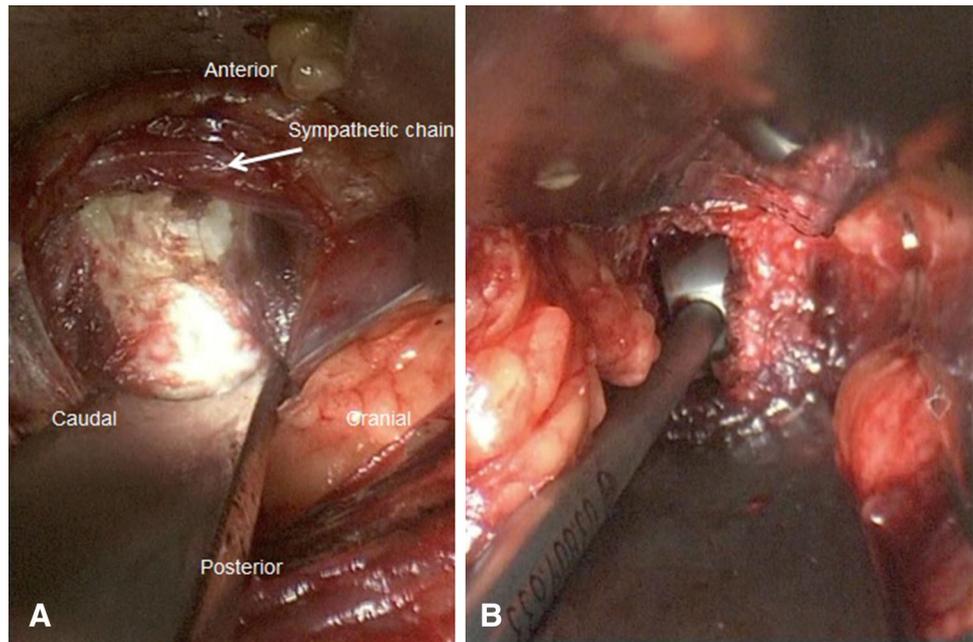
Fig. 1 A slight retraction of the psoas muscle (white arrows) with an approximately 30°-tilted table open the physiologic corridor to the anterolateral aspect of the lumbar spine.

is accessed by blunt dissection along the retroperitoneal fat tissue. The peritoneal sac is mobilized anteriorly. The anterior longitudinal ligament served as a medial landmark and the border of the psoas muscle is identified as a lateral landmark and retracted on the disc space level. Special attention is given to the genitofemoral nerve, which is running right on top of the psoas muscle, and to the sympathetic chain in the anterior third of the vertebral body (Fig. 2). If necessary the sympathetic chain is mobilized anteriorly. The segmental blood vessels usually do not need ligation, especially in multilevel cases, unless the vertebral body needed to be exposed completely for vertebral body replacement in fracture cases.

In multilevel cases, the incision is enlarged up to 6 cm or the same 4-cm incision is used through a sliding window technique. Langenbeck hooks or self-retaining retractors are used for further exposure and preparation of the target area. Imaging guidance (fluoroscopy) is used to confirm the correct level.

After discectomy the vertebral endplates are prepared and the subchondral bone is exposed. To achieve interbody fusion historically, the graft types used have changed. Whereas in the early cases (1998–2003), a tricortical bone graft from the posterior or anterior iliac crest was used, titanium alloy or polyetheretherketon implants filled with autologous bone, tricalcium phosphate, or BMP were used more frequently at later stages.

Fig. 2A–B (A) The psoas muscle is retracted by a Langenbeck hook to expose the anterolateral aspect of the disc space. (B) After mobilization of the sympathetic chain anteriorly and covered by another Langenbeck hook the trial implant is inserted.



Patients were mobilized on the day of surgery. Light food was served until the patient's first bowel movement. Certoparin, 3000 International Units once a day, was used for thromboembolic prophylaxis until the patient was fully mobilized.

All patients underwent a left-sided minimally invasive retroperitoneal oblique anterolateral approach to the lumbar spine between L1–L2 and L4–L5. Overall 1205 levels were treated. Fifty-nine patients (7%) had previous anterior lumbar spine surgery, 11 patients (1.4%) at the index segment. The surgery addressed the level at L4–L5 637 times (53%), 371 times (31%) at L3–L4, 175 times at L2–L3 (15%), and 22 times (2%) at L1–L2. The majority of patients had single-level surgery ($n = 506$, 62%), 222 had two-level (27%), 81 had three-level (10%), and only three patients (0.4%) had four-level interventions.

In most of the cases (98%), oblique lumbar interbody fusion was part of a 360° fusion either dorsoventral ($n = 729$) or ventrodorsal ($n = 65$). In 18 cases a standalone anterior procedure was performed. In 593 cases a single-stage and in 219 cases a two-stage procedure was performed. Operating time for the oblique lumbar interbody fusion averaged 110 minutes (range, 30–410 minutes) per procedure or 59 minutes per level on average.

Results

Thirty of the 812 patients (3.7%) who underwent oblique lumbar interbody fusion experienced a complication during the hospital stay. During the early postoperative period, there were two superficial (0.24%) and three deep (0.37%)

wound infections. All deep wound infections were treated with revision surgery. The superficial infections healed with local wound care. Additionally we observed five superficial (0.62%) and six deep (0.74%) hematomas. The superficial hematomas occurred in the blunt muscle-splitting corridor of the anterolateral abdominal wall muscles; however, these did not have to be decompressed surgically. Only one of the deep hematomas underwent surgical drainage. All the others improved with conservative treatment (Table 1). There were no abdominal or urologic injuries. A postoperative paralytic ileus occurred in two patients. Both were treated conservatively with laxative measures.

There were three intraoperative vascular injuries (0.37%). In each case surgery was done at L4–L5. One case was an anterior revision at the index level. While revising an anterior lateral plate, the common iliac vein on the left side lacerated. Through the same approach the hole in the vein could be closed by stitches. In the second vascular injury, a surgeon performing his fifth oblique psoas-sparing approach lacerated the common iliac vein on the contralateral side while clearing the disc space with a rongeur. The bleeding was managed with direct pressure and topical hemostatic agents. The patient was observed in the intensive care unit for several days without any further intervention. The third vascular injury involved the aorta during an anterior fusion for spondylodiscitis. While introducing a mesh-type cage in the L4–L5 intervertebral space, the posterior wall of the aorta, which was adherent to the disc space was injured with the sharp edges of the cage. A vascular surgeon patched the injury, and this patient experienced no additional complications during the postoperative course.

Table 1. Overview of the access-related complications

Complication	Number	%	Treatment
Infection	5	0.62	
Superficial	2		Local wound care
Deep	3		Revision surgery
Hematoma	11	1.35	
Superficial	5		Observation
Deep	6		1 revision surgery, 5 observations
Abdominal			
Paralytic ileus	2	0.24	Observation and laxative measures
Vascular Injury	3	0.37	
Vena iliaca communis left	1		Suture
Vena iliaca communis right	1		Direct pressure and topical hemostatic agents
Aorta	1		Patch (vascular surgeon)
Neurologic	3	0.37	Observation
Direct irritation of the ilioinguinal and genitofemoral nerve	1		
Irritation of the lumbar plexus resulting from retractor pressure	2		

Nine patients experienced a neurologic injury (1.1%, nine of 812). In six patients (0.73%) a meralgia paresthetica was seen postoperatively. All patients who experienced this complication had undergone harvesting of a tricortical bone block from the anterior iliac crest. This graft-harvesting procedure was performed in this case series a total of 207 times. In the other three patients (0.37%) a postoperative radicular sensorimotor deficit was observed. In two cases L4–L5 was involved. Both cases were single-level procedures. One patient who underwent surgery for spondylitis with a psoas abscess postoperatively reported severe groin pain and sensory deficit in the groin and the medial thigh. A neurologic examination verified an injury to the ilioinguinal and genitofemoral nerves. One of the other two patients who had surgery at L4–L5, reported severe 2–3/5 muscle weakness of the L5 innervated muscle groups with numbness. The neurologic examination verified an L5 radiculopathy, which could not be explained by the posterior procedure. The other patient underwent surgery at L3–L4 and awoke with a 2/5 quadriceps weakness and a 3–4/5 weakness of the L4 and L5 innervated muscles. The two patients improved fully to 5/5 strength without additional surgical interventions under observation and physiotherapy. The sensory deficit persisted with time, but with less intensity.

Discussion

Anterior lumbar fusion techniques are an integral part of spine surgery, but anterior approaches to the lumbar spine are associated with a high risk of vascular complications,

particularly at L4–L5 and above, and with the midline approaches [7, 12, 39]. To reduce risk of vascular injury, lateral approaches have been established [28, 29]. The “extreme” or “direct lateral” transpoas approaches have increased in popularity, partly because of the natural distance to the abdominal vessels [19, 30, 38, 40]. However, numerous studies have shown neurologic injury resulting from this transpoas approach, which is in close anatomic proximity to the lumbar nerve plexus [2, 16, 18, 25, 26]. The oblique anterolateral retroperitoneal approach to the lumbar spine passes anterior to the psoas muscle and lateral to the abdominal vessels [11]. We found that the access through this anatomically predefined pathway was associated with a low risk of vascular and neurologic complications in a large cohort at a single center.

Limitations of our study include retrospective, chart-based data collection which potentially could be associated with underreporting of complications such as superficial wound infections or hematomas. Nevertheless, the complications that led to consecutive, secondary interventions were all well documented, including severe complications with considerable clinical effects such as vascular and radicular injuries. A second limitation is that the investigation focused on the perioperative, inpatient observation period, whereas complications which might present at later stages during the postoperative course such as late infections and/or pseudarthrosis were not assessed in the framework of the study. Finally, this is not a comparative study. Head-to-head comparisons with other anterior approaches like the extreme lateral transpoas approach and anterior approaches are needed to compare the challenges and risks of each approach. The results of our study

represent the percentages of complications for this specific oblique anterolateral approach done in a high-volume center by highly specialized spine surgeons.

The percentage of perioperative complications in total with the oblique lumbar interbody fusion approach was 3.7%. We observed five superficial (0.62%) and six deep (0.74%) hematomas. Comparable figures have been reported for other types of less-invasive lateral approaches from 0.17% to 6% [23, 34, 40]. Our transmuscular approach may have contributed to a slight increase of postoperative retroperitoneal hematomas. Our overall infection risk of 0.62% is comparable to those reported for the midline or extreme lateral access routes of 0% to 6% [5, 12, 15, 24, 32, 34, 39–41]. With respect to previous studies on the oblique psoas-sparing approach, in the largest series of 179 patients, Silvestre et al. [44] did not report on the general risk of infection and hematoma. Ohtori et al. [36, 37] used the oblique psoas-sparing approach for varying indications and only for small patient cohorts (12 and 35 patients) without reporting on either infection or hematoma. Owing to the small cohorts, these figures were not meaningful with respect to the low incidence of these complications in general. After reviewing our large case series with 812 patients, the oblique psoas-sparing approach revealed comparable proportions of general access-related risks such as infections or hematomas.

Vascular complications occurred in 0.37% (three of 812 patients) and included the left common iliac vein ($n = 2$) and the aorta ($n = 1$). This is lower than the risk of vascular complications with the midline approach, which ranges from 1.9% to 15% [3, 5, 7, 13, 39, 41], and probably is attributable to use of access lateral to the abdominal vessels with the oblique psoas-sparing approach. In most instances, even because of the right lateral positioning of the patients and the left-sided approach, there is no need for any vessel preparation. Mayer [28] did not report any vascular complications in his initial delineation of the oblique lumbar interbody fusion technique. Using an identical oblique lumbar interbody fusion technique, Silvestre et al. [44] reported a vascular complication risk of 1.68% including iliac and iliolumbar venous lacerations. These results are comparable to those for far lateral approaches such as the extreme lateral transpsoas approach, which were developed specifically to avoid vascular injury, and which range from 0% to 0.11% in large case series [22, 40]. All three vessel lacerations in our series involved the L4–L5 segment, and we recommend careful and meticulous preparation and more posterior dissection of the anterior border of the psoas muscle.

Neurologic complications of the lumbar plexus or genitofemoral and/or ilioinguinal nerve occurred in 0.37% of patients (three of 812). Using the natural “safety” corridor between the anterior longitudinal ligament as a medial

landmark and the psoas muscle as a lateral landmark, the target area is covered by only the fibers of the sympathetic chain. The low percentage of lumbar plexus injuries in our patients is in line with reported percentages using the oblique lumbar interbody fusion technique (four of 179 patients, two with persisting [44] or no irritation [1, 24]). Conversely, the risks of neurologic complications were less frequent in anterior lumbar interbody fusion procedures. Faciszewski et al. [12] reported a 0.10% risk of injury of the lumbar plexus (one of 930 patients) and in 0.43% postsympathectomy syndromes (four of 930 patients). Other authors did not comment on any neurologic complications [5, 39, 41]. Neurologic complications are the most severe and most frequently encountered complications with the extreme lateral transpsoas approach. In a review summarizing 18 studies with a total of 2310 patients, 304 patients had complications related to lumbar plexus injury representing a 13% risk [2] despite intraoperative neuromonitoring. Although many of these complications were reported as transient, persisting neurologic symptoms might occur in different intensity in as much as 18% [15, 25, 33, 46]. Because the access corridor is transmuscular for this technique, intramuscular preparation is likely the main underlying reason for the above-described nerve root injury.

The anterolateral minimally invasive oblique lumbar interbody fusion approach is a less-traumatic surgical technique for anterior lumbar fusion procedures. While using an anatomic access route between the abdominal vessels and the anterior border of the psoas muscle, the numbers of vascular and neurologic complications were low. These findings are based on a retrospective chart review which focused on perioperative complications during in-hospital stays, which lacked a comparison group. Future randomized studies with longer followup will need to evaluate later-presenting complications and compare this approach with other midline or far-lateral transpsoas approaches. However, we recommend the oblique lumbar interbody fusion technique as a safe alternative for anterior lumbar fusion procedures. It can be performed without costly neuromonitoring and without the need for an additional surgeon for access.

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