Surgical complications of the anterior approach to the L5/S1 intervertebral disc

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Aim. The aims of this study were to describe the incidence and type of perioperative complications that occur with minimally invasive anterior retroperitoneal spinal surgery performed at the level of the L5/S1 intervertebral disc.
Methods. A retrospective review of 175 patients: 103 women and 72 men, average age 45, who had undergone anterior spinal surgery at level L5/S1 from January 2001 to February 2011. The preoperative diagnoses were: degenerative disc disease in 87 (50%), failed back surgery syndrome in 53 (30%) and spondylolisthesis in 35 patients (20%).
The surgical steps in the minimally invasive anterior retroperitoneal approach from the right side to disc L5/S1 are described. All surgical intraoperative anatomical anomalies and complications directly related to the anterior spinal surgery were documented.
Results. Intraoperative pathological-anatomical anomalies were found in 34 patients (19%) and intra – and postoperative minor complications in 24 patients (12%) but no serious complications. The main intraoperative complication was peritoneal opening without visceral injury (5%) and the main postoperative complication was weakness of the right abdominal wall (3%).
Conclusion. Retroperitoneal access and surgery at level L5/S1 disc space is a safe procedure when performed by a knowledgeable and experienced spine team. During surgical planning for an anterior approach to the LS spine, the surgeon must carefully assess the neuroimaging results, such as MRI, to minimize potentially disastrous vascular complications.

Key words: lumbosacral spine, surgery, complications, interbody fusion, arthroplasty

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INTRODUCTION

Despite increased use of anterior spinal surgery, there is little documentation of the specific types and frequencies of complications associated with its use. Review of the spinal surgery literature revealed a dearth of studies that address the morbidity and mortality rates in large samples of patients who had undergone anterior surgery specifically at level L5/S1.

The aims of this study were to report prospectively the incidence and specific types of perioperative complications that occur with minimally invasive anterior retroperitoneal spinal surgery performed at level of the L5/S1 intervertebral disc.

MATERIAL AND METHODS

We reviewed all cases of anterior surgery at level L5/S1, treated at the Department of Neurosurgery from January 2001 to February 2011. The study group consisted of 175 patients: 103 women and 72 men, average age 45 years, range 24–76 years.

The preoperative diagnosis was degenerative disc disease (DDD) in 87 (50%), failed back surgery syndrome (FBSS) in 53 (30%) and spondylolisthesis in 35 patients (20%). They suffered from low back pain (LBP) and radiculopathy itself and conservative treatment was not effective for a minimum of 6 months. The diagnosis was established using generally accepted methods including history-taking and physical examination, radiography and magnetic resonance imaging (MRI) of the lumbosacral (LS) spine.

Sixty four (37%) patients had undergone one or more prior abdominal surgeries including appendectomy in 30 (17% of 175 patients), cesarean section in 39 (38% of 103 female); and cholecystectomy, gastric surgery, inguinal hernia in 2 each and umbilical hernia in 1.

Anterior spinal surgery at level L5/S1 – surgical steps:
Anesthesia and positioning

This type of surgery was performed retroperitoneally under balanced general anesthesia and adequate neuromuscular block for good surgical access; intravenous prophylactic application of antibiotics and low molecular weight heparin (LMWH) were obligatory.

The patients were placed in a supine Trendelenburg position (the table was tilted head-down 20-30°) with the lumbar spine hyperextended and legs in maximum ab-

duction. The legs were supported by soft cushions and fixed onto leg holders. The surgeon stood between the legs of the patient and was thus working in the plane of the L5/S1 disc space. The level of the L5/S1 disc space was marked onto the skin after a lateral X-ray projection as well as the anterior border of the promontory.

Access to the LS junction

A 6-8 cm skin incision was made in the midline of the abdomen centered over L5/S1 which is usually the transition zone between the lower and middle third of the umbilical-symphyseal distance. The skin incision can be placed transverse or longitudinal. In females, a transverse incision is preferred. The subcutaneous tissue was divided to expose the anterior rectus muscle sheath, and right sheath was divided longitudinally along the direction of its fibers and the epigastric vessels were coagulated as needed. The lateral part of muscle was retracted laterally and the transversalis fascia divided as required. The peritoneum and its contents were then retracted medially by blunt dissection with cottonoids in retroperitoneal space to expose the right iliopsoas muscle. The bifurcation of the right common iliac vessels and right ureter were identified. The ureter was located running laterally over the iliac vessels at the pelvic brim. The right ureter was swept along medially with the peritoneum and retracted using Langenbeck hooks. In most instances, the aorta and vena cava bifurcate into the iliac vessels over the L4/5 disc space or L5 vertebral body so the L5/S1 disc is easily accessed, but abnormally low bifurcation can restrict access to the L5/S1 disc space. The prevertebral retroperitoneal adipose tissue was exposed along the medial border of the right common iliac artery and carefully retracted to the left side including the superior hypogastric plexus. This was done very gently using cottonoid pads, avoiding damage to the plexus. Bi-polar coagulation should be avoided or at least restricted to a minimum. The middle sacral artery/vein were exposed, closed with a clip and transected. The left common iliac vein was identified and gently retracted to the left side. Thus, the anterior circumference of L5/S1 was exposed. The retractor blades (Synframe, Synthes, USA) were then inserted underneath and between the common iliac vessels in order to expose the anterior intervertebral circumference. The blades were fixed to the ring of Synframe and fastened to the table. The disc space level was then verified under fluoroscopic control.

Discectomy and preparation of implant bed

The anterior longitudinal ligament and the anulus fibrosus were incised in a rectangular shape. The disc was emptied with rongeurs. The endplates were curretted and carefully removed with chisels and the subchondral bone was smoothed with a high-speed drill. If necessary, the endplates can be removed as far posterior until the posterior longitudinal ligament is exposed. Thus, decompression of the anterior part of the spinal canal at L5/S1 can also be performed. The orientation of the implants was in the midline as far as possible. We have used titanium spacers (Syncage, Synthes, USA, or Synfix, Synthes, USA, or Pyramesh, Medtronic, USA) or PEEK (poly-ether-ether-keton) spacers (Visios, Synthes, USA) for ALIF. Additional cancellous bone from the iliac crest as well as from the removed parts of the vertebral bodies and artificial bone (Chronos, Synthes, USA) were impacted into the spacer as well as anteriorly for fusion. We have used Active-L (B-Braun, Germany) or Prodisc-L (Synthes, USA) implants for TDR (Total Disc Replacement). The retractor was removed and the suction drain was inserted retroperitoneally. The fascia (anterior sheath) of rectus muscle was closed with a running resorbable suture and, subcutaneous tissue and skin were sutured.

The whole operation, including surgical approach was performed by an experienced neurosurgical team.

ALIF (Anterior Lumbar Interbody Fusion) was performed in 143 patients, including 85 patients with stand-alone fusion, 12 patients with concomitant anterior plating (Oracle plate, Synthes, USA) and 46 patients with additional posterior transpedicular fixation (USS, Synthes, USA). Arthroplasty (TDR) was done in 32 patients.

Postoperative care and follow-up

Typically, patients were mobilized early and allowed to ambulate within 48 h of surgery. In cases of ALIF, bending, twisting, heavy lifting, and heavy exercise were restricted and lumbar orthosis was recommended to help reduce motion while fusion occurred. Patients with TDR had no restrictions. The surgeon examined the patients and radiographs were obtained at follow-up examinations of 6 weeks, 6, 12 and 24 months.

All surgical intraoperative anatomical anomalies and complications, postoperative in-hospital and complications that occurred after discharge from the hospital directly related to the anterior spinal surgery were prospectively recorded. Complications related to the implant healing were not included in the study. The minimum follow-up required for inclusion was 6 months.

RESULTS

The number of patients and percentage of intraoperative pathological-anatomical anomalies we found are shown in (Table 1).

The number of patients and percentage of intraoperative and postoperative complications we found are shown in (Table 2).

At follow-up we found no hardware failure on X-ray (implant displacement or pseudoarthrosis). Clinically, no patients was worse after surgery. 164 patients were satisfied with the surgery and reported improvement, 11 patients were not improved and we later indicated posterior transpedicular fixation at L5/S1 segment for enhancement of the stability.

Table 1. The number of patients and percentage of intraoperative pathological-anatomical anomalies.

Intraoperative pathological-anatomical anomalies	No. of patients	(%)
Atypically bulky vasa sacralis mediana	3	(1.7)
Atypical position of the left iliolumbal vein	1	(0.6)
Medial position of the left common iliac vein	7	(4.0)
Medial position of the right common iliac vein	1	(0.6)
Very low bifurcation of great vessels (at level of disc L5/S1)	4	(2.3)
Atypically bulky and coiled right iliac arteries	2	(1.1)
Larger intraabdominal scar tissue after previous abdominal surgery	9	(5.1)
Steep sacral inclination	2	(1.1)
Huge anterior osteophytes at level L5/S1	5	(2.9)
Total	34	(19.4)

Table 2. The number of patients and percentage of intraoperative and postoperative complications.

Complications	No. of patients	(%)
Intraoperative:		
Peritoneal opening without visceral injury	9	(5.1)
Vascular injury of small veins	2	(1.1)
Postoperative:		
Wound incompetence	2	(1.1)
Weakness of the right abdominal wall	5	(2.9)
Sympathetic dysfunction on the right side	2	(1.1)
Hypesthesia of the right groin and thigh	1	(0.6)
Total	21	(12.0)

DISCUSSION

An anterior approach to the lumbar spine was first described for the management of spondylolisthesis and Pott´s disease in the 1930s (ref.[1-3]). Anterior lumbar interbody fusion (ALIF) was described first by Capener in 1932, and has been used since, for the treatment of a variety of lesions such as spinal deformity, spinal instability, tumors, infection, and chronic disabling low back pain, including that arising from failed back surgery[4]. Although in the early 1970s Stauffer and Coventry condemned this approach because, in their eyes, it meant „too much surgical trauma to the patient" (ref.[5]), other authors have reported satisfactory results[6-10]. Even a laparoscopic approach for ALIF at the LS level has been described[11,12], but it seems, this method was associated with considerable technical difficulties as well as with a higher complication rate because of the necessity for preparation and dissection of the major abdominal vessels[10,13].

Faciszewski et al. have retrospectively reviewed 1223 cases in which anterior spinal fusion was performed in the thoracic and lumbar spine and reported an overall complication rate of 11.5%, including risk of death (0.3%), paraplegia (0.2%) and deep wound infection (0.6%). The risk of complications was increased for patients over age 60 years, for women, and for patients with preexisting health problems[8]. Tiusanen et al. have reported a detailed clinical outcome study in a series of 83 patients with ALIF. Complications included unintentional sympathectomy (43%), retrograde ejaculation (in 24% of males), venous injury (18%), deep venous thrombosis (5%) and infection (3%) (ref.[14]). Baker at el. reported a 15% incidence of vascular complications following ALIF in 85 patients[15]. Rajaraman et al. retrospectively reviewed 60 patients with ALIF and 24 general surgery-related complications occurred (38%), including sympathetic dysfunction in 10%, vascular injury in 6.6%, somatic neural injury in 5%, sexual dysfunction in 5%, prolonged ileus in 5%, wound incompetence in 3%; and deep venous thrombosis, acute pancreatitis, and bowel injury in 1.6% each[16]. Štulík et al. found injury to the major blood vessels in 1.3% patients after retroperitoneal lumbar spine exposure. In one

patient the vascular injury was associated with trauma to the ureter[17]. Korge et al. reported on 454 patients who had undergone anterior surgery in the LS segment. Approach-related vascular complications occurred in 0.5% (mainly left common iliac vein). Injuries to the gastrointestinal tract and urogenital tract (bladder, ureter) did not occur and there were no infections[18].

The leading intraoperative complication in these series of ALIF was vascular injury (a frequency rate 0.5%–18%). Arterial injury is rare and usually presents as thrombotic occlusion or intraoperative or delayed massive hemorrhage. Most venous injuries are related to the exposure rather than to implant placement. Mechanisms of injury include excessive venous traction, avulsion, and laceration[9,14-18]. Peritoneal perforation during retroperitoneal exposure is not uncommon and in these cases immediate closure of these defects when recognized, was performed. More important, however, is the recognition of bowel perforation, fortunately a rare complication[16]. Kim et al. reported six patients with steep sacral inclination (mean 37°) and despite the difficult surgery there were no significant complications and they concluded in selected cases, a steep sacral slope may not be an absolute contraindication of ALIF (ref.[19]). Early postoperative ileus following retroperitoneal exposure usually lasts 2 to 3 days. The rate of abdominal wound dehiscence after retroperitoneal exposure is 0.6 to 3% (ref.[8,16,20]). Regarding late postoperative complications, deep venous thrombosis is reported to occur at a rate of 1.6 to 5% in these series and after surgery performed in the vicinity of major blood vessels in the abdomen at a rate 7 to 8% despite of use of LMWH (ref.[14,16,21]). The reported incidence of sexual dysfunction varies from 0.5 to 24%. Retrograde ejaculation is believed to be caused by damage to the superior hypogastric plexus of the sympathetic system located in front of the L5 and S1 vertebral bodies. There is no anatomical reason for impotence to result from a standard ALIF procedure, because the parasympathetic plexus responsible for erection is located deep in the pelvis[8,14,16]. Injury to the lumbar sympathetic chain located on the anterolateral aspect of the vertebral bodies was revealed as warmer limb or foot due to loss of sympathetic vasoconstriction of the affected side and has been recognized at a rate 1.4 to 43% (ref.[14,16,22]).

Damage to the left iliac vein is the most threatening complication associated with L5/S1 surgery. The low iliocaval junction positions and medially located left common iliac vein reduce the size of the operative window and increase the risk of vascular damage at surgery. Anatomic studies carried out on cadavers have demonstrated great variation in the origin of the inferior vena cava. Harmon reported an incidence of 32% for anomalies of the greater veins[23]. Capellades et al. performed MRI angiography (on 134 patients) and four groups of iliocaval junction position were established: very high (L4 vertebral body and higher levels), high (disc L4/5), low (middle third of L5 vertebral body), and very low (caudal third of L5 vertebral body and disc L5/S1). Left common iliac vein position was measured in axial MRI, and three groups were established: lateral, intermediate, and medial. The results were as follows: very high lateral position included 3.7% of the patients, high lateral 48.1%, high intermediate 10.5%, high medial 0.75%, low lateral 15%, low intermediate 4.5%, very low lateral 0.75%, very low intermediate 2.3%, and very low medial 7.5%. In 18% of the study population, the venous structures overlapped the center of the L5/S1 disc, reducing the operative window. The medial vein position was significantly more frequent in men[24]. Cho et al. evaluated, in a cadaver study, the anatomical features of iliac vessels with respect to the anterior approach to the LS spine. Only 60% of the specimens were judged to have easy accessibility to the LS spine[25]. Ebraheim et al. called the retroperitoneal space anterior to the LS junction the „triangular safety zone“. They described bifurcation of the aorta as the apex of the triangle, the right common iliac artery and left common iliac vein as the two feet of the triangle, and the sacral promontory as the floor of the triangle. The mean width and height of the triangular safety zone were 60 and 40 mm, respectively[26].

Meticulous preoperative planning is paramount for the successful performance of a retroperitoneal minimally invasive approach to L5/S1. Conventional X-ray of the LS spine provides information on the anterior height of the intervertebral space L5/S1, on the sacral inclination as well as on the orientation of the intervertebral disc space plane. The level of bifurcation of the aorta and vena cava must be determined preoperatively. The prevertebral space of the LS junction must be evaluated very carefully on MRI. The course of the common iliac artery and vein on both sides in particular, must be determined. When previous abdominal operations have been performed, the indication for a minimally invasive approach must be evaluated individually.

Despite the preoperative planning, we found 19.4% of intraoperative pathological-anatomical anomalies (see Table 1) were a source of potential complications and surgery in these cases was more difficult. The total rate of complications in our study was 12% (see Table 2). We had no serious complications such as death, excessive intraoperative or postoperative bleeding, thrombembolism, infection, visceral injury, ileus, LS plexus injury, retrograde ejaculation or sterility. Regarding intraoperative complications, the peritoneum was artificially opened closely and sutured immediately without relevance. Bleeding from small veins was stopped using clips with no injury to great vessels. Regarding postoperative complications, most frequently we found weakness of the right abdominal wall, postoperative electromyography of the LS plexus was always negative and the issue for the patient was more cosmetic. In three patients the exact cause was dehiscence of the rectus muscle fascia and plastic surgery of the abdominal wall was later performed. We observed wound incompetence in two patients because of subcutaneous seroma and the wound was once resutured under local anesthesia. Sympathetic dysfunction on the right side in two patients, probably as result of injury to the right lumbar sympathetic chain, was revealed as warmer limb but this presented no problem for the patient. Hypesthesia of the

right groin and thigh in one patient was likely the result of injury of to the genitofemoral nerve during retroperitoneal preparation on the surface of iliopsoas muscle and hypesthesia slowly spontaneously improved.

CONCLUSION

Retroperitoneal access and surgery at level L5/S1 disc space is a safe procedure when performed by a knowledgeable and experienced spine team and can be used with confidence when the nature of a patient´s spinal disorder dictates its use.

During surgical planning for an anterior approach to the LS spine the surgeon must assess carefully the neuroimaging results, such as MRI, to minimize potentially disastrous vascular complications.

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