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Case Report

Fusion of the L5-S1 Segment in Degenerative Lumbar Spine Disease Using the Extreme Lateral Interbody Fusion Technique: A Case Report Study

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Abstract

Study design: This study is a single center case report study with 3 cases of degenerative lumbar spine disease treated with the XLIF procedure at the level L5-S1.

Objective: The purpose of this case report study is to demonstrate the possibility of treating degenerative lumbar spine disease at the level L5-S1 using the XLIF procedure.

Summary and Background of Data: There are several standard surgical techniques for the treatment of degenerative lumbar spine diseases that have failed conservative treatment. Interbody fusion can restore the proper alignment of the spine hereby leading to indirect decompression of the nerve roots. The XLIF procedure is a relatively recent retroperitoneal and transpsoas major muscle approach allowing the insertion of interbody implants. This approach has shown good results but for anatomical reasons it is limited at the lumbar spine to the segments L1-L5.

Methods: A single center case report study with 3 cases of degenerative lumbar spine disease treated with the XLIF procedure at the level L5-S1.

Results: All 3 patient were successfully operated at the level L5-S1 with an XLIF procedure.

Conclusion: This case series suggests that the XLIF procedure is a safe, feasible and timesaving procedure to treat the segment L5-S1 in selected patients with severe degenerative lumbar spine disease and failed conservative

treatment. Preoperative anatomical evaluation of the correlation of the iliac crest to L5 is necessary. The procedure should be performed with the aid of neuromonitoring and direct visualization during dissection of the psoas muscle should be achieved.

Keywords: Degenerative Lumbar Spine; Neuromonitoring; Lateral Interbody Fusion; Surgery

1. Introduction

The Extreme Lateral Interbody Fusion (XLIF) method is a minimal invasive technique and a valuable alternative to the well-known traditional standard techniques (TLIF, ALIF, PLIF) for the operative treatment of degenerative lumbar spine diseases like degenerative scoliosis and degenerative disc disease [1-4]. Degenerative scoliosis has an estimated prevalence of 6% in people over the age of 50 [5-7]. Non-surgical management remains the primary treatment for this condition. Patient with a history of failed conservative treatments may require either a decompression or in more severe cases interbody fusions. Interbody fusion has the notable benefit of restoring the proper alignment of the spine and the nerve roots can be decompressed either directly or indirectly [8-10].

The XLIF procedure was developed in the late 1990s and early 2000s and it can be used to obtain access to the lumbar spine using a lateral approach that passes through the retroperitoneal fat and psoas major muscle. This approach provides the ability to release, reconstruct and fuse the spine while simultaneously providing indirect decompression of the neural elements through disc space distraction and spinal alignment. The great abdominal vessels are not encountered. The blood loss, operative time and tissue damage are reduced compared to posterior approaches. As with other minimal invasive approaches the postoperative pain and the hospital stay are reduced and the return to activities of daily living is faster [11-14].

During this procedure the psoas muscle and the nerve roots that rise from the lumbar plexus are in danger and they can be injured if a good anatomical exposure is not performed [1]. Risks include excessive traction and direct injury to these structures, which can result in paresthesia, paralysis and/or muscle weakness, although these complications appear to get better or fully recover in the first 6 months after surgery [15-18]. Limitation do exist with this approach. The inferior edge of the 12^{th} rib and the superior edge of the iliac crest limit the potential exposure sites to L1-L5 [19-23], therefore only few cases are described in the literature, where the segment L5-S1 was treated with the XLIF technique, due to anatomical reasons [18, 21].

In this report we present 3 cases treated in our spine department, who presented with a multisegmental degenerative condition, where the segment L5-S1 was also included into the fusion with the XLIF technique. Thereby we would like to demonstrate that the XLIF technique at the level L5-S1 under direct sight through a trans-psoas access and the use of neuromonitoring is a safe and reproducible procedure.

2. Case Report

We report three patients who presented with symptomatic multilevel degenerative changes requiring interbody fusion from the lumbar spine to the sacrum. All procedures were performed by the same surgical team in one center in the German-speaking part Switzerland under the guidance of the same senior lead surgeon. This was the first case series performing XLIF L5-S1 for this team. All surgeries were completed as same-day procedures. All cases were performed within a span of 200 working days. Imaging performed preoperatively included standing x-rays of the lumbar spine and a lumbar spine MRI. All three patients were operated under general anesthesia, the surgeons in this study included the use of neuromonitoring (SSEP, MEP) as their standard protocol for the XLIF, the extensile trans-psoas approach was used and the patients were reviewed in a follow-up at 6 weeks and 3 months postoperative. The outcome measures used include VAS for leg and back pain, and standing x-rays which showed the correction of the pre-operative deformity.

2.1 Patient 1

A 79-year-old woman presented with a long history of progressively worsening chronic low back pain, bilateral radiculopathy and neurogenic claudication. Relevant medical conditions included obesity (BMI 45), high blood pressure and high cholesterol. Preoperatively she could only walk with a wheeled walker for several minutes, after which she had to rest because of excruciating radiating neurological pain. On clinical assessment there was no motor or sensory weakness. Conservative treatment over a 1 year period (steroid injections) failed, and surgery was planned. Pre-operative imaging included standing radiographs and an MRI. The patient presented with multilevel segmental degeneration from L3 to S1 with a L4-L5 Grade 2 Meyerding anterolistesis, and severe facet joints arthrosis with subluxation. The MRI revealed severe spine stenosis at all 3 levels with associated loss of disc height and neuroforaminal stenosis. The preoperative assessments showed no obvious issues of concern for the transpsoas approach. We performed the XLIF from L3-S1, with the patient in a right lateral decubitus position. The surgical technique as described by Pimenta [1] was followed: a blunt dissection with swabs was performed and the psoas muscle was visualized. The correct level was identified under fluoroscopy before splitting the muscle. Then the muscle was splitted under direct sight between the front and middle third. The annulus of the disc space was identified and a self-retaining retractor was used and the surgeon wore a head lamp during the entire surgery. Safe docking of the spreaders onto the intervertebral disc space was made under continuous intraoperative Neuromonitoring control (SSEP, MEP) (Figure 1 and 2). No microscope was used. A 6,4 single cm skin incision was made, the surgery time was 290 minutes, the blood loss was approximately 350 ml. The XLIF procedure was followed by a percutaneous pedicle screw spondylodesis of the same levels. None of the transpedicular screws were cemented. The first segment treated was L5-S1, followed by L4-5 and L3-4. On postoperative day one, the patient was neurologically intact and hemodynamically stable. The mobilization of the patient began on the first postoperative day with full weight bearing. The inpatient acute care lasted for 11 days, followed by two weeks of inpatient extended care in a rehabilitation clinic and another two months of physical therapy twice a week. Physical therapy was focused on upper body training, gait training, and balance/proprioception exercises. On a follow-up examination after 6 weeks, the patient was asymptomatic and able to walk with walking sticks. Her quality of life improved drastically. Her VAS reduced from 7 to 3. At 3 months after surgery the VAS was reduced to 2. Her 6-

week and 3-month-postoperative radiographs showed satisfactory placement of interbody cages and bilateral pedicle screws in all treated segments (Figur 3 and 4).

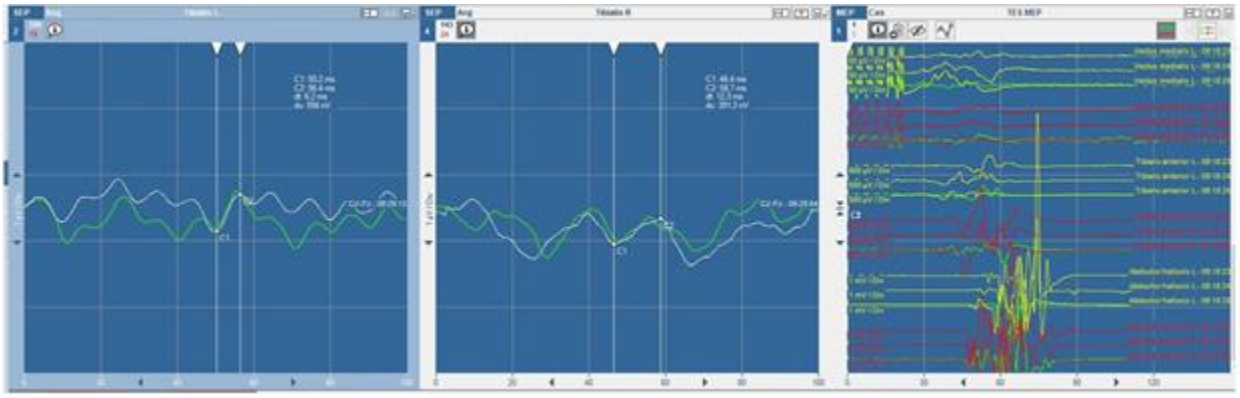

Figure 1: Preoperative SSEP and MEP.

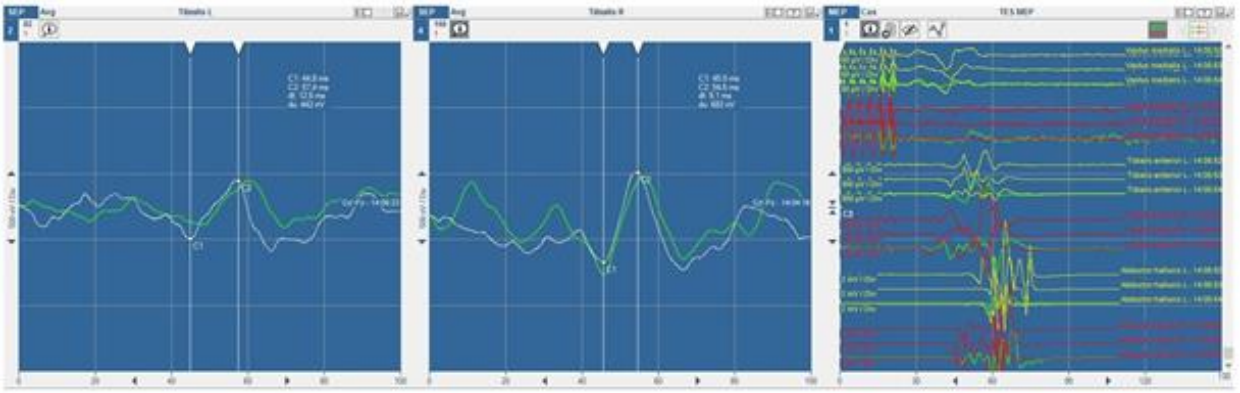

Figure 2: Postoperative SSEP and MEP.

Figure 3 and 4: Pre- and postoperative x-rays performing an XLIF procedure L5/S1.

2.2 Patient 2

A 78-year-old woman was seen in our outpatient surgery, complaining about a history of 2 years of severe low-back pain radiating to both legs. Relevant medical co-morbities included high blood pressure and obesity (BMI 39). She could only walk for 20 minutes before she had to sit down and rest. Non-surgical treatments like facet joint infiltration and sacral block brought only partial and temporary relief. The physical examination revealed normal strength and sensation in the lower extremities. The Lasegue-Test was negative on both sides. Pre-operative exams included an MRI and a standing X-ray. The imaging demonstrated a severe degenerative left convex scoliosis L2-S1 with associated degenerative disc disease. The MRI scan showed no obvious issues of concern for the transpsoas approach and no other anatomical variation. She underwent an XLIF procedure from L2-S1. The surgical procedure resembled the procedure described for Patient 1. The surgery time was 373 minutes, the total blood loss was 300ml. Interbody fusion grafts were placed at the L2-S1 followed by a percutaneous pedicle screw fixation at the same levels. The patient was placed in a true 90° lateral decubitus position. A single skin incision, 13cm long, was performed on the right abdominal side with the midpoint above L4. The first treated segment was L4-5, then L5-S1 followed by L3-4 and L2-3. Following completion of this retro-peritoneal part of the surgery the retractor was removed, and no peritoneal violations were evident upon inspection. The Neuromonitoring showed no abnormalities during the entire procedure. The patient was then turned into a prone position and transpedicular screws in the segments L2 -S1 were cemented. The patient recovered well post-operatively and was able to walk with minimal assistance. She was able to leave the acute care after 12 days. A clinical review in our outpatient clinic 6 weeks after surgery showed no pain radiation into the lower extremities, and she needed no significant analgesia. The back pain was substantially reduced in comparison to preoperatively, with the VAS reducing from 8 to 4. The wounds healed without incident. Physiotherapy was continued and after 3 months her VAS was down to 2 and she could walk unaided for long distances. An x-ray after 3 months showed a correct position of the implants and the screws.

2.3 Patient 3

This 71 year-old-woman was seen in our outpatient surgery with several years of incapacitating low-back pain radiating to the right leg. The medical history included hypertension, sleep apnea and gastroesophageal reflux disease. The BMI was 35. Conservative treatment including several steroid infiltrations were unsuccessful. Neurological examination showed no motor or sensory deficits and normal reflexes. Preoperatively imaging included an MRI and plain radiographs. These showed a multisegmental degeneration from L3 to S1. Preoperatively the patient was able to walk without any walking aid. The preoperative assessments showed no obvious issues of concern for the transpsoas approach. We decided to perform XLIF L3-S1 followed by a percutaneous spondylodesis at the same levels. The patient was positioned in the left lateral decubitus position, and a 9 cm single skin incision was made. The surgery time was 246 minutes and the blood total loss 250ml. The first treated segment was L5-S1, followed by L4-5 and L3-4. X-ray image examination showed good stability and disk height. The inpatient acute care lasted for 10 days, followed by 14 days of inpatient extended care in a rehabilitation clinic. On a follow-up examination, the patient was symptom-free. The pain on a VAS scale was by 1. Her 6-week and 3-month-postoperative radiographs showed correct placement of interbody cages and bilateral pedicle screws in all treated segments.

3. Discussion

Severe degenerative spine diseases are successfully treated with insertion of interbody grafts through the traditional and well established anterior (ALIF) and posterior (TLIF, PLIF) approaches. These have been reported to have high rates of success for lumbar spinal fusion due to the bone graft being under compression. Correction of the alignment and restoration of disc height leads to indirect decompression of the spinal canal [24]. The anterior approach requires access through the abdomen using a retroperitoneal approach, with the potential risk of vascular and visceral injuries, and retrograde ejaculation [25]. This approach can be technically challenging and increasingly an access surgeon is used for safe and adequate exposure [26]. The main concern with the posterior fusion approaches (PLIF and TLIF) is the extent of neural retraction required, with the potential for nerve root injury, dural tears, epidural bleeding and subsequent epidural fibrosis. Advantages include easier access to the posterior structures [including the lamina, ligamentum flavum and facet joints] enabling a satisfactory direct decompression. As the size of the implants is smaller compared to the anterior and lateral approaches, it may be more difficult to correct coronal imbalance and restore lordosis [especially at L5/S1] [27]. In recent years the focus of research has been directed to advances in minimally invasive spine surgery, with the objective of lessening the approach related morbidity associated with traditional open spine surgery [28]. Alternative approaches have been developed and used with the aim of minimizing spinal and paraspinal muscle dissection, reducing recovery time, blood loss, and tissue damage. These include the extreme lateral lumbar interbody fusion (XLIF) [29-31]. This procedure offers the possibility of inserting a cage and graft through a transpsoas approach, with theoretical advantages of reduced blood loss, shorter operating time and lower risk to the neural and vascular elements. Our average blood loss was 300ml. The large footprint, with the cage straddling the perimeter of the vertebral bodies, make it attractive for deformity correction [32]. There are currently a few reports of the L5-S1 segments treated with an XLIF procedure. The XLIF technique is not suitable for routine access to the L5/S1 level, due to the location of the iliac crest that obstructs the lateral access [33, 34]. A study of Kanno et al. showed that the XLIF is unique in the way that access to the lumbar spine is obtained via a lateral approach by splitting the center psoas major muscle. In this regard, it is extremely difficult to approach L5-S1 because of the presence of the iliac crest and therefore the OLIF technique was preferred by other authors to treat patients [35]. Our experience suggests that the XLIF including the segment L5-S1 is a feasible, safe and timesaving procedure in highly selected patients. We selected our 3 cases and planned a XLIF operation because the preoperatively standard X-rays showed that the iliac crest height did not reach over the middle of the L5 vertebral body, making us feel that an XLIF approach was an anatomical possibility. According to the study from Tanida et al. [36] there is concern about the lumbar plexus at the level L5-S1, and in patients with transitional vertebrae, because the plexus often migrates anteriorly. In some patients the psoas major muscle rises laterally or anteriorly at the L4-5 disc level and detaches from the most posterior aspect of the L4-5 disc space. This is called the "rising psoas sign". The potential for nerve injury is of particular concern in these patients. In our 3 cases we did not address the so called "rising psoas sign". The patients in our study were operated under direct sight, with the aid of a head lamp, and the psoas muscle fibers were carefully dissected under direct vision and with the aid of neuromonitoring to prevent vascular or nerve root damage. The study of Nunley et al. describes that neurologic complications following LLIF surgery are predominantly transient. The surgeries performed in this study, using a special retractor system, add to the body of literature that most neurologic complications are transient and resolve by

12-month follow-up [37]. The skin incision with an average length of 9.3 cm was still very small compared to an anterior or posterior approach [1, 29]. All 3 surgeries were performed using Neuromonitoring. Electrodes were installed in both the extremities for triggered SSEP and MEP during surgery. In the study of Wilson et al. in addition to the standard somatosensory evoked potential (SSEP) and motor evoked potential (MEP) monitoring, triggered EMG (tEMG) is utilised while passing through the psoas muscle. The EMG probe is attached to sequential dilators, which provides a threshold nerve response indicating the proximity to the motor nerves [38]. Using our indications the XLIF procedure is feasible at the L5-S1 disc level with satisfactory results even in obese patients with multilevel degenerative lumbar spine disease. Performing the complete fusion through the XLIF approach is timesaving compared to a combined anterior/posterior procedure. Our average surgery time was 303 minutes.

4. Limitations

There are several limitations that should be taken into consideration. The presented study is a single center case report study with only 3 cases. Larger studies with longer follow-up were needed to confirm the validity of the approach.

5. Conclusion

Although this is an initial report with only 3 cases, it does suggest that the XLIF technique for the level L5-S1 is a valuable option in selected patients with severe degenerative lumbar spine disease and failed conservative treatment. Preoperative anatomical evaluation of the correlation of the iliac crest to L5 has to be made. The procedure should be performed with the aid of neuromonitoring and direct visualization during dissection of the psoas muscle should be achieved.

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