Eur Spine J (2011) 20:1584–1586
DOI 10.1007/s00586-011-1997-x

OPEN OPERATING THEATRE (OOT)

Minimally invasive lateral transpsoas approach with advanced neurophysiologic monitoring for lumbar interbody fusion

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Keywords
Spinal fusion · Minimally invasive · Lumbar vertebrae · Spinal diseases · XLIF · Neuromonitoring · EMG

Introduction

The minimally invasive, lateral, transpsoas approach for lumbar interbody fusion (extreme lateral interbody fusion, XLIF), developed in 2003, is an alternative approach to anterior lumbar interbody fusion (ALIF) [1]. The XLIF approach minimizes approach related complications common to the direct anterior approach, namely vascular and visceral injury, without the need for an access surgeon [2, 3]. In order to safely traverse the psoas muscle, which contains the nerves of the lumbosacral plexus, real-time, surgeon-directed neuromonitoring (including free-run and evoked electromyography (EMG) in directional orientations with discrete-threshold responses) is used [4].

Case description

A 55-year-old female, presented with progressively increasing lower back and bilateral leg pain, which spiked during trunk movement, for approximately 1.5 years. The patient had failed non-operative treatments, and symptoms became unbearable in the 6 months prior to surgery. Patient reported lower back pain was 10/10 (visual analogue scale (VAS)) with leg pain rated as 7/10. Oswestry disability index (ODI) was 48%. Physical exam demonstrated decreased lumbar range of motion, without evidence of root deficit, and pain on palpation over the spinous processes in the lower lumbar spine. X-ray and computed tomography (CT) showed loss of disc height, slight retrolisthesis, endplate sclerosis, and slight lateral recess narrowing at L4–L5 with endplate changes evident on the superior endplate of L5. On MRI, Modic I changes were seen at L4–L5, with normal intensity and shape at all other levels.

As the level being treated was L4–5, additional information was obtained to assess safety of the lateral approach, where position of the iliac crest as well as nervous and vascular tissue may guide preoperative planning. The L4–5 disc space in this case was above the superior edge of the iliac crest on lateral radiographs, the position of the nerves of the lumbar plexus were in the posterior third of the disc space and the aorta and vena cava were in the far anterior portion of the disc space on axial MRI. These findings suggested that there was a comfortable transpsoas working channel to the lateral aspect at the disc avoiding bony, nervous, and vascular anatomy.

Surgical procedure

The XLIF procedure [1] was performed under general anesthesia with the patient in the lateral decubitus position on a radiolucent operating table with a break placed at the index level. Surface electrodes were placed at major dermatomes of the lower limbs to allow for recording of EMG signals during surgery. Avoiding the use of paralytic anesthetics allowed for reliable EMG monitoring of the lumbar plexus during both the approach through the psoas

Electronic supplementary material The online version of this article (doi:10.1007/s00586-011-1997-x) contains supplementary material, which is available to authorized users.

muscle and the procedure. Fluoroscopy was used to localize the diseased disc, and access was gained 90° off-midline through an approximately 3 cm incision. Blunt dissection was performed to access the psoas muscle with sequential dilators used to traverse the psoas muscle and access the lateral aspect of the disc space. Each dilator is integrated with a localized EMG stimulating field on the distal end, which was rotated during stimulation to provide 360° information on the position of motor nerves in the vicinity of the dilator. In addition, discrete EMG threshold responses are given for each response elicited, which provide information on the relative distance of motor nerves to the instrumentation, where a lower response threshold indicates closer nerve proximity compared to a higher response threshold [4, 5]. Once a corridor was made through the psoas muscle, the lateral disc space was accessed, and the retractor was placed over the final dilator, discectomy and disc space preparation were performed using standard techniques under direct visualization. Once disc preparation was complete, an intervertebral cage, which spans the ring apophysis with a wide aperture (prefilled with calcium triphosphate granules and autologous bone) was placed, resting on the strongest bone (that of the lateral aspects of vertebral endplates). Closure was performed with stitches in the external oblique fascial layer, subcutaneous layer, and skin without a drain, as significant bleeding was not observed. Estimated blood loss was 120 ml.

Postoperative information

Postoperative pain was managed with a combination of endovenous acetaminophen, and endovenous or subcutaneous morphine as needed.

The patient began eating on the 1st postoperative day, was able to sit and stand on the 2nd postoperative day, and was discharged to home on the 5th postoperative day with oral analgesics. She reported anterior thigh pain during the 1st and 2nd postoperative days, which resolved by the 3rd postoperative day. No motor or sensitive deficit was observed.

Six weeks after surgery she reported an ODI score of 10, back pain VAS of 2 and leg pain VAS of 2. No complications presented.

Discussion and conclusion

XLIF is a technique indicated for patients necessitating interbody fusion in the lumbar spine (other than L5-S1). Advantages of the approach include utilizing a minimally invasive access with direct visualization, the ability to place large interbody cages, which allow load to be applied to the strong bone of the ring apophysis, which resists subsidence, and allowing for a large contact area of host bone with graft or bone substitute. Compared to open anterior access its advantages include maintenance of the anterior longitudinal ligament, a less invasive approach corridor, and avoidance of great vessels.

To allow for a safe lateral access, one must utilize a good knowledge of neural anatomy (lumbar roots, abdominal wall nerves, and nerves on the surface of the psoas muscle) [6] and vascular anatomy, using accurate preoperative planning (identification of the position of vessels, lumbar plexus, iliac crest, osteophytes, and any deformity), careful patient positioning, gentle surgical manipulation, and the use of and adherence to intraoperative EMG for real time identification of the lumbar plexus within the psoas muscle [5].

Transient mild anterior thigh and/or groin pain or sensory changes are anticipated postoperative side effects of the transpsoas approach, due to irritation of sensory nerves. Another common side effect of the approach is hip flexion weakness, distinctly different from motor weakness due to neuropraxia, which results from psoas muscle irritation during the procedure, and resolves as the psoas muscle heals, typically within a month. Neuropraxic injuries to motor nerves are rare, though their occurrence can largely be mitigated by the use of an adherence to advanced neuromonitoring techniques. In a 2011 multi-centre, prospective trial of 102 patients treated at L3–4 and/or L4–5 with XLIF, Tohmeh et al. found 27.5% of patients exhibited mild transient postoperative hip flexion weakness on the side ipsilateral to the approach, 17.5% experienced transient upper medial thigh sensory loss, and new motor deficits were observed in 3 (2.9%) patients [4]. All instances of motor deficit resolved by 6 months postoperative. Overall complication rate, reported in the largest series (600 cases) to date by Rodgers et al. was 6.7%, a 1.8% reoperation rate, with 0.7% new motor deficit rate, which resolved in all patients by three months postoperative [2]. A review of the lateral approach for lumbar interbody fusion literature performed by Youssef et al. in 2010 found, in 14 peer-reviewed publications reporting patient outcomes (8 degenerative, 6 deformity), VAS improvement ranging from 32.4% to 80%, ODI improvement ranging from 39% to 82.1%, and a 89.4% patient reported outcome satisfaction rate [3].

This approach and technique allow for excellent disc preparation and fusion, in cases requiring interbody fusion (such as in discogenic pain). The minimally invasive nature of the approach paired with the ability to obtain adequate support on osteoporotic bone, makes XLIF a strong option in treating higher risk populations (e.g., elderly, comorbid, etc.) [7, 8]. Other indications for the lateral minimally invasive approach include arthroplasty, fracture or tumor, corpectomy, arthroplasty revision, or drainage of infected

tissue [9–12]. Limitations of the technique are the need for specific instruments, relative complexity of patient preparation, the need for careful positioning, and concerns about safety of the passage near the lumbar plexus.

Our experience, represented in the current case study, shows XLIF to be a safe, minimally invasive alternative approach for conventionally approached lumbar interbody fusion. However, adherence to safety measures, most notably advanced neurophysiologic monitoring modalities, detail to preoperative planning, and patient positioning, is paramount for the reproducibility of the approach.

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