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ORIGINAL PAPER

What every spine surgeon should know about transforaminal lumbar interbody fusion surgery for herniated discs

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Abstract

Purpose The aim of this study is to report our experiences on managing large lumbar disc herniations with several symptoms by surgery with transforaminal lumbar interbody fusion (TLIF) and to shed light for spine surgeons about TLIF surgery.

Methods We retrospectively evaluated our database of patients with various lumbar spine pathologies who underwent TLIF surgery from 2014 to 2017. We separated 18 patients who had been operated on for extruded disc herniation, which causes severe pain and radicular symptoms. The pain was quantified by visual analog scores (VAS). The disability status were pre-operatively and post-operatively evaluated by the Oswestry Disability Index (ODI). We evaluated the patients for at least two years. Interbody fusion was detected by routine radiographs at six, 12, and 24 months after surgery.

Results An ODI outcomes analysis demonstrated a statistically significant improvement in the six and 24-month mean scores compared with the pre-operative scores on the same scales. Patients' mobility improved significantly after surgery, as indicated by the decrease in the Oswestry Disability Index from 72 to 23 over two years ($p < 0.001$). Pain rapidly decreased in all patients and continued to decrease at the time of the latest follow-up. The mean pre-operative VAS scores for pain was 8.8; it had improved to 2.4 after surgery ($p < 0.05$). Within the follow-up period of two years, the ascertained mean VAS declined from 8.8 to 1.4 ($p < 0.001$). The average disc space height at the herniated levels was fairly well maintained. No patient had evidence of implant failure. Interbody fusion was graded as definitely solid in 100% of cases two years post-operatively. One patient displayed a superficial wound infection. Following appropriate debridement and antibiotics, the wound healed without sequelae. No major complications were observed, including permanent neurological deficit, pulmonary embolism, peri-operative cardiac event, or death.

Conclusions The findings of our study and those in the literature showed that primary herniated disc patients with radicular and chronic low back pain, degenerative changes, bi-radicular symptoms, and instability are required to have fusion after a discectomy. Being a heavy-duty worker is also a criterion for fusion surgery. TLIF is performed by a unilateral approach preserving the interlaminar surface on the contralateral side, which can be used as a site for additional fusion. As an effective results TLIF procedure should be chosen for fusion surgery.

Keywords Lumbar disc hernia · Transforaminal lumbar interbody fusion · Low back pain · Radicular symptom

Introduction

In a herniated disc, the soft, jelly-like centre of the disc pushes all the way through the outer ring. It can press on one or more nerves and can cause pain, burning, tingling, and numbness. Low back pain is also seen, as it may be due to the degenerative process that led to the herniation. Surgery is typically recommended only after a period if nonsurgical treatment has not relieved painful symptoms or for patients who are experiencing the symptoms of muscle weakness, difficulty walking, and a loss of bladder or bowel control. The surgical treatment remains discectomy. The herniated part of the disc is removed along with any additional fragments that are putting pressure on the spinal nerve. The inclusion of a fusion for routine discectomies is not recommended [1]. Generally, surgeons hesitate to suggest fusion surgery, but fusions could also be required in surgical treatment. The incorporation of a lumbar fusion may be

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considered an option when a herniation is associated with evidence of spinal instability, chronic low back pain, bi-radicular symptoms, and/or severe degenerative changes or if the patient participates in heavy-duty work. A variety of fusion techniques applied where necessary are available. Transforaminal lumbar interbody fusion (TLIF), developed by Harms [2], is a spinal fusion procedure that fuses the front and back section of the spine through a posterior approach. Because of its posterolateral extracanalar discectomy and fusion, it has been reported as a safe technique. Indications for a TLIF approach include all degenerative pathologies, including disc herniations, broad-based disc prolapses, degenerative disc disease, recurrent disc herniation, pseudoarthrosis, and symptomatic spondylosis [3]. The aims of this study are to report our experiences on managing large lumbar disc herniations with several symptoms by surgery with TLIF and to shed light on spine surgeons about TLIF surgery.

Materials and methods

We retrospectively evaluated our database of patients with various lumbar spine pathologies who underwent TLIF surgery from 2014 to 2017. We separated 18 patients who had been operated on for extruded disc herniation, which causes severe pain and radicular symptoms. The patients (12 females and 6 males), with a mean age of 44 years (range 21–65 years), also had variable components of degenerative changes in adjacent end plates. All the patients in this series had low back pain as their predominant symptom, with varying degrees of radicular pain and neurologic symptoms. All patients underwent at least six months of non-operative care before coming to surgery.

The distribution of the fused levels was sequenced as follows: L3–L4 ($n = 2$), L4–L5 ($n = 12$), and L5–S1 ($n = 4$). The cage material was not always the same: for peek, $n = 11$, and for titanium, $n = 7$.

All the patients underwent general anaesthesia. With patients in the prone position under radiological control, the posterior midline approach was used.

Back and leg pain was quantified by visual analog scores (VAS) collected from the patients pre-operatively, post-operatively, and at the final follow-up. The disability status were pre-operatively and post-operatively evaluated by the Oswestry Disability Index (ODI). The clinical outcome was assessed at a minimum of two years' follow-up and compared to a pre-operative baseline value using ODI and VAS.

A pre-operative radiological evaluation included anteroposterior and lateral plain radiograph and magnetic resonance imaging (MRI) (Fig. 1). The patients were evaluated pre-operatively and post-operatively at one, six, 12, and 24 months' follow-up. Interbody fusion was detected by routine radiographs at six, 12, and 24 months after surgery (Fig. 2). We performed a computed tomography scan to confirm the fusion rate in three patients (Fig. 3). Definitive fusion was identified by the formation of trabecular bony bridges between contiguous vertebral bodies at the instrumented levels.

A Student t test was used for the comparison of continuous variables. P values below 0.05 were accepted for significance.

Surgical techniques

The TLIF approach involves placing the patient in a prone position after the patient is put under general anaesthesia. A posterior midline incision was made extending slightly beyond the levels to be approached, followed by subperiostal dissection of the muscles until complete exposure of the transverse processes. Pedicle screws were inserted to both sides. A distraction of the involved segment was performed using a specific retractor that was compatible with the screw heads (Fig. 4) on the opposite side. A unilateral resection of the inferior articular facet of the superior vertebra was performed, unilaterally exposing the intervertebral vertebral foramen. The posterolateral portion of the ipsilateral disc space of the vertebral foramen was exposed. Other actions included coagulation (with bipolar) of the small epidural vessels and visualization and protection of the dura medially. The extruded herniated disc was removed, and the spinal cord and nerves were decompressed. Then, the remaining disc was completely

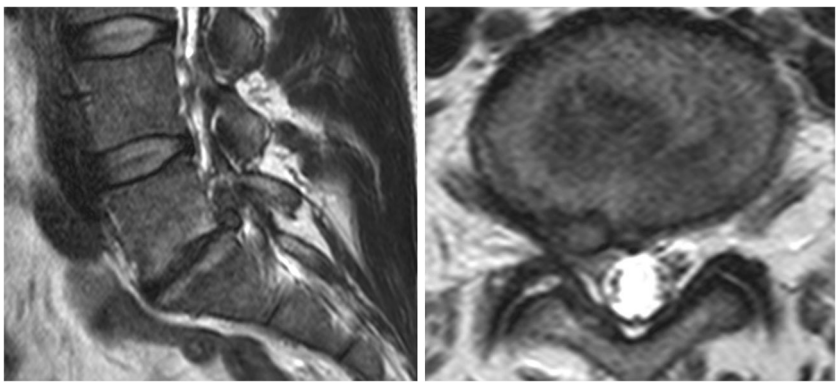

Fig. 1 Magnetic resonance images of a preoperative patient

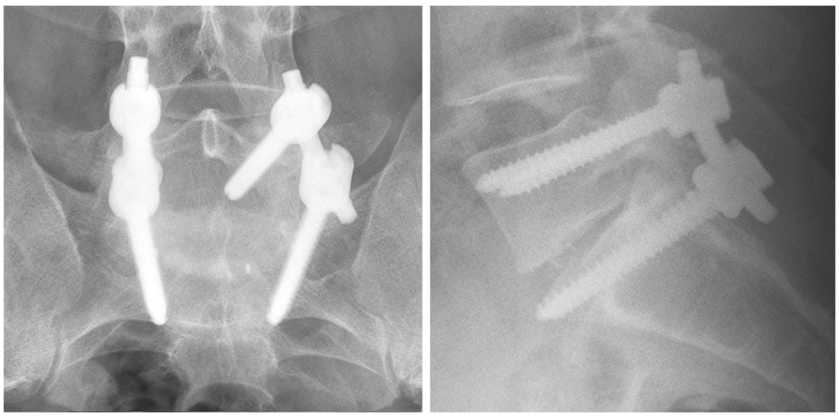

Fig. 2 X-ray images at 6 months after surgery

removed. Superior and inferior end plates were prepared. The TLIF cage, which was filled with cancellous bone from facet and lamina, was placed in the discectomy area. Then, the rods were fixed and compressed with the screws. Finally, the deposition of bone graft for posterolateral fusion between the transverse processes was performed.

Results

We identified 18 subjects who underwent a one-level stabilization with TLIF for extruded disc herniation with pain, radicular symptoms, and degenerative changes in adjacent end plates. The mean blood loss was 280 mL, and the mean post-operative length of stay was 4 days. All cases were followed up for a mean of 31 months (range 24–48 months) post-operatively. No major surgical complication was observed. There were no complications related to internal fixation breakage, loosening, or displacement.

All patients achieved spinal fusion in the last X-ray control. In our experience, the two different cage materials (titanium or peek) do not influence the rate of fusion to a statistically relevant degree. Pre-operative MRI and post-operative X-ray images of the patient in whom we use titanium cage are shown in Fig. 5, and the images of our patient where peek cage was used are shown in Fig. 6.

We used the ODI questionnaire for three time frames: pre-operatively, six months after surgery, and two years after surgery. The pre-operative and six month and two year post-operative scores were compared and analyzed in this study. An ODI outcomes analysis demonstrated a statistically significant improvement in the six and 24-month mean scores compared with the pre-operative scores on the same scales. The mean pre-operative ODI score of 72 improved to 31 at six months ($p < 0.05$). Patients' mobility improved significantly after surgery, as indicated by the decrease in the Oswestry Disability Index from 72 to 23 over two years ($p < 0.001$).

Pain rapidly decreased in all patients and continued to decrease at the time of the latest follow-up. The mean pre-operative VAS scores for pain was 8.8; it had improved to 2.4 after surgery ($p < 0.05$). Within the follow-up period of two years, the ascertained mean VAS declined from 8.8 to 1.4 ($p < 0.001$).

The average disc space height at the herniated levels was fairly well maintained. No patient had evidence of implant failure. Interbody fusion was graded as definitely solid in 100% of cases two years post-operatively (Fig. 3).

One patient displayed a superficial wound infection. Following appropriate debridement and antibiotics, the wound healed without sequelae. No major complications were observed, including permanent neurological deficit, pulmonary embolism, peri-operative cardiac event, or death.

Discussion

Lumbar discectomy for disc herniations is one of the most common spinal procedures [1]. However, fusion, the surgical alternative to discectomy, has been performed for primary disc herniations [4, 5]. Generally, surgeons hesitate to suggest fusion

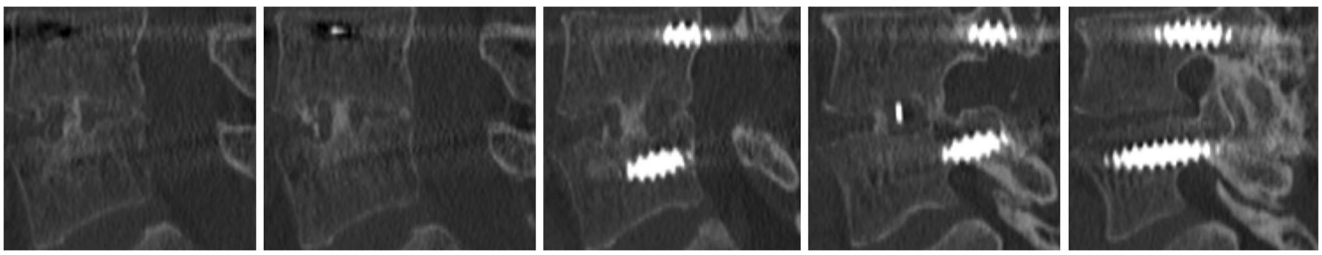

Fig. 3 Computed tomography scan images at 2 years after surgery

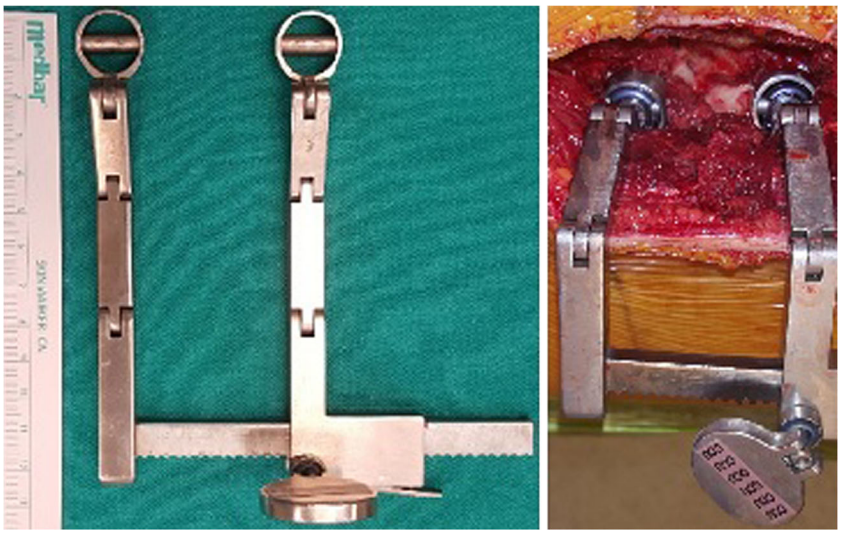

Fig. 4 Specific retractor

surgery for disc herniations. Controversy remains about the indication of spinal fusion in the treatment of lumbar disc herniation. Some authors have stated that satisfactory results can be obtained by discectomy alone [7, 8]. According to the other authors, lumbar fusion gives better protection against the recurrence of pain [4, 6]. Long-term results after primary discectomies have been less positive, with success rates of 18–79% in previous studies [9–12]. After discectomy surgeries, patients have a continued risk for recurrent herniation, one of the more common causes of recurrent radiculopathy. Residual back pain and recurrent disc herniation were important factors affecting the long-term results of discectomy alone [4, 5, 11]. Recurrent herniation has been reported in 5 to 27% of patients, representing the major cause of surgical failure, given the overall rate of unsatisfactory results of discectomy [13–16]. Residual low back pain after discectomy alone was reported in 21 to 54% [4, 11, 14, 16] of cases. The recurrence of symptoms after an initial period of symptomatic relief can be caused

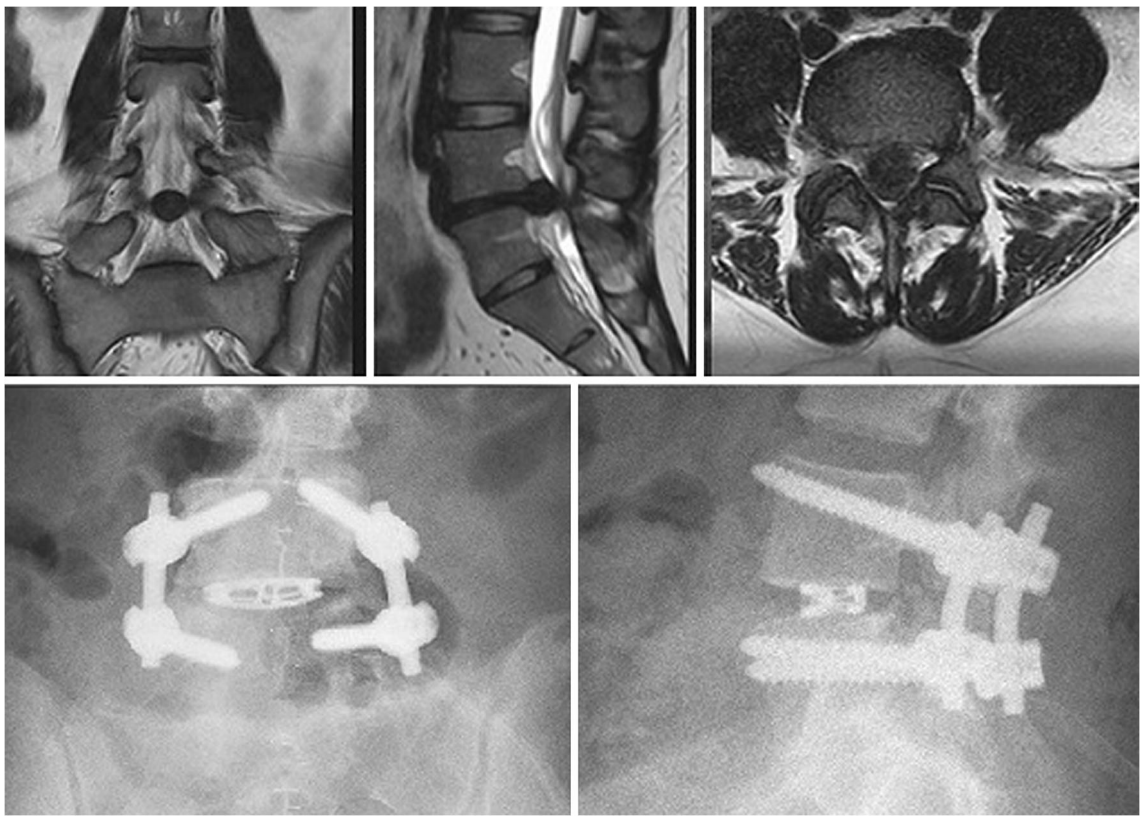

Fig. 5 Preoperative MRI and postoperative X-ray images of the patient in whom titanium cage was used

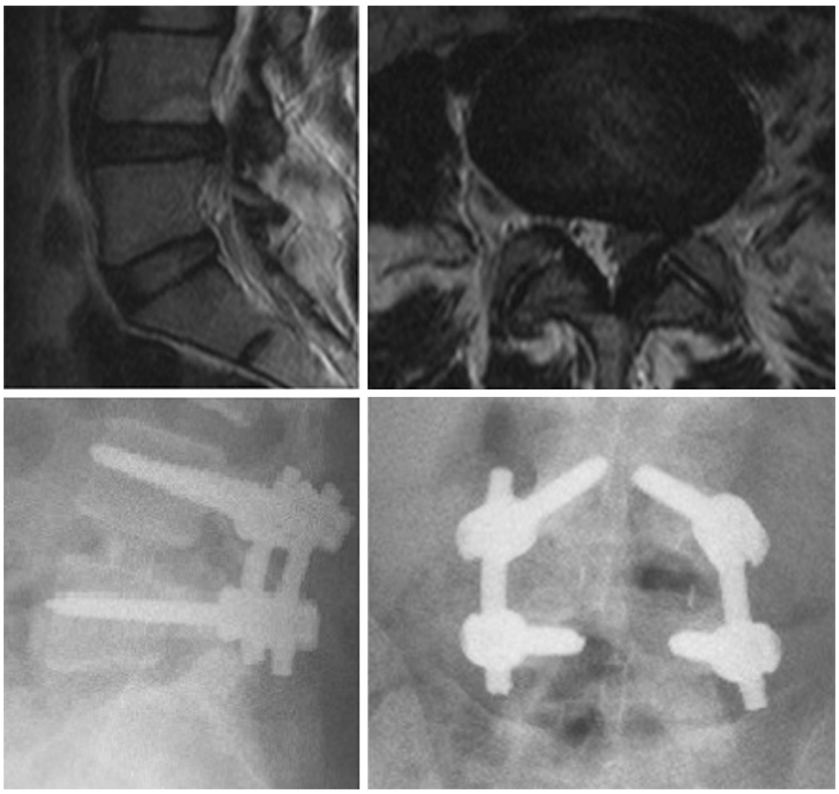

Fig. 6 Preoperative MRI and postoperative X-ray images of the patient in whom peek cage was used

by a recurrence of herniated disc, epidural fibrosis, foraminal stenosis, or segmental instability.

Some of the question that remain to be answered include the following: Do the wrong indications increase the recurrence rate? Should fusion surgery be performed because of high recurrence rates? Which procedure should be chosen for fusion surgery? What about TLIF?

First, which patients have had more recurrent disc issues?

Cinotti prospectively reviewed 26 patients requiring re-operations and noted that men with marked disc degeneration were at a particularly high risk [17].

In a previous study [18], it was reported that herniations associated with a small annular defect (< 6 mm) had a 1% recurrent herniation rate compared with those with a large defect (> 6 mm), which had a 27% recurrent herniation rate and a 21% re-operation rate.

In a retrospective study for recurrent disc herniations, young age, male gender, smoking, and traumatic events were found to be significant risk factors [19].

In a randomized study of 84 patients, Barth et al. found the recurrent herniation rate to be 12.5% with radical discectomy versus 10% with limited discectomy [20].

A recent systematic review concluded that a limited discectomy might be associated with less risk for long-term low back pain but with more risk for recurrent herniation than radical discectomy [21].

Eie reported in their study that the discectomy-alone patients reported a significantly higher incidence of pain recurrence (27% of patients) [15].

Should fusion surgery be performed?

As indicated in the first generation of the Lumbar Fusion Guidelines, justification for fusion for simple disc herniations is lacking [1]. Spinal fusion is a potential option in patients with primary disc herniations who have significant chronic axial back pain and bi-radicular symptoms, work as manual laborers, have severe degenerative changes, or have instability. Patients with a new onset of herniated disc and radiculopathy in the presence of axial low back pain or radiographic instability also need fusion surgery [4, 5]. Advocates for fusion during the discectomy claim that stabilizing the segment may prevent late-onset instability and the development of chronic low back pain.

A retrospective study of 80 cases involved manual labourers treated via discectomy alone or with discectomy and fusion [22]. At the one year point, 53% of the patients in the discectomy group and 89% of those in the fusion group were able to resume and maintain pre-operative manual labor work activities. Although the discectomy patients did return to the fusion group, 22% of them could not maintain their work

activities due to lumbar fatigue. In this study, it was concluded that the addition of fusion should be considered for manual laborers returning to and staying at their pre-operative level of function.

Satoh et al. published a retrospective review of 351 cases that were followed up for 5 years [6]. They divided two groups involving patients with disc herniations treated with fusion and patients treated with discectomy alone. The fusion group demonstrated significantly better outcomes with respect to low back pain. The frequency of revision surgery was significantly higher in patients who did not receive a fusion. They reported that patients with disc herniations and instability or massive herniations can be successfully treated with fusion at the time of primary discectomy.

In our study, all patients were active manual workers. They had massive disc herniations with radiculopathy and chronic low back pain. There were radiologically degenerative end plate changes in all the cases.

Which procedure should be chosen for fusion surgery? What about TLIF?

Amongst all the lumbar spinal fusion techniques, combined anterior-posterior fusion offers the highest mechanical stability and the best chances of bony fusion [23]. Lumbar interbody fusion procedures can provide circumferential spinal stabilization through a single posterior approach. Lumbar interbody fusion is performed using five main approaches: posterior lumbar interbody fusion (PLIF), transforaminal lumbar interbody fusion (TLIF), oblique lumbar interbody fusion/anterior to psoas (OLIF/ATP), anterior lumbar interbody fusion (ALIF), and lateral lumbar interbody fusion (LLIF). There is no clear definitive evidence for one approach being superior to another in terms of fusion or clinical outcomes.

ALIF/OLIF/LLIF approaches are anterior to the transverse process and involve a retroperitoneal corridor to the lumbar spine. PLIF and TLIF approaches are posterior to the transverse process and involve traversing the spinal canal or foramen for access to the disc and interbody space.

Niemeyer et al. compared ALIF and TLIF techniques in 27 patients with post-discectomy syndrome [24]. In the ALIF group, they found higher blood loss and persistent retrograde ejaculation in three male patients, but there were no surgery-related complications in the TLIF group.

The main concerns with the posterior fusion approach is the extent of neural retraction required, with particular concerns surrounding potential nerve root injury, dural tears, and epidural fibrosis. To address this limitation, the TLIF approach was described by Harms and Jeszenszky [2] as a modification of the PLIF procedure. The TLIF procedure has rapidly gained popularity. The TLIF technique requires less retraction of the thecal sac and neural elements than with the PLIF technique. The angle of approach normally obtained during TLIF allows a unilateral approach to the disc space, thus reducing operative time and blood loss. This has been shown to reduce the incidence of post-operative radiculitis. TLIF usually is performed by a unilateral approach preserving the interlaminar surface on the contralateral side, which can be used as a site for additional fusion. In recent years, various approaches have been defined for TLIF surgery, including percutaneous endoscopic and minimally invasive TLIF [25–27]. However, they did not have a clear advantage over open TLIF surgery.

In our study, all the patients achieved spinal fusion in the last control. There were no complications related to spinal cord or nerve injury, dural tear, internal fixation breakage, loosening, or displacement.

In conclusion, the findings of our study and those in the literature showed that primary herniated disc patients with radicular and chronic low back pain, degenerative changes, bi-radicular symptoms, and instability are required to have fusion after a discectomy. Being a heavy-duty worker is also a criterion for fusion surgery.

Compliance with ethical standards

Conflict of interest The authors declare that there is no conflict of interest.

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