Transforaminal lumbar interbody fusion in failed back surgery

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Received 10 March 2011
Accepted 25 March 2011

Egyptian Orthopedic Journal 2012, 47:265–270

Background data
Spinal surgery on the lumbar region, particularly neurological decompression procedures, may rapidly relieve disabling symptoms, like sciatic pain and cauda equina syndrome. Many of these procedures require a limited number of specialized surgical equipment; hence they gained popularity worldwide. During the last two decades there has been extensive use of transpedicular fixation to regain stability of the destabilized spine, destabilized through wide laminectomies, major facetectomies, disease processes such as degenerative or lytic spondylolisthesis, or as a sequel to severe infection. Revision surgery is known to be a difficult decision; it is usually associated with increased morbidity, neural complications like dural tears, perineural fibrosis, and secondary neural canal stenosis. To minimize such morbidities during revision surgery, instrumented posterolateral and posterior lumbar interbody fusion (PLIF) procedures have been developed. More recently transforaminal lumbar interbody fusion (TLIF) through choosing a more lateral door with a graft or a cage graft has been recommended to decrease morbidities observed with PLIF cages for treatment of patients with failed back surgery.

Purpose
The aim of this study was to evaluate the results of instrumented transforaminal interbody fusion in treatment of failed back surgery and to prove its efficacy and competence as a successful alternative procedure to PLIF surgery with less morbidity especially in revision cases.

Methods
Forty-two patients with previous failed back surgery, all suffering from low back pain and 12 suffering from sciatica, were treated by instrumented TLIF with and without cages. Average follow-up was 36 months. Patients were evaluated for time to union, relief from symptoms, neurologic recovery, complications, and return to normal activity. The Visual Analog Scale and the Oswestry Disability Index were used to measure clinical outcome.

Results
The results were excellent in 35 patients (83.3%), good in four patients (9.5%), and fair in three patients (7.1%). According to postoperative radiographs, fusion was complete in 6 months in 33 patients (78.6%), in 9 months in 39 patients, and in 12 months in 42 patients.

Conclusion
TLIF is a very effective procedure, yielding a high rate of union and functional recovery from failed back surgery due to different causes including previous spinal fusions, with a low rate of complications.

Keywords:
failed spine surgery, posterior lumbar interbody fusion, transforaminal lumbar interbody fusion

Egypt Orthop J 47:265–270

1110-1148

Introduction

The concept of posterior lumbar interbody fusion (PLIF) was first described by Cloward [1] for the treatment of lumbar disc disease. More recently, Blume [2] described the unilateral transforaminal approach for segmental lumbar interbody fusion to treat failed cases of back surgery after instrumented bilateral pedicular fixation with PLIF. The transforaminal lumbar interbody fusion (TLIF) procedure was modified and popularized by Harms *et al.* [3]. The described technique included interbody fusion with posterior facet and interlaminar arthrodesis on the contralateral side. Added intertransverse fusion converted the technique into a 360° fusion technique.

The main step in the TLIF procedure is the anterior interbody support and induction of interbody fusion, which restores sagittal balance and foraminal height.

A corticocancellous autograft from the iliac crest or allograft has been used extensively in PLIF and recently in TLIF surgery. Different types of cages were used to provide primary support and stability to the graft before it is incorporated into the fusion mass. The progress in research on new types of cages lead to the development of different kinds and shapes of cages, particularly the PEEK and the biodegradable types. Minimally invasive TLIF procedures with percutaneous pedicular fixation have been adopted recently with encouraging results [4].

Material and methods

Forty-two patients among whom 30 had persistent low back pain and 12 had low back pain with sciatica were selected for posterolateral TLIF procedures at the Ain Shams University Hospital in the period between May 2003 and October 2008 with an average follow-up period of 36 months.

Twenty-eight women and 14 men with a mean age of 36 years (range 28–58 years) were included in the study; all patients had undergone previous surgery. Twenty-six patients had undergone single-level open discectomy or debridement: 18 patients for L4–5 and eight patients for L5–S1 (of those, two patients had pyogenic postoperative discitis caused by *Staphylococcus* species and one had spondylitis caused by *Brucella* species. Twelve patients underwent double-level discectomy and four patients underwent surgeries at more than two levels. Thirty patients were referral cases from other centers. Patients suffered from back pain and/or sciatica for varying periods of time that ranged from 6 to 18 months before presentation. Patients in this study were laborers and manual workers, although 12 patients were had light-duty jobs or were housewives.

Preoperative workup performed for all patients included obtaining plain radiographs with anteroposterior, lateral standing, and flexion–extension dynamic views and MRI. The presence of titanium screws and rods did not interfere with MRI.

Figure 1

(a) MRI showing peridural fibrosis on the left side of L4–5 after a previous discectomy. (b) Radiograph of the same patient at final follow-up showing fusion evident through the cage.

Surgical hints

The level of the surgery was confirmed by the C-arm. The transforaminal approach was adopted on the affected side where patients had sciatic pain, a tight foraminal area, or lateral recess, as observed using computed tomography and/or MRI (Fig. 1a), in order to decompress the root at that side. The procedure began with the insertion of pedicular screws on both sides without exposure of the canal in the midline where the scar tissue is located in order to avoid dural tears, bleeding, or root injury caused by dissection through the scar tissue and root retraction.

Monoaxial screws were used for one-level fusion surgery; polyaxial screws were used only in double-level or triple-level surgeries.

The rod was inserted on the contralateral side and distraction was performed to increase the disc space and open the intervertebral foramen. The screws were tightened while performing distraction on the side opposite to the cage insertion side.

Subtotal facetectomy of the inferior facet on the selected side for surgery allows good exposure to the nerve root, dura, and disc. Thus, there was no need to remove too much bone from the lamina to expose the disc and nerve roots after inferior facetectomy.

Much care was given to the nerve-root decompression in patients with sciatica. Nerve-root decompression is not recommended for patients with low back pain only.

The osseous endplates should be preserved to avoid graft and cage subsidence under compression during follow-up.

Although distraction on the opposite side is maintained, a cancellous bone graft was packed into the anterior part of the disc space to enhance early intervertebral fusion and act as a biological marker to detect fusion in the presence of metal cages. In the three patients with infection, we used corticocancellous iliac block grafts without cages.

We used different types of cages, provided they had enough fenestrations to accommodate adequate amounts of bone grafts. The cage should be inserted at the middle segment of the disc space under image control to protect it from anterior or posterior dislodgement.

A proper sized cage is that which could maintain proper height and neural foramen distraction with indirect neural decompression till fusion is completed. Small-sized cages could be inserted much more easily, but the bigger-sized cages are preferred; extra-large cages should be avoided, to prevent excessive distraction, which could strain the ligaments and annulus and cause back pain after surgery.

Trial cages were used to select the proper size before the real one is inserted. Check radiographs using C-arm anteroposterior and lateral views were used to confirm the alignment, the sagittal view configuration, the position of the cage in the middle, the position of the graft anterior to the cage, the size of the neural foramen and the parallel endplates, as well as the position of the pedicular screws. The rod was applied on the cage side, the cage or the graft was then compressed, following which the screws were tightened on both sides.

Posterolateral intertransverse fusion on the operated side was performed in addition to TLIF to increase the surface area for fusion. It could be performed in addition to TLIF in patients with high levels of instability, like in those who had spondylolisthesis or infection with bone destruction. The wound was then closed over suction drainage.

Postoperative program and follow-up

Lumbosacral support for the first 12 weeks was advised for all patients.

Patients started walking 1–2 days after surgery. Regular follow-up visits were scheduled every 2 weeks for the first 2 months, then monthly till 6 months, then every 3 months for the first 2 years, and then every 6 months till the end of follow-up.

Clinical evaluation was conducted using VAS and ODI questionnaires for low back and leg pain.

Fusion was detected and followed up by plain radiography within the first 6 months.

Criteria of fusion were as follows:

(1) Trabecular bone formation connecting the anterior part of the vertebral bodies across the disc space in front of the cage.
(2) Trabecular bone formation connecting the transverse processes in the combined interbody and intertransverse fusion cases.
(3) Trabecular bone formation across the peak cages (Fig. 1b).
(4) Absence of any radiolucent lines around the cages or the pedicular screws.
(5) No implant failure or pulled-out screws.
(6) No detectable motion in flexion–extension radiographs obtained at the final follow-up.

Results

Clinical outcome was scored according to VAS and ODI.

The results were considered excellent if improvement was greater than 75%, good if it was 50–75% during the last follow-up, fair if it was 25–50%, and poor if it was less than 25%.

The results were excellent in 35 patients (83.3%), good in four (9.5%) patients, and fair in three (7.1%) patients.

According to postoperative radiographs, radiological fusion was complete in 6 months in 33 patients (78.6%), in 9 months in 39 patients, and in 12 months in 42 patients. Although intertransverse fusion was weak in one patient with postdiscectomy discitis, intervertebral fusion (graft without a cage) proceeded in the forward to backward direction and was complete in 7 months (Fig. 2).

No cases of pseudarthrosis or nonunion were observed in this study.

Complications

We encountered no intraoperative complications in this study. One patient had motor weakness of dorsiflexion of the toes and the ankle joint on the right side as a result of traction on the roots. He recovered completely after 4 months. One patient had superficial wound infection that was cured by treatment with antibiotics for 2 weeks. One patient had persistent low back pain for 1 year following complete bone fusion, after which he showed considerable improvement and stopped the analgesics gradually over the following 8 months.

Discussion

Interbody fusion techniques like PLIF and ALIF are known to be superior to posterior and posterolateral techniques with respect to the final result. Compression forces acting on the graft in PLIF and ALIF techniques allow rapid fusion, whereas tension forces acting on the posterior and posterolaterally inserted grafts delay the fusion although the fusion mass is much bigger in the posterolateral fusion. However, pseudarthrosis may take place within the posteriorly located masses. The overall results for soft fusion bone grafting alone without instrumentation ranged from 46 to 90%, fusion rates increased to 80–90% with the addition of spine instrumentation to bone grafting in lumbar fusion as reported by Katz [5].

Interbody fusion by the transforaminal technique with pedicular screws and rods in the treatment of 42 patients

Figure 2

Serial radiographs of patients with postoperative discitis treated by TLIF without a cage, reaching fusion in 7 months. (a) Early postoperative TLIF with graft, (b) 3-month postoperative fusion starting anteriorly, (c) anteroposterior view of complete fusion in 7 months, (d) lateral view of the complete fusion.

who had previous failed surgery allowed graft compression, although the midline scar from the previous surgery was avoided. We reported full fusion rates in 33 patients 6 months after surgery, in six patients 9 months after surgery, and in three patients 12 months after surgery.

The great success of the TLIF technique in revision surgery cases in this study resulted from inserting the graft under compression forces, while maintaining the disc height and root decompression with sagittal balance restoration. The transforaminal fusion far from the scar tissue in the midline avoided dural tears and excessive bleeding, which are reported in association with revision PLIF surgery.

The higher fusion rate is also related to the wide surface area available for fusion and the compression loads applied on that area, as 80% of the load is carried anteriorly across the vertebral bodies and discs, whereas 20% of the load is carried by the facet joints posteriorly [6].

Rosenberg and Mummaneni [7] have reported complete cure of low back pain after transforaminal fusion in 16 of 22 patients, whereas radicular pain was resolved completely in 19 patients who had radicular pain and low back pain due to neural canal decompression and disc height restoration 1 year later. Lowe *et al.* [8] reported good and excellent clinical results in 79% of thin patients in a 40 patient series. They also reported 10% suspected pseudarthrosis that was confirmed in one patient. Although their study has nearly the same number of patients as reported in this study on 42 patients, their results were inferior to the results of the present study; in addition, two patients in their study had dural tears and one had late infection.

This study dealt with more difficult cases; all revision cases after previous discectomy through fenestration, partial laminectomy (24 patients), PLIF (six patients), and posterolateral fusion with implant failure and nonunion (12 patients), have persistent low back pain, whereas 12 patients have sciatic pain and low back pain.

Eight had right-sided sciatica and four had left-sided sciatica. Sciatic pain has been totally cured by decompression fusion surgery in 11 patients. One patient had motor power loss associated with right-sided sciatica as a complication of excessive nerve-root traction during surgery, which improved after a 4-month duration with disappearance of neurological pain and full motor power recovery.

Low back pain disappeared after 4 months in 35 patients with excellent results. Four patients had considerable improvement in their back pain; they used oral analgesics once or twice daily. Three patients used analgesics more than three times daily with intramuscular injection every 2 days.

The radiographic outcome of this study compared favorably with those of other studies such as studies by McAfee *et al.* [9] and Yan [10]. Solid fusion was achieved in all patients of this study at different stages: 6 months in 33 of 42 patients, at 9 months in 6 of 42 patients, and at 12 months in 3 of 42 patients.

Posterolateral fusion was carried out in addition to interbody fusion in patients with greater instability; complete fusion occurred in four patients of this study who had been treated by posterolateral fusion alone with an insufficient graft for grade 3 spondylolisthesis, as biological and mechanical problems were corrected during the second surgery.

The TLIF technique was a very successful surgical option for the correction of a failed disc or fusion surgery without neural retraction, as is the situation after PLIF surgery, which leads to dural tears and different grades of root injury.

The presence of midline scar tissue surrounding the dura and the roots in revision surgery makes second PLIF a real risk with many complications.

The pedicular screw and rod system has been used in all patients in this study with a corticocancellous graft alone in 10 patients and posterolateral cages in 32 patients. We performed single-level fusion in 30 patients and double-level fusion in 12 patients: eight patients for L4–L5 and L5–S1and four patients for L3–L4 and L4–L5.

The operations were performed to treat residual back pain with or without sciatic pain in 24 patients and failed fusion in 18 patients: 12 patients after failed posterolateral fusion and six patients after failed PLIF. Thirty-three patients had solid fusion by 6 months (78.6%), six patients in 9 months (14.3%), and only three patients (7.1%) at 1 year.

In this study, the TLIF procedure proved to be the best available surgical option for revision surgery after failure of open disc surgery, laminectomy, posterolateral fusion, and PLIF without scar dissection at the midline, with minimal complications, and with excellent clinical and radiographic results.

Conclusion

The TLIF technique for revision surgery is safe and very effective. A higher fusion rate and minimal complications are reported in treating difficult cases in this study. A unilateral approach to the spinal canal, osseous endplate preservation, good grafting, and centralized cage positioning are key factors for the success of this procedure. Posterolateral intertransverse fusion is carried out in addition to TLIF in patients with major instabilities like spondylolisthesis and in those with more vertebral body affection (cases complicated with infection). TLIF should be considered for fresh cases in order to avoid the high rate of complications after PLIF and posterolateral fusion alone, as its value has been proven in revision cases in this study.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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