

Transforaminal lumbar interbody fusion for lumbar disc disease and listhesis – Is it advantageous?

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Abstract

Introduction: Among various spine disorders, degenerative conditions like lumbar disc disease and spondylolisthesis are commonly encountered. Surgery is the option if conservative management fails. Fusion is the only option to alleviate instability. Transforaminal Lumbar Interbody Fusion (TLIF) is a promising procedure to achieve this goal. The aim of our study was to evaluate whether unilateral TLIF with one cage is comparable with other established techniques.

Materials and Methods: This is a prospective study with 11 males & 11 females who have undergone TLIF for disc disease and low grade listhesis. A single TLIF cage was used for single level pathologies. In one patient with contiguous two level disc disease, two level TLIF was performed.

Results: Results were analysed with respect to intra-op parameters (like surgery duration, blood loss, etc.) and post-op parameters (like fusion, pain relief, etc.). Oswestry Disability Index was used to measure functional outcome. There was a statistically significant improvement in post-op scores ($p < 0.0001$). One complication in the form of Ischemic Optic Neuropathy was encountered.

Conclusion: Proper patient selection and surgeon's expertise are important for a successful outcome. TLIF has many advantages when compared to other fusion techniques. It is an ideal management for treating degenerative disc disease and listhesis of low grades.

Keywords: Transforaminal, Lumbar interbody fusion, Spondylolisthesis, Lumbar disc disease, Degenerative, Radiculopathy.

Introduction

The incidence of back pain in the working class people is on such a steep rise in recent years, that, it is the second most common complaint necessitating the patient to visit a physician. The loss in productivity is considered to be greatest with back pain than any other medical condition.^{1,2} With the advent of technology related occupations, the sitting posture is adopted for long hours which may have a deleterious effect on the spine, especially if the posture is incorrect. Lack of exercise and obesity add to the increasing incidence of back pain.

Among various spine disorders, degenerative conditions such as lumbar disc disease and spondylolisthesis need special treatment in the form of physiotherapy and surgery. Patients with lumbar disc disease and spondylolisthesis are treated conservatively with rest, pain medications and physical therapy. Surgical management is indicated in certain cases or in cases which do not respond to conservative management. Although several surgical modalities of treatment for these conditions are available, lumbar arthrodesis is one of the commonest surgeries done for these conditions.³ The indications, techniques and outcomes of these procedures are unclear even now.⁴ Posterolateral fusion has been considered the gold standard for treatment of low grade spondylolisthesis for a long time.⁵ There are three types of interbody fusions- Anterior Lumbar Interbody Fusion (ALIF), Posterior Lumbar Interbody Fusion (PLIF), Transforaminal Lumbar Interbody Fusion (TLIF). In recent times, better outcomes have been reported with TLIF techniques. This technique is theoretically superior as it avoids the complications of anterior and posterior approaches.⁶

The aim of this study was to evaluate whether unilateral TLIF with one cage is comparable with established techniques regarding outcome, fusion rate and complications.

Materials and Methods

This was a prospective study conducted at tertiary care centre with a sample size of 22 patients (including 11 males and 11 females in the age group of 22-58 years) with degenerative lumbar disc disease and low grade spondylolisthesis, who fit the inclusion criteria, with clinicoradiological follow up done for each case. A written informed consent was obtained from all patients. The period of study was from May 2014- July 2017.

Inclusion Criteria

1. Degenerative lumbar disc disease patients not responding to conservative management.
2. Central disc herniation.
3. Recurrent disc disease post surgery (Failed back syndrome).
4. Grades 1 and 2 spondylolisthesis.

Exclusion Criteria

1. Age <18 years or >60 years
2. Infection
3. Sequestered disc
4. Spondylolisthesis Grade III and IV
5. Medical Contraindications for surgery

Patients were selected from the outpatient department based on the inclusion and exclusion criteria, and a

complete primary survey was carried out, which included eliciting the complete and detailed history of the patient including an Oswestry Disability Index scoring, and a clinical examination to identify the neurological deficits. The level of the pathology was diagnosed clinically and confirmed with X-rays and MRI scans.

The pre-operative planning included preoperative anteroposterior, lateral, dynamic x-rays and MRI and CT scan (if required). Intervertebral disc heights were recorded and slip grading was done (Meyerding classification). Pre-operative Oswestry Disability Index was measured using the questionnaire. The post-operative clinical and radiological evaluation was done at 4 weeks, 8 weeks, 12 weeks by postoperative clinical examination, Oswestry Disability Index, X rays and CT scans.

Procedure

The procedure was similar to that described by Harms⁷. Patient was placed prone on a Hall's frame on a radiolucent table, with adequate padding of bony prominences and face. Bladder was catheterised and abdomen was left free of pressure. (Fig. 1)



Fig. 1: Patient is positioned on Hall's frame

A standard midline posterior approach to lumbar spine is used. The spinous processes, the transverse processes and pars interarticularis were exposed without dissecting onto the cephalad facet joint capsule. At this point, an intraoperative fluoroscopic marker was used to confirm the vertebral levels. Laminectomy was done in all cases with isthmus spondylolisthesis.

Pedicle screws were applied using standard technique, in our study, most commonly the intersection technique was used. Pedicle screws were applied a level above and a level below the degenerated disc, or in cases of spondylolisthesis, into the slipped vertebra and into the vertebra below it.

Transforaminal Osteotomy

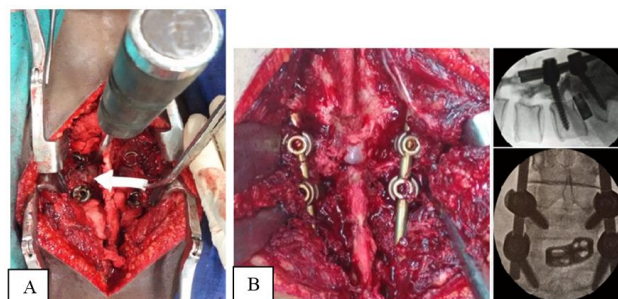


Fig. 2A: Facetectomy for transforaminal approach; **B:** After application of cage and rods

Transforaminal access to disc space was obtained by removing the facet completely on one side (Fig. 2A). The side with the maximum neural pathology or pain was chosen for this osteotomy. The osteotomy of the inferior articular facet of the vertebra above, was 'L' shaped, with care taken not to violate the pedicle. The osteotomy of the superior articular facet of the vertebra below, was transverse, made as low as possible to maximise exposure. The osteotomy was done after application of pedicle screws. Laminectomy was done in all cases with isthmus spondylolisthesis. While doing this, the ligamentum flavum must be dissected off the lamina and off the dural sac. This process completely decompresses the nerve root on this side. The nerve root must be identified at this point, and should be confirmed to be free of adhesions and compression. The thecal sac was also identified and any bleeding vessels seen in this area were coagulated using bipolar electrocautery. Once this was done, using a nerve root dissector/retractor, the dura was retracted medially and the nerve root retracted superiorly. Both retractions were done gently and served to avoid incidental durotomy or neurotomy. Following this, a complete discectomy was done and end plates were curetted.

A pre-cut titanium rod was applied to the side opposite to the side of the osteotomy. Distraction of the vertebrae was done using the distraction device and the rod was locked to the pedicle screw heads using pedicle head fixation screw. Following this, TLIF cage was inserted after preparing the cage with cancellous bone chips. The bone graft used in this study was from the posterior iliac crest and removed lamina. AP and lateral views were taken using C-arm image intensifiers (Fig. 2B) to ensure central placement of the cage. After cage insertion, compression was done.

Any remaining bone graft was placed in the intertransverse region after removing soft tissues and freshening of bone surfaces. This was done after a thorough lavage with normal saline. The surgical incision was closed in layers with a suction drain in situ. After extubation, the lower limb movements and pulses were checked; duration of surgery, blood loss during surgery and urine output were recorded. An illustrative case of TLIF is shown in Fig. 3.

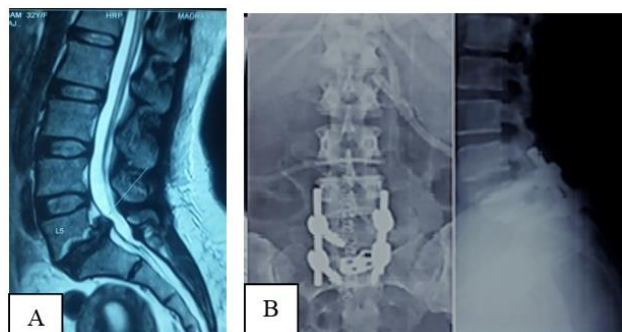


Fig. 3: Illustrative case – L5-S1 disc disease with listhesis
A: Pre op MRI; B: Post op X-rays (2.5 year follow up)

Results and Analysis

This study included both male and female patients in equal representation, with 11 patients each. The operating time in the study ranged from a minimum of 3 hours to a maximum of 5 hours which was a two-level TLIF surgery. The mean operating time in our study was 3.477 hours. The blood loss during surgery was calculated for each case, immediately after the completion of the surgery. A fully soaked gauze pad was considered as 50ml. The amount of saline used during the surgery was subtracted from the amount collected in the suction apparatus. Our study had a mean blood loss of 262.5ml.

The patients were followed up for a period of 6 months to 3 years (Mean duration of follow up- 1.2 years). The assessment of improvement in quality of life was done by comparing the pre-operative Oswestry Disability Index (ODI) score to the post-operative score followed by a statistical analysis using the paired t-test (Fig 4, Table 1).

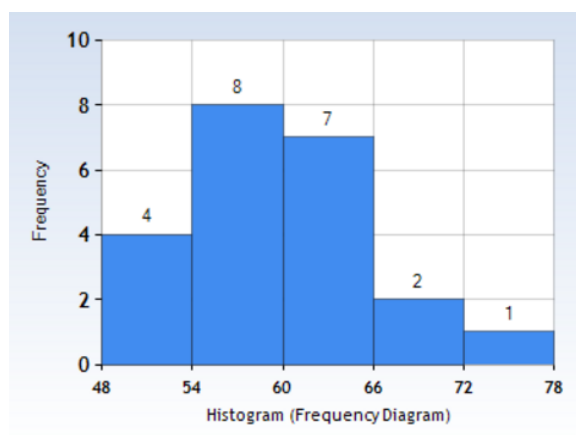


Fig. 4: Histogram – Frequency diagram for ODI scores

The post operative score was good (Minimal disability) in 92% patients. There was a statistically significant reduction in the Oswestry Disability Index score post-operatively denoted by the P-value <0.0001. This indicates that there is a good functional outcome and a significant improvement in the quality of life.

One rare and serious complication was encountered during the course of this study. The patient who underwent two-level TLIF (Fig. 5) for a recurrent disc prolapse had

post-operative vision loss of the left eye. Initially it was provisionally diagnosed as a central retinal artery occlusion (CRAO) but later after adequate evaluation including a spectral optical coherence tomography (OCT), the diagnosis was revised to posterior ischaemic optic neuropathy (PION).



Fig. 5: L3-L4 and L4-L5 disc disease – two level TLIF done
A) Pre op MRI B) Post op X-ray

After revision of diagnosis, the patient was started on Inj. methyl prednisolone succinate 500mg iv BD for 3 days followed by oral prednisone 20mg TDS for a period of 11 days. There was improvement in the vision from, 'no perception of light' on the day of surgery to 'finger counting at close range' on the 7th POD. After completion of steroid therapy, the vision further improved to 5/60. During the recent follow up, the vision was 6/18.

One patient died of unknown cause, 8 weeks after surgery. None of the patients included in our study had intra-operative dural tear or post-operative infection as complications. There was no case with implant failure. Progression of the spondylolisthesis did not occur in any patient.

Discussion

The primary aim of spinal fusion surgery is to obtain a solid arthrodesis and consequently, alleviate pain.⁸⁻¹⁵

PLIF was first attempted by Cloward in 1940 and later revised by Lin.¹⁶ But there were problems with PLIF¹⁷ like – a) cannot be done above L3 (for fear of injuring conus medullaris), b) excess dural retraction and scarring, c) damage to posterior longitudinal ligament. Similarly, ALIF is associated with risk of retrograde ejaculation, injury to iliac vessels and longer rehabilitation time.¹⁷

Lumbar interbody fusion through a transforaminal approach was first described by Harms and Rolinger in 1982.¹⁸ Harms published his results of TLIF surgery along with Jeszenszky et al, in 1998.⁷ Their study included 191 patients operated between 1993 to 1996. They reported excellent results in cases of spondylolisthesis who underwent TLIF surgery. The degenerative cases and post-discectomy patients gave moderate results. But a standardised questionnaire was not used for evaluating patients and measuring the outcome. The complications experienced by the patients in their study included 12 cases of implant loosening, dural leaks in 9 patients, nerve root damage in 3 patients and post-operative infection in 4 patients.

Table 1: Paired t-test comparing pre op and post op ODI scores

	Sample size	Mean	Standard deviation	Variance	Standard error of means	P-value
Pre-operative Oswestry Disability Index	22	58.909	6.6326	43.9913	1.41	<0.0001
Post-operative Oswestry Disability Index	22	2.2727	5.1379	26.3982	1.10	

In comparison, our study used the ODI scoring system with which objective outcome measurement and comparison is possible. Our study had a smaller sample size, but the functional outcome was comparable to that of Hackenberg et al, who studied 52 patients followed up for a period of minimum 3 years[P]. The P-value in our study showing the statistical significance of ODI scores post-operatively was <0.0001, which was comparable to their study which had a P-value of <0.001. The union rate in our study was comparable to that of standard published literature (only one patient in our study had a delay in radiological union, who clinically, was asymptomatic. This delay did not affect the patient's overall functional outcome).

Humphreys et al¹⁹ compared 34 patients who underwent PLIF technique, with 40 patients who underwent TLIF technique with respect to blood loss, operation time and complications. There was no significant difference in these parameters for single-level fusions using either technique. With two level fusions, TLIF surgery was found to have significantly less blood loss. No serious complications were seen with the TLIF group, whereas PLIF had several complications. Our study did not encounter any major surgical complications except one, described below. The mean operating time in our study was 3.477 hours, which was comparable to that of standard studies.¹⁹ Shorter the surgical time, lesser are the incidences of complications related to prolonged surgery, such as hemorrhage, shock, paralytic ileus, basal atelectasis, post-operative wound infection. None of these were seen in our study.

Contralateral radiculopathy after TLIF has been reported.⁶ The reason may be due to contralateral disc tissue pressed out of intervertebral space by the cage. We did not encounter this problem, because we have performed laminectomy and hence decompressed spinal canal contralaterally also.

The mean blood loss in our study was 262.5ml which was significantly lesser than standard studies, which had mean blood loss values averaging 485 ml for one-level fusions and about 560 ml for multiple level fusions.¹⁷

Regarding the patient who developed post-operative vision loss after spine surgery, literature gives a very low incidence of this complication. The incidence of PION after spine surgery in prone position is 0.027-0.2%.

The American Society of Anaesthesiologists Postoperative Visual Loss Registry²⁰ is the largest study conducted till date for post-operative vision loss. From their registry, some conclusions regarding this condition can be derived. They studied 93 cases with post-operative vision loss after prone position spine surgery. Of these, 83 cases

had the etiology of Ischaemic Optic Neuropathy (ION) of which Posterior Ischaemic Optic Neuropathy (PION) comprised 56 cases, Anterior Ischaemic Optic Neuropathy (AION) were 19 cases, and 8 cases were unspecified. The remaining 10 cases were Central Retinal Artery Occlusion (CRAO), etiologically. Those cases in the ION group were found to be bilateral 66% of the time, signifying a systemic etiology. CRAO was always unilateral, probably due to direct eye compression on the affected side. Overall, males were found to be more affected by post-operative vision loss (with 72% of the total cases) as compared to females. Out of the 93 cases, 89 cases had an estimated blood loss during surgery greater than 1000ml and a duration of anaesthesia greater than 6 hours. The Registry discussed that the optic nerve vasculature was uniquely vulnerable to hemodynamic changes in prone position, as compared to other organs in the body. This was postulated to be due to a probable absence of autoregulation around the optic nerve vasculature. ION is sometimes termed as a “compartment syndrome of the optic nerve”. Head-rest syndrome was described by Dunker et al., wherein direct ocular compression by a malpositioned head rest compromises the perfusion pressure of the optic nerve circulation, leading on to ischemia of the optic nerve, i.e. ION.²¹

According to Nickels et al, the condition is considered irreversible with no effective treatment.²² The patient in our study experienced partial recovery of vision and now has residual loss of visual field, in spite of which he is able to carry out his day to day activities with modification of his vocation. Only in one reported case in literature, a single patient experienced complete recovery of vision after adequate management.²³

The advantages of TLIF technique are:

1. TLIF can be done at all levels of lumbar spine.
2. Maximises fusion and stability (hence can be used in patients with smoking and diabetes who have low fusion rate).
3. Lesser retraction of dura and of the nerve roots, leading to lesser scarring.
4. Better access to the neural foramen and better decompression.
5. Operative time, blood loss are significantly reduced.
6. Interspace height is maintained by the cage.
7. The normal lordosis of the lumbar spine can be restored by the TLIF titanium cage with in-built lordosis angles between 5°-10°.
8. Anterior placement of the cage results in better load sharing.

9. Revision surgery is simplified because dural planes are undisturbed.
10. Immediate pain relief is afforded by the cage itself and long term relief of pain is achieved by the fusion occurring between the vertebral bodies.
11. Early mobilisation, lesser hospital stay, early return to work.

Even though this study has its limitations of smaller sample size and lesser duration of follow up, the functional outcomes of the patients undergoing TLIF surgery were statistically significant. Hence, degenerative lumbar disc disease and low grade spondylolisthesis can be managed effectively using TLIF technique for a good functional outcome.

Conclusion

Patients must be selected properly, after thorough evaluation and identification of the cause of their back pain. Conservative management in the form of physiotherapy and antiinflammatory medications must be tried first. Epidural injections and facet joint infiltrations may be attempted before suggesting surgery to the patient. Etiology, pathogenesis and diagnosis must be properly studied and confirmed before subjecting the patient to surgery.

In conclusion, our study suggests TLIF surgical technique with bone grafting as an ideal management strategy to treat degenerative lumbar disc disease and low-grade spondylolisthesis in view of good results with respect to functional outcome and lesser blood loss, lesser duration of surgery and low complication rate.

Conflict of Interest: None.

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