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Outcomes of surgical treatment in form of transforaminal lumbar interbody fusion in patients of degenerative lumbar spine

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Abstract
Introduction: The goal of fusion of the lumbar spine is to alleviate pain. Different circumferential fusion techniques have been described such as combined anterior–posterior fusion (APF), instrumented posterior lumbar interbody fusion (PLIF) and transforaminal lumbar interbody fusion (TLIF). The TLIF procedure has rapidly gained popularity because of its posterolateral transforaminal discectomy and fusion. It has been reported as a safe technique, without the potential complications described when using combined APF and PLIF techniques.
Materials and methods: A retrospective clinical and radiographic study of 52 patients with symptomatic degenerative lumbar spine treated with TLIF was performed. Through a classic posterior midline incision, the side of facetectomy was chosen according to the subject's symptoms of leg pain if present. A posterolateral discectomy, endplate preparation and insertion of a peek cage with additional bone graft locally harvested were performed. The posterior fusion was instrumented with pedicle screws and titanium rods.
Results: Improvement in ODI score from 63% to 13% and in mJOA score from 9 to 25 at final follow up shows TLIF procedure improves the general condition of patient. Few complications (Dural tear, Local wound infection, Broken implant) encountered during study (observed in 25% patients) do not affect overall long term outcome. PLIF has been associated with high incidences of neurological complications, up to 13.6% permanent neurologic lesions in Barnes' *et al*. study, which is not observed in TLIF.
Conclusion: TLIF allows surgeon to achieve anterior fusion with low risk of injuring the nerve root by minimal retraction of the root. The advantages of this technique are: less complications, the simplicity and speed of execution and versatility. Adjacent segment disease and accelerated disc degeneration above or below the level of fusion is major concern on long term follow up.

Keywords: TLIF, degenerative lumbar spine disease, interbody fusion

Introduction
Problem of degenerative lumbar spine is also a big issue. Surgical treatment for degenerative disc disease by lumbar inter-body fusion only with the bone graft without posterior fixation resulted into nonunion, graft collapse, graft resorption, inconsistent fusion and nonrelief of pain. These problems were due to instability of spine that is the direct result of performing the operation in form of extensive posterior element removal. By utilizing transpedicular screws, rods and inter body fusion with cage, surgeons are now able to perform extensive laminectomy, facetectomy, nerve root decompression and restoration of high degree of stability which permits early postoperative ambulation. Transforaminal lumbar interbody fusion (TLIF) is an increasingly popular treatment for degenerative lumbar conditions. Its unilateral posterior approach enables anterior column stabilisation and 360º fusion, while reducing the morbidity associated with posterior and anterior lumbar interbody fusion (PLIF and ALIF) [3]. We evaluated the outcomes in form of clinical improvement in symptoms, radiological fusion rates, complications, and adjacent segment degeneration associated with TLIFs.

Materials and Methods
Retrospective clinical and radiological study of 52 cases of degenerative lumbar spine treated with decompression, transpedicular screw fixation with interbody fusion in form of cage or

bone grafting was performed. The skeletally mature patients (more than 40 years) included in this study with lumbar canal stenosis, recurrent disc herniation, facetal hypertrophy, instability and lumbar degenerative spondylolisthesis. (Fig-1) And patients with acute prolapsed intervertebral disc, severe spondylolisthesis (more than grade I–II), traumatic lumbar spine disease and active infection were excluded from study.

52 patients with 34(65%) male and 18(35%) female with average age 57 years ranging from 40 to 78 years underwent TLIF procedure for different lumbar spine disease. (Table-1, 2) patients were operated for discectomy and they were presented with recurrence of symptoms and MRI of them was showing lumbar canal stenosis due to recurrent disc herniation so they were planned for interbody fusion and posterior instrumentation. 30 patients had L4-L5 disc affection. 7 patients had double level affection out of which 3 patients had L3-L4,L4-L5 discs affection and 4 patients had L4-L5,L5-S1 discs affection.

All of the patients in this series had low back pain as their predominant symptom, with varying degrees of radicular pain, neurologic symptoms, disturbed sleep pattern and reduced walking distance. All patients underwent at least 6 months of nonoperative care of medication, physiotherapy and lumbosacral brace before coming to surgery.

The bilateral, posterior pedicle screw-rod instrumentation was performed using a consistent surgical technique. The patient was placed in a prone position. A midline incision was made, and the posterior elements down to the tips of the transverse processes were exposed subperiosteally. Pedicle screws were placed bilaterally free handed. Rods are inserted after giving curve to rods as to align lumbar lordosis. Distraction is done between two levels of screws. Dural sac and roots are decompressed by standard laminectomy. The side of facetectomy was chosen according to the subject's symptoms of leg pain if present. On the side of radicular pain or neurological affection foraminal decompression is done by removing some bone and osteophytes surrounding them. One facet is removed if symptomatic. Bone graft is kept and appropriate size peek cage is inserted in sagittal plane and gradually rotated so that it lies over anterior aspect of vertebral space and stays transversely to give maximum support. In some patients we use tricortical bone graft instead of cage. Some pieces of bone graft from spinous process inserted in surrounding space. Lastly compression is done between pedicle screws. Layer wise closure was done with drain. Physiotherapy was started the next day, ambulation with a lumbosacral belt was encouraged as long as the pain was tolerable. The drain was removed about 48 hours after surgery. Patients were discharged when independently ambulant, and capable of self-care. Sitting on the floor, sitting cross legged and stooping forward are avoided for minimum of 1 month post operatively.

Patients are reviewed at monthly intervals and screened for any complication, examined for neurological status, back pain, radicular pain, walking distance and persistence of any symptoms or recurrence of any symptoms. Union status is checked on the x ray as well as the status of the graft incorporation at final follow up. Patients were reviewed with oswestry disability index (ODI) [11] and modified Japanese association score (mJOA)(10). X-rays were taken to see any complication like implant failure.

Union is defined by [1] flexion-extension lateral x-rays $<3^0$ movement at the fusion level [2] Trabecular pattern is seen on anterior or posterior aspect of cage on lateral x-ray [3] intact hardware [17].

Adjacent segment disease can be identified clinically and radio logically. Radio logically, adjacent segment degeneration is defined by the presence of [1] progression of arthritic grade more apparent in the segments adjacent to the fused segment than that of other segments, or [1] instability in the adjacent segments (defined as spondylolisthesis of >4 mm translation, or segmental kyphosis of >10° on lateral flexion and extension radiographs) [1].Clinically, adjacent segment degeneration is defined as the presence of new symptoms (back pain or lower limb pain), which were confirmed by MRI when radiographic evidence was absent.

Table 1: Different lumbar pathology in patients

	No of Patients	%
Facetal Hypertrophy	24	46%
Instability	28	54%
Degenerative Scoliosis	0	0%
2nd Surgery For Recurrent Disk	2	4%
Lumbar Canal Stenosis	52	100%

Table 2: improvement in ODI score

ODI	Average
pre op	63%
final follow up	13%

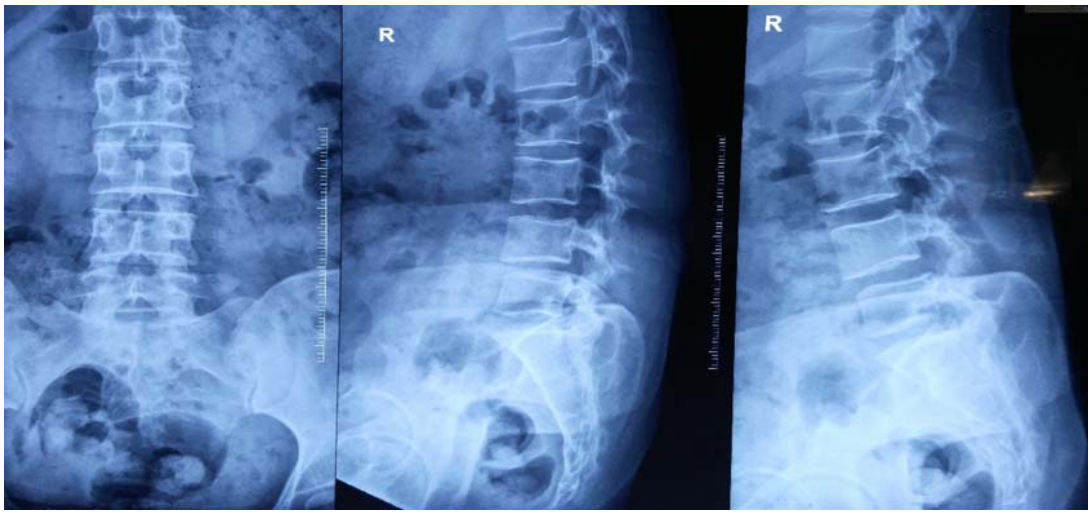

Fig 1: L4-L5 grade 1 spondylolisthesis on pre op x-ray

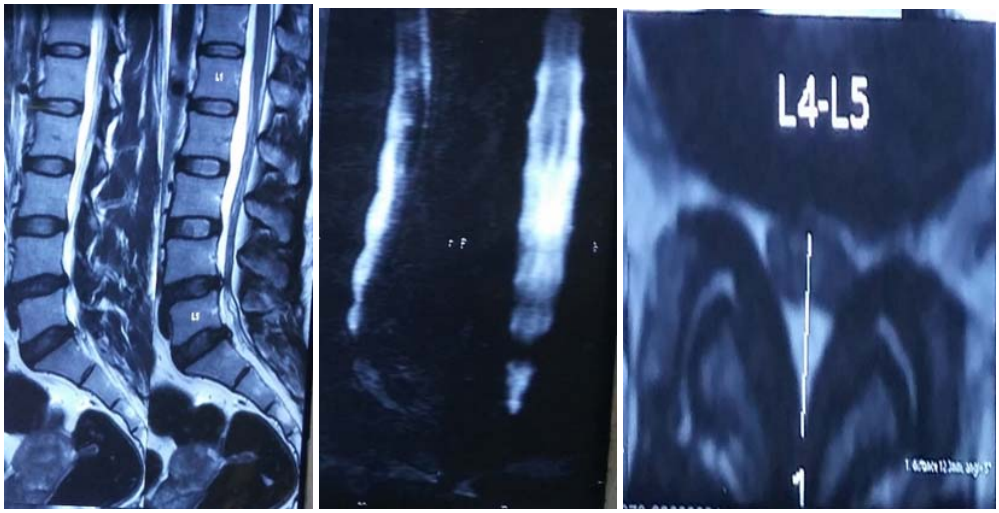

Fig 2: MRI showing L4-L5 canal stenosis and facet hypertrophy

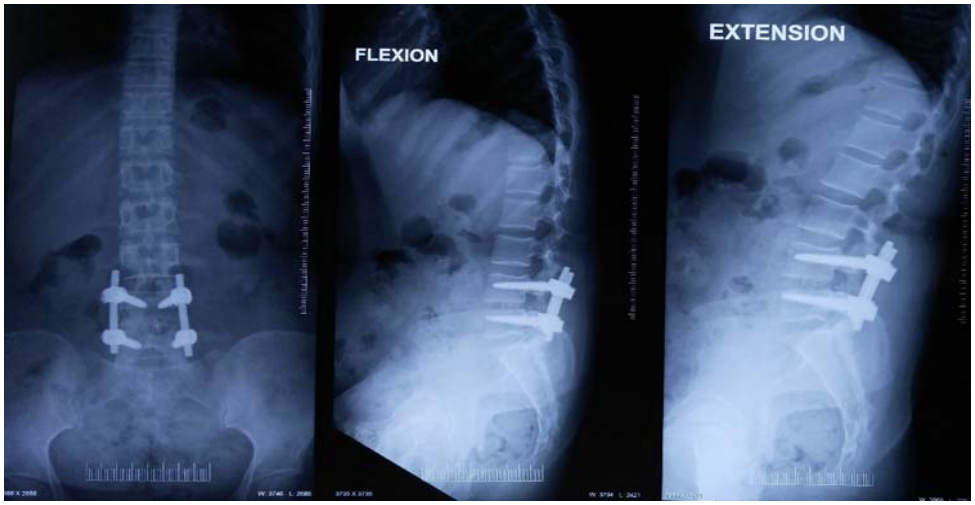

Fig 3: No movement on flexion-extension view

Results

This is a retrospective study of 52 patients with mean age 57years (range 40-78) operated with TLIF. All patients had symptoms of radicular pain, back pain and reduced walking distance. In this study 57% patients had predominantly left sided radicular pain, 26% of patients had right sided radicular pain and 17% patients had both lower limb radicular pain. Comparison of preoperative and post-operative symptoms suggest most of the patient have improvement in symptoms. 65% of patients have improvement in low back pain and 83% of patients have improvement in radicular pain and walking distance and 86% of patients have normal sleep pattern postoperative suggestive of good clinical outcome of this operative procedure. In this study this is the data showing number of patients who had other signs or symptoms like upper limb symptoms, urinary frequency, bowel bladder affection, sensory disturbances like hypoesthesia in specific dermatome (L5 hypoesthesia or S1 hypoesthesia), motor symptoms in specific group of muscle (4 patients had EHL weakness and 1 patient had foot drop) or restriction of straight leg raising test. All patients have recovered sensory and motor symptoms but foot drop did not recover.

In this study improvement in average ODI score is from 63% to 13% and improvement in average mJOA score is from 9 to 25 with 80% improvement suggests good clinical outcome. At final follow up 80% patients showed excellent, 17% showed good and 3% showed average results. (Chart-2)

In this study all the patients are showing solid union through the cage but 3 patients are not showing union outside the cage, rest 47 patients are showing solid union outside the cage. In two patients isolated tricortical bone graft block is used and in 5 patients (out of 7 double level fixations) one level cage and one level bone graft is used. They all are showing solid union at bone graft site. In this study 34 patients are showing trabecular pattern on x-ray. On lateral x-ray flexion-extension view average movement at fusion level is 1.74^0 (no gross movement) suggesting union. No subsidence of cage is seen through either superior end plate or inferior end plate in any patients.

Overall 13 (25%) patients showed complication in this study.

We have identified intra operative inadvertent dural tear in 3 (6%) patients. They were repaired with mersilk 4-0. And post repair valsalva manoeuvre checked to confirm repair of dura which did not show any leak. No other intra operative complications like haemorrhage or damage to major structures were identified.

In early post-operative period 4 (8%) patients had mild serous discharge. They were seen as a soaked dressing. No active pus discharge was found. They were treated by continued use of antibiotic. They all were normal by the time of stitch removal and did not progress to any major complication. No patients faced complication in form of deep vein thrombosis,

hemodynamic instability.

One patient faced neurological weakness in form of some foot drop and quadriceps weakness post operatively. It was recovered fully by 2 months. At final follow up patient was neurologically normal.

In late complication one patient had broken implant on follow up x-ray but patient had no major complains and this is an incidental finding.

Two (4%) patients had late infection after 2 months of stitch removal. Out of them one patient had serious wound infection which led to wound gapping and raw area at the stitch line and had deep infection treated by higher antibiotic but finally implant removal was done in that patient at 4 months. At final follow up at two year the patient had no major complain or neurological worsening and back pain and radicular pain was relieved. Another patient having infection was treated by higher antibiotic only, no surgical intervention required but that patient has some stiffness and muscle spasms at the local site at one year follow up.

In this study two (4%) patients are showing adjacent segment disease. one patient is showing adjacent segment disease in form of radiological evidence of increase motion, end plate sclerosis, osteophytes, reduced disc space and increased lumbar spondylolisthesis above the fusion level and clinically patient has recurrence of back pain and lower limb radicular pain after 2 year of surgery. Another patient is showing clinically recurrence of symptom and increase motion on adjacent segment.

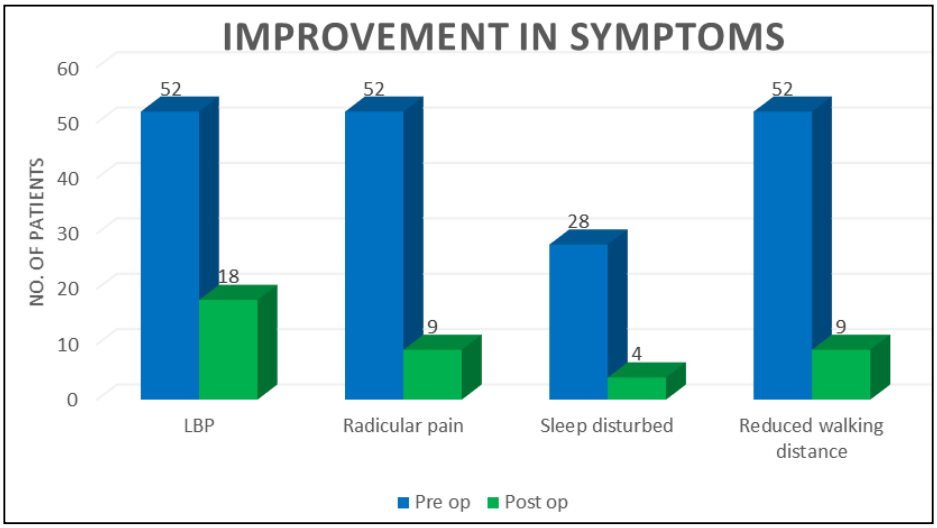

Chart I: Improvement in symptoms in post-operative as compared to preoperative period

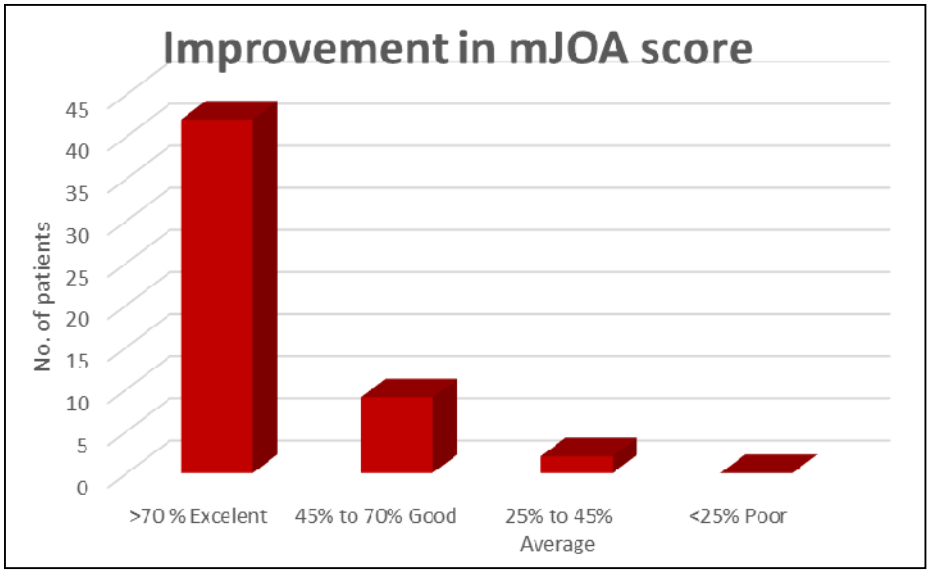

Chart II: Improvement in mJOA score.

mJOA	Average
pre op	9
Final follow up	25
improvement	80%

Discussion

Degenerative spondylolisthesis in adults is characterized by the loss of disc height across the affected segment with sagittal translational and is often coupled with rotational deformity [5]. Lumbar spondylolisthesis is a disease with several aetiopathogenetic origins, as shown by Marchetti and

Bartolozzi [14]. The aspect of pathologic anatomy and radiological findings, the age and clinical appearance of the patients are different when they are diagnosed.

If conservative treatment fails this may be an indication for surgery. The different surgical techniques used must be selected on the basis of the aetiology, symptoms and radiological findings. Franco Postachhini *et al* (1996) studied results of management of lumbar canal stenosis. He found that in short term approximately 80% of patients have a satisfactory outcome, but about 20% of these deteriorate later [8]. Radicular pain and intermittent claudication are the symptoms most often relieved by operation. If several levels are decompressed there are higher chances of failure, rather than decompression done at a single level. Patients with severe stenosis have as good results as those with mild stenosis. Old age does not spoil the quality of the result. Subtotal or total facetectomy is associated with a high incidence of postoperative instability, but too limited removal of the articular processes risks persistence or recurrence of radicular symptoms. About 10% of patients undergo a second operation, usually because of instability or recurrent stenosis. In this study we have included 2 (4%) patients in this study who were previously treated only with discectomy and decompression in whom we have to do fusion and fixation after recurrence of symptoms. The gold standard of the spondylolisthesis surgical treatment is fusion [2].

The different techniques for fusion discussed in literature have advantages and disadvantages with mixed and variable results and with the possibility of having several complications, (6) which must be taken into account in the choice of treatment. The goal of the surgical treatment of spondylolisthesis includes: the stabilization of the motion segment, the decompression of neural elements, the reconstitution of disc space height, and the restoration of sagittal plane translational and rotational alignment. The goal of stabilizing the spondylolitic level is accomplished by arthrodesis from a posterior, anterior, or combined approach [5]. Depending on the severity and clinical features of the spondylolisthesis, it may also be desirable to reduce the forward translation, increase disc space height, decompress the neural elements, and increase or restore lumbar lordosis. Posterolateral instrumented or noninstrumented fusion (with or without decompression), anterior interbody fusion, and circumferential fusion have all been reported to provide acceptable fusion rates and clinical outcomes in adult patients with spondylolisthesis [5].

The postero-lateral fusion without instrumentation presents a fairly high risk of pseudoarthrosis and loss of correction, particularly if there is significant slippage of the vertebra and a local kyphosis. The use of an internal fixation gives a lower rate of non-fusion, thanks to the improvement of primary stability, but increases the risk of infection and possible iatrogenic damage. The reduction of spondylolisthesis presents considerable advantages, such as the restoration of normal anatomy with the correction of local kyphosis and sagittal balance, improved decompression of the neurological elements and a favourable condition for fusion. However, a postero-lateral fusion, after reduction, has a high risk of instrumentation failure with the possibility of breakage or loss of correction. That is why we need circumferential fusion (PLIF) or associated anterior approach, but this increases the surgical time and Intra-and post-operative risks. Amongst all the lumbar spinal fusion techniques, combined Anterior and Posterior Fusion (APF) offers the highest mechanical stability and the best chances of bony fusion [16]. However, it is well recognized that the anterior approach may result in severe, sometimes life threatening intraoperative complications, because the surgeon has to work in proximity of major anatomical structures.

Biomechanically, TLIF provides anterior column support and a posterior tension band [15]. Interbody fusion techniques were developed in an attempt to preserve the load-bearing capacity of the spine, restore the sagittal plane alignment, and use the compressive loading on the bone to enhance the likelihood of fusion. The interbody fusion immediately produces a biomechanically stable postoperative spine, thus enhancing the opportunity for arthrodesis.

In this study pre-operative ODI score is 63% and at final follow up this comes down to 13%. So by TLIF procedure overall there is recovery in disability. And pre-operative average mJOA score in 9 which improved up to 25 at final follow up with average 80% of improvement. And in mJOA score improvement, 42 patients (81%) have excellent, 9 patients (17%) have good and 1 patient (2%) has average improvement. In study of Deng-lu Yan (5) *et al* average JOA improvement was 84.1%. In study by Fan Shunwu *et al* [7] ODI score improvement from 52% to 27.2% at 2 years follow up. On reviewing these studies and our study, overall TLIF procedure has favourable outcome.

Posterior lumbar interbody fusion (PLIF) was first attempted by Cloward [17] in 1940 and later revised by Lin.(13) Posterior approach avoids the morbidity factors associated with an anterior path to the spine. The PLIF procedure has gained popularity, with indications including spinal stenosis, instability, degenerative disc disease, spondylolisthesis, spondylolysis, and bilateral disc herniation. Although the PLIF procedure is useful in many cases, there are complications and contraindications. To obtain unobstructed access to the disc, the surgeon must retract the dural sheath out to midline. This manipulation can lead to nerve damage or neurogenic pain. Additionally, PLIF usually is limited to L3–S1 because of the increased risk of damage to the conus medullaris and cauda equine resulting from the need for retraction above these levels. The transforaminal lumbar interbody fusion (TLIF) technique was described by Harms and Jeszenszky as a modification of the well-established PLIF procedure [9]. The TLIF uses a posterior approach to the spine that runs through the far lateral portion of the vertebral foramen accesses the disc space, which provides the surgeon with a fusion procedure that may reduce many of the risks and limitations associated with PLIF, yet produces similar stability in the spine. This has been shown to reduce the incidence of postoperative radicular pain. TLIF usually is performed unilateral approach preserving the interlaminar surface on the contralateral side, which can be used as a site for additional fusion. Like PLIF, TLIF is easily enhanced when combined with posterolateral fusion and instrumentation. Both procedures can provide circumferential spinal stabilization through a single posterior approach, but the more lateral access to the disk space in the TLIF technique requires less retraction of the thecal sac and neural elements than with the PLIF technique. In August 2007, Chad D. Cole *et al* carried out a study of comparison of low back fusion techniques by transforaminal lumbar interbody fusion (TLIF) or posterior lumbar interbody fusion (PLIF) approaches in patients with vertebral body instabilities and spinal deformities. The chief advantages of the TLIF procedure included a decrease in potential neurological injury, improvement in lordotic alignment given graft placement within the anterior column, and preservation of posterior

column integrity through minimizing lamina, facet, and pars dissection. The primary indication for the use of PLIF is spinal deformity or instability. Segmental fixation can provide immediate postoperative stability, correct anatomical deformities, and possibly enhance fusion rates, especially if multiple levels are to be fused.

Altering the attachment sites for the musculature is likely to affect the mechanics of the lumbar spine. This could lead to a change in direction of applied forces on the spinal column, increased pain during the recovery process, and a prolonged recovery time. With PLIF, the spinous processes of the involved vertebrae are destroyed. These bony structures serve as attachment sites for the muscular envelope that covers and supports the spinal column. Without the spinous processes intact, the muscular envelope produced by the erector spinae muscles cannot be restored properly. Patwardhan *et al* determined that the compressive load carrying capacity of the lumbar spine increased when the load path remained within a small range around the rotation centres of the lumbar segments.

Minor complications rates vary from 20 to 35.3% [18] and a revision rate of 7.6% has been reported [12]. General complications include ileus and pseudomembranous colitis [18]. Specific complications include pseudoarthrosis, pedicle screw malposition haematoma, symptomatic contralateral disc herniation, dural tears, wound infection, wound dehiscence, seroma formation, donor-site infection, as well as transient and persistent radiculopathy [12, 18]. In this study, no patient had a life-threatening or permanent neurological complication or revision. In this study 3 patients (7%) had peroperative dural tear. 4 patients (9%) had mild serous discharge in early postoperative period. One patient developed early postoperative neurological weakness. All were recovered and all the complications in this study had no major adverse effects. Two patients were late complication of infection and out of them one patient underwent implant removal. Overall in this study there is no major complication rate. This shows this procedure of TLIF is obviously advantageous.

Adjacent segment degeneration may be caused by increased stress and hypermobility above a fused segment, in addition to the normal ageing process of the spine. This leads to premature degeneration of the facet joints, and spinal instability. Accompanying facet hypertrophy and thickening of the ligamentum flavum may result in canal or foraminal stenosis in adjacent segments. In this study 2 patients (4%) developed adjacent segment disease clinically by reappearance of symptoms and radiologically after 2 years of operation. Adjacent segment degeneration adversely affects functional outcomes, and thus long-term follow-up and/or additional surgical intervention are needed. 70% of the cases of adjacent segment degeneration developed proximally, which is consistent with another study [3]. MRI is better than radiography in picking up adjacent segment degeneration and should be conducted for patients developing new back or lower limb related symptoms.

Conclusion

The study evaluated the clinical and radiographic results in 52 patients who underwent interbody fusion and posterior instrumentation in degenerative lumbar spine. The analysis of the mid-term results of degenerative lumbar spine treatment with pedicle screw fixation and interbody fusion mainly TLIF gave a very satisfactory response. The technique of putting interbody cage and bone graft anterior to cage with pedicle screw fixation is forming a solid construction with 360^0 of fusion and is reliable in allowing an optimal primary stability and creating the best biomechanical conditions to obtain a solid fusion. The success of the surgery is due to the correct indication. Using diagonal insertion of a single threaded cage and bone graft anterior to cage with supplementary transpedicular screw and rod instrumentation enables sufficient decompression and good number of patients achieves solid interbody fusion by optimum duration.

Reviewing the literature and in our experience, the TLIF procedure had led to shortened surgical times, less neurologic injury, and improved overall outcome. In this study improvement in ODI score from 63% to 13% and in mJOA score from 9 to 25 at final follow up shows TLIF procedure improves the general condition of patient.

TLIF procedure allows surgeon to achieve anterior fusion with low risk of injuring the nerve root. Minimal retraction of the root required while putting the anterior cage in comparison to PLIF.

The advantages of this technique are: few complications, the simplicity and speed of execution and versatility. Few complications (Dural tear, Local wound infection, Brocken implant) encountered during study (observed in 25% patients) do not affect overall long term outcome. Adjacent segment disease and accelerated disc degeneration above or below the level of fusion is major concern on long term follow up, it is observed in 4% patient in this study.

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