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A prospective study of functional outcome of lumbar diseases treated with single-level instrumented posterior lumbar interbody fusion

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Abstract
Background: Fusion of the spine is a type of treatment option when the movement of the spine is the source of the pain-the theory being that if the painful vertebrae do not move, they should not hurt. Posterior interbody fusion has many advantages compared to other methods of fusion.
Aims and Objective: To study the functional outcome of lumbar diseases treated with single-level instrumented posterior lumbar interbody fusion.
Material and Method: A hospital-based prospective study was conducted in the Department of Orthopedics at a tertiary care center from November 2019 to May 2021. The patients were informed about the study in all respects and informed written consent was obtained. Follow up period was for 6 months.
Results: A total of 30 patients were included in our study. The radiological union rate was found to be 73.3 percent. The average time taken for the procedure was 3.5 hours. The average blood loss was 237 milliliters. The improvement in the postoperative VAS score at the six-month mark was drastic and significant, as proven by a "p-value" of < 0.0001. Improvement in quality of life, an assessment, based on the Wilcoxon signed-rank test comparing Oswestry Disability score (ODS) and Oswestry Disability Index (ODI) preoperatively and postoperatively, was statistically significant, showing a reduction in Oswestry Disability index and score postoperatively, indicating significant improvement in the quality of life.
Conclusion: PLIF is used to treat a degenerative disc with narrowing disc space, spinal canal stenosis, or a case of spondylolisthesis that hasn't responded to conservative treatment. In light of the results and minimal complication rate, we would recommend the PLIF technique combined with bone grafting as an appropriate technique for spondylolisthesis and degenerative disc disease.

Keywords: Posterior lumbar interbody fusion, degenerative disc disease, spondylolisthesis, oswestry disability score

Introduction
Low back pain (LBP) is one of the most commonly reported problems in the world. The most common causes of LBP are injury or overuse, pressure on neural tissue from different pathologies (disc herniation, stenosis, generative disc disease, etc.)
Spinal fusion is a surgical treatment that is used to treat abnormalities with the vertebrae. It's a "welding" procedure. The core principle is to fuse the troublesome vertebrae so that they heal into one solid bone.
Posterior lumbar interbody fusion (PLIF) is done to obtain interbody vertebral fusion through a posterior approach. The advantage of PLIF over anterior lumbar interbody fusion (ALIF) is the avoidance of vascular and reproductive system complications that can occur with anterior lumbar surgery. PLIF is used in the treatment of a variety of spinal pathologies which are degenerative disc disease, severe instability, spondylolisthesis, deformity, and trauma.
Inter-body fusion techniques have been developed to provide solid fixation of spinal segments while maintaining load-bearing capacity and proper disc height. The developmental evolution of posterior spinal segment instrumentation is derived from the pathologies of deformity correction and fracture fixation. Posterior rather than anterior fusions are preferred by most because this technique is more flexible; it permits the exploration of defects, nerve roots, and intervertebral defects [1].

Materials and Methods

A hospital-based prospective study was conducted in the Department of Orthopedics at a tertiary care center from November 2019 to May 2021, following institutional guidelines and after ethical committee approval. The patients were informed about the study in all respects and informed written consent was obtained. The period of study was from 1st November 2019- to 31st March 2021.

Inclusion Criteria

1. Patients of age less than 70 years
2. Pain in the lower back 6 or more months with or without localized radiating pain to lower limbs.
3. Neurological claudication
4. Neurological deficit
5. Symptomatic Degenerative disc diseases
6. Symptomatic spondylolisthesis not relieved by conservative management/ isthmic or degenerative spondylolisthesis
7. Instability
8. Patients giving consent for surgery

Method

We reviewed all patients who fit our criteria and had undergone surgery in our hospital.

1. All patients were from the outpatient department
2. Preoperative x-ray of the lumbar spine in anteroposterior and lateral views, MRI of the spine were taken(Figure 1,2,3)
3. All surgeries are performed in a specified manner
4. The specified postoperative protocol was followed for all patients
5. The outcome was measured based on VAS score, ODI, and ODS
6. Radiological assessment was done at 6 months

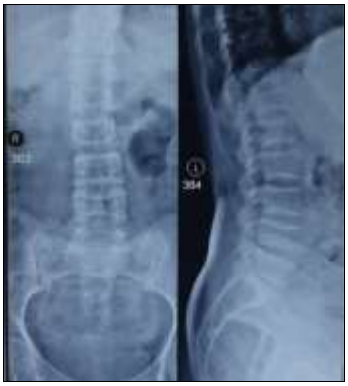

Fig 1: Pre-op x-ray- L4-L5 spinal canal stenosis with degenerative disc disease

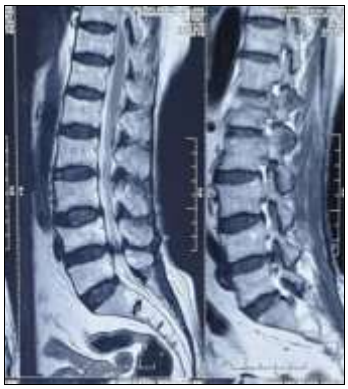

Fig 2: Pre-op MRI- in sagittal view

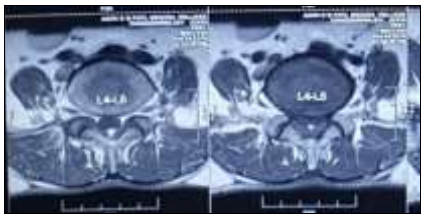

Fig 3: Pre-op MRI- coronal view showing L4-L5 spinal canal stenosis with degenerative disc disease

Procedure

Anesthesia

Under general anesthesia, the surgery is performed.

Position

The patient is catheterized in the preoperative room or after anesthesia. The patient was put in the prone position on an operating table, in hyperextension to create lumbar lordosis. The abdomen hanging free. Pressure points are well padded.

Incision and procedure

An 8-14cm long midline incision is made over the affected site after confirming under C-Arm. For the appropriate vision of the posterior vertebral arches, paraspinal muscles are separated from the lamina at sufficient levels on both sides, and self-retaining retractors are implanted. Then, the image intensifier confirms the spinal level for surgery.

Pedicle screw insertion

Pedicle entry was made under fluoroscopic guidance. All walls were probed for integrity. Titanium poly axial Pedicle screws were inserted in the upper and lower vertebral bodies on either side.

Decompression

A laminectomy is performed. The facet joints overlaying the nerve roots can then be severed when the nerve roots have been seen. Pituitary rongeur, Kerrison rongeur, and curettes are used in removing the ligamentum flavum, bone spurs. The morselized posterior elements were preserved as a graft source for interbody fusion. Then the nerve roots are retracted to one side and the disc space is cleared of the disc material.

Cage placement

The disc space is distracted for restoration of the normal disc height, and also for determination of the appropriate size spacer to be placed. The cage is packed with morcellised compacted bone (local autograft). The next step is the insertion of locally taken bone graft in the anterior aspect of intervertebral space, followed by an interbody cage with bone graft inside, into the disc space [2].

Two small metal rods are put, connecting the ipsilateral screws. The two vertebral bodies are compressed for good contact of the cage with bone. Two small metal rods are put, connecting the ipsilateral screws. The correct placement of the spacer is confirmed using x-rays. (Figure 4, 5)

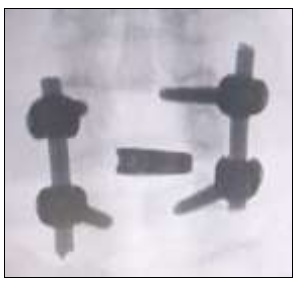

Fig 4: Post-op x-ray ap view

Fig 5: post-op lateral view

Closure

The deep fascial layer and subcutaneous layers are closed with absorbable sutures. Non-absorbable stitches are used for skin closure.

Postoperative protocol: Patients are advised to restrict movements, avoid any weight lifting activities in the first 2-4 weeks. Physical therapy should be done in this period. Patients were followed up at 1, 3, 6 months. An x-ray was taken during each visit. Patients were allowed to resume moderate level work 3 months post-surgery.

VAS score, ODI, and ODS scores were evaluated at end of 6 months, fusion was evaluated at the of 6 months.

Results

A total of 30 patients were included in our study from November 2019 to May 2021 of which 21 were male and 9 were females. 16 patients belonged to the listhesis group whereas 14 patients belonged to the disc bulge group. The most common level affected was L4-L5(15 patients) followed by L5-S1(8 patients), L3-L4(6 patients), and L2-L3(1 patient). (figure 6)

The radiological union rate was found to be 73.3 percent. (table 1) The average time taken for the procedure was 3.5 hours. The average blood loss was 237 milliliters.

The improvement in the postoperative VAS score at the six-month mark was drastic and significant, as proven by a "p-value" of < 0.0001. (table 2)

Improvement in quality of life, as assessment, based on the Wilcoxon signed-rank test comparing preoperative and postoperative Oswestry Disability score (ODS) (table 3) and Oswestry Disability Index (ODI) (table 4), was statistically significant, showing a reduction in Oswestry Disability index and score postoperatively, indicating significant improvement in the quality of life.

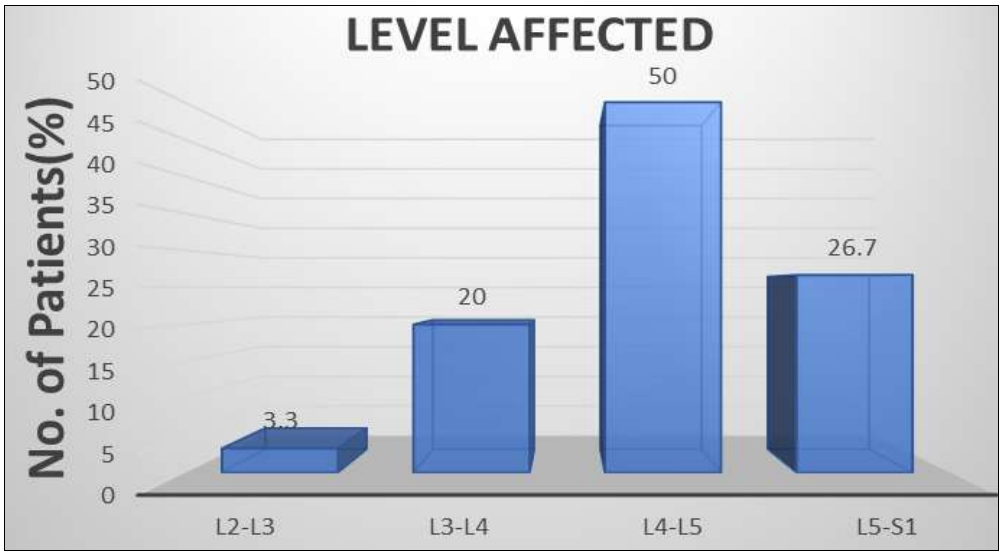

Fig 6: Levels affecting spine

Table 1: Rate of radiological union

Union	No. of patients	Percentage
Present	22	73.3
Absent	8	26.7
Total	30	100.0

Table 2: Preoperative and postoperative visual analogue scale (VAS)

Variables	Pre		Post		Wilcoxon signed rank test	P value
	Mean	±SD	Mean	±SD		
VAS	6.50	1.009	0.47	.937	-4.824	0.0001*

*: Statistically significant

Table 3: Preoperative and postoperative Oswestry Disability score (ODS)

Variables	Pre		Post		Wilcoxon signed rank test	P value
	Mean	±SD	Mean	±SD		
ODS	3.47	.571	1.03	.183	-4.939[b]	0.0001*

*: Statistically significant

Table 4: Preoperative and postoperative Oswestry Disability Index (ODI)

Variables	Pre		Post		Wilcoxon signed rank test	P value
	Mean	±SD	Mean	±SD		
ODI	60.87	8.577	6.60	5.946	4.788	0.0001*

*: Statistically significant

Complications

We came across one case of intraoperative dural injury, which was well sutured with no further complications to the patient. 1 patient had a postoperative wound infection on day 8 which was controlled with thorough debridement, IV antibiotics and the case showed radiological union and the quality of life improved. 1 patient with a pre-operative neurological deficit didn't improve with the surgery and post-operatively didn't show union. 1 patient developed a postoperative neurological deficit but also showed union. There was no incidence of breakage of the Screw or failure of the cage. There was no Progression of slip in any of the cases. (Figure 7)

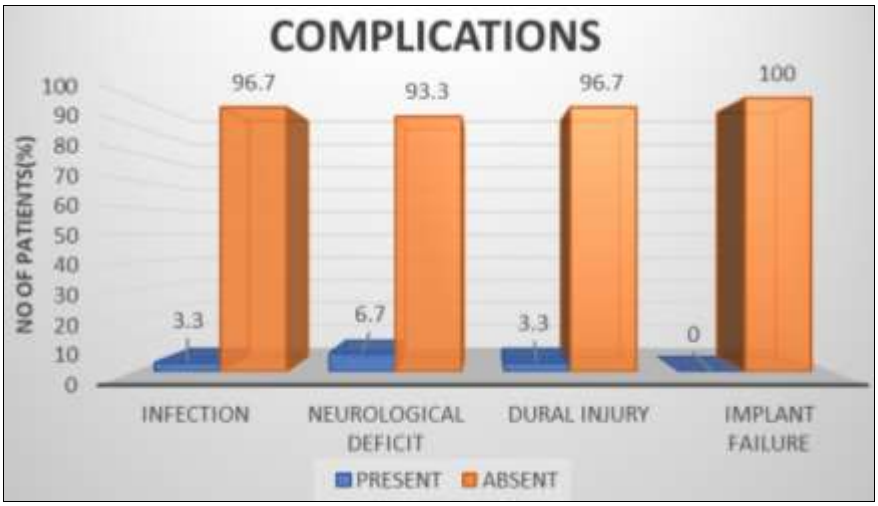

Fig 7: Complications

Discussion

Bony fusion is the goal in the treatment of lumbar or lumbosacral spondylolisthesis. Fusion rates rise with years of follow-up, regardless of instrumentation.

Despite the small sample size, fusion results were comparable to those achieved in previous standard studies for the course of the short follow-up period. After interbody arthrodesis, fusion rates improved from 66 percent in the first year (of 83 patients evaluated by Stauffer and Coventry [3]) to 91 percent at two years when Bagby and Kuslich titanium cages were utilized [4, 5, 6] and 96 percent when Ray titanium cage was used [7]. They believe that with further follow-up, the fusion rates will be higher.

Though the radiological union rate in our study was only 73.3 percent, the clinical outcome, as measured by improvements in socioeconomic and functional indicators as measured by the Oswestry Disability Index and score, was excellent as compared to Michael Horeb [8]. Because the interbody spaces have a greater vascular supply than the posterolateral spaces, there is more fusion. Our study's average operation duration was 3.5 hours, which was comparable to previous research 65. Primary bleeding, basal atelectasis, shock from blood loss, postoperative wound infection, and paralytic ileus are some of the problems linked with lengthy surgery.

Our study's mean blood loss was 237 mL, which was less than Sanganagouda S Patil *et al*. study of 360ml [9].

The choice to conduct a single-level PLIF for degenerative disc disease was made following discussion with the patients in the study by Nick Birch, Sean Grannum, and Nadim Aslam [10]. Degenerated disc disease is a good indication for PLIF, according to the findings of this study. Many studies have shown that interbody arthrodesis can reduce the discomfort that persists following a successful discectomy for degenerative disc disease. The nerve supply of the disc has been discovered in studies, which is more in the event of a deteriorated disc. As a result, discectomy alone can result in failed back surgery syndrome and instability. To avoid this, the disc, which is the source of discomfort, should be removed. Fusion with a spacer should only be performed when a black disc is linked with intervertebral disc space narrowing.

The cage with bone graft is implanted in the anterior region of the disc space during PLIF surgery. The anterior gutter has a higher surface area than the posterolateral gutter. The bone in the anterior portion is compressed, resulting in better healing since the bone is stressed (Wolff's law). The bone is not under enough tension in posterolateral fusions. Because of these two factors, PLIF surgery has a higher success rate than posterolateral fusion.

Posterior instrumentation provides immediate surgical stability, and bone fusion was formed subsequently, preventing slip advancement as reviewed by Huan Liu [11].

Patients who had pedicle-screw instrumentation had a considerably higher rate of fusion than those who did not. Instrumentation's success is based on establishing and maintaining disc space height, giving it a better alternative for people with mechanical back pain, foraminal stenosis, and radiculopathy. The biomechanics of a pedicle screw is that it resists axial force by tightly buttressing the spine; however, because the anterior column does not share the load, stress occurs at the screw plate or rod junction, resulting in screw breakage. Deformities are caused by the flexion and extension components of the applied moment arm. During axial loading, pedicle screw fixation may fail, resulting in translation deformity, breakage, screw pull out, failure of hardware, and toggling. To avoid complications, we must utilize an interbody cage.

Use of cage

- It does not resorb
- Fusion occurs early compared to without the use of cage
- Higher fusion rates
- Structural stability before fusion occurs
- Slip progression is stopped
- Development of any deformity is limited
- Height of the disc and foramen is maintained
- Can share the load of the anterior vertebral body

Conclusion

Even though this study included a small number of patients and a short follow-up period, the results suggest that the PLIF procedure can successfully treat painful spinal disorders such as degenerative disc disease and spondylolisthesis.

The key to success is proper patient selection, which is the outcome of correctly identifying the etiopathogenesis, diagnosis, and natural history of low-back pain and its treatment (both nonoperative and operative).

A degenerated disc with disc space narrowing, spinal canal stenosis, or a case of spondylolisthesis that hasn't responded to conservative treatment, are indications for PLIF.

In light of the results and minimal complication rate, we would recommend the PLIF technique combined with bone grafting as an appropriate technique for spondylolisthesis and degenerative disc disease.

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