Original Research Paper

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PROSPECTIVE STUDY OF SHORT TERM FUNCTIONAL RESULTS OF POSTERIOR LUMBAR INTERBODY FUSION

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ABSTRACT **Background:**low back pain caused due to Degenerative disc diseases,facet joint degeneration, spondylolysis and spodylolysthesis leading to difficulty in performing activities of daily living and thus needs surgical management. There are various modalities of surgical management in adults like posterior lumbar interbody fusion (PLIF), transforaminal lumbar interbody fusion (TLIF), minimally invasive transforaminal lumbar interbody fusion (MITLIF), oblique lumbar interbody fusion/anterior to psoas (OLIF/ATP), lateral lumbar interbody fusion (LLIF) and anterior lumbar interbody fusion (ALIF).The purpose of this study was to evaluate the short-term functional outcome of PLIF in patients operated for painful Lumbar spinal condition with regard to the VAS and ODI and monitor patient satisfaction after surgery till 1 year .

Methods: This study was conducted at tertiary care medical college and hospital,Aurangabad where 30 adult patients who underwent surgical treatment by posterior lumbar interbody fusion between September 2019 to October 2021 were included. Patients were assessed using VAS and ODI score.Patients were followed up on 1 st , 3rd and 6 th ,12 th month postoperatively.

Results: Improvement in quality of life and pain relief was drastic and significant as calculated from the ODI score and VAS score improved from 63.4 and 6.73 preoperatively to 5.07 and 1.8 respectively at 12 months postoperative after PLIF.

Conclusion: Hence, we conclude that PLIF significantly improves quality of life postoperatively because of relief of back pain and neurological symptoms.

KEYWORDS : Degenerative, neuroclaudication, posterior lumbar fusion, radiculopathy, spondylolisthesis

INTRODUCTION

Back pain causes more lost productivity than any other medical condition,[1,2] and is the second most prevalent symptom that prompts a person to seek medical attention. According to reports, almost 80% of the population in the United States has had low back discomfort at some point in their lives.[3,4] our study includes patients from rural farming population of Marathwada region. These patients indulge in rural agriculture hard work involving repetitive lumbar flexion actions causing accelerated degeneration at lumbar region which causes low-back pain.

Lumbar arthrodesis is a popular surgical treatment for treating low-back pain. Even now, there are many debates about the indicators, methodology, and results. [5] The operation of spinal fusion for the treatment of back pain is becoming more popular in developed countries. Along with the procedure, criticism of it and research into existing data on its outcomes are on the rise. The foundation of spinal arthrodesis is fusion, which is used to treat painful joints in any portion of the body. Initially, spinal fusion was performed to treat infectious disorders, deformity, and injuries to the spine. The successful experiences and technological improvements (imaging, surgical techniques, implants) allowed spinal fusion to be used in the surgical management of unstable motion between adjacent vertebrae or pain caused by a deteriorated intervertebral disc.

The key to success in spinal arthrodesis is that it should be undertaken only after a definite pathoanatomical diagnosis for the patient's symptoms has been established. Lumbar spinal arthrodesis can reduce or eliminate discomfort once the aberrant spinal motion is controlled or the deteriorated intervertebral disc is removed. A thorough understanding of the etiopathogenesis, diagnosis, and natural history of low-back pain, as well as its therapy (both non-surgical and operational), should aid the surgeon in determining the best treatment for the patient.

The surgical options for interbody fusion of the lumbar spine include: posterior lumbar interbody fusion (PLIF), transforaminal lumbar interbody fusion (TLIF), minimally invasive transforaminal lumbar interbody fusion (MITLIF), oblique lumbar interbody fusion/anterior to psoas (OLIF/ATP), lateral lumbar interbody fusion (LLIF) and anterior lumbar interbody fusion (ALIF).

PLIF procedure commonly performed for a variety of painful spinal conditions, such as spondylolisthesis and degenerative disc disease, among others.

The posterior lumbar interbody fusion (PLIF) procedure has become an important part of the modern spine surgeon's toolbox. Cloward [6] is credited with developing the techniques and key principles of today's surgery, emphasising the importance of wide spinal canal exposure to minimise nerve root injuries, the use of structural graft to prevent intervertebral collaps and the complete removal of nuclear material from the disc space and replacement with bone to promote fusion. Cloward was highly chastised because when other surgeons attempted the surgery, it failed miserably.However, widespread acceptance of PLIF did not occur until the advent of pedicle screw instrumentation. The load-sharing anterior column support of PLIF could be added to protect the pedicle screws without requiring a separate anterior incision.

Another advancement that favoured the use of PLIF was the invention of the interbody fusion cage by Brantigan and the titanium mesh cage by Harms, which eliminated the need for structural grafts from the iliac crest, which was the leading cause of donor site morbidity. The availability of pedicle screw instrumentation and interbody cages aided in the gradual acceptance of Cloward's pioneering operation.

Despite recent advancements, such as the development of transforaminal and direct lateral approaches to the disc, which have lowe mired the frequency with which PLIF is performed, PLIF remains the index procedure of the spinal fusion.

The purpose of this study was to evaluate the short-term functional outcome of PLIF in patients operated for painful Lumbar spinal condition with regard to the VAS and ODI and monitor patient satisfaction after surgery till 1 year.

MATERIALS AND METHODS

30 patients were included in this prospective study, conducted in the department of orthopaedics in government medical college and hospital,Aurangabad between September 2019 to October 2021.This is a prospective type of study done to analyse short term functional outcomes of posterior lumbar interbody fusion.

INCLUSION CRITERIA:

1. Degenerative disc disease or spondylolisthesis(grade 1 or 2)
2. Progressive neurological deficit in spite of conservative management.
3. Age 30 – 70 years
4. Both male and female
5. Severe intractable low back pain
6. Absence of systemic infection
7. No previous arthrodesis at target level
8. Adult patients

EXCLUSION CRITERIA:

1. Scoliosis,kyphosis and other congenital deformities of spine
2. Malignancy
3. Patient with spinal Infection
4. High grade spondylolisthesis
5. Pediatric age-skeletally immature
6. Mentally unstable patients
7. Paraplegia

Preoperative assessment:

Detailed history and complete physical examination with neurological assessment.

Basic investigations to rule out any other comorbid conditions which includes complete blood count, random blood sugar, renal function tests and hepatitis HIV serology .

Plain x- ray of lumbosacral spine Anteroposterior, lateral and special views including flexion and extension views to assess instability.

Magnetic resonance imaging of lumbosacral spine with whole spine survey including sagittal. Coronal and axial views. Both T1 and T2 weighted images are taken.

Pre-operative assessment using the Visual Analogue Scale, the Oswestry disability index Was done.

DESCRIPTION OF POSTERIOR LUMBAR INTERBODY FUSION SURGERY

Anesthesia: The procedure is carried out under general anaesthesia. The patient has been intubated and is hooked up to a ventilator. Antibiotics are given intravenously before to surgery.

Position: The patient is catheterized and placed in a prone position on a Halls frame on an operating radiolucent table. The pressure points are properly cushioned.

Incision and procedure:

The surgical site is cleaned, and sterile drapes are draped over it. On the back, a three- to six-inch long midline incision is performed over the afflicted area. The deep fascia is separated in the midline, paraspinal muscles are peeled from the lamina at appropriate levels on both sides, and self-retaining retractors are used to properly visualise the posterior vertebral arches. The image intensifier then confirms the surgical level.

Pedicle screw insertion:

Pedicle entry was made under fluoroscopic guidance. All walls were probed for integrity. Pedicle screws (Titanium) were inserted in the upper and lower vertebral bodies.

Decompression:

A laminectomy is performed. Following visualisation of the nerve roots, the facet joints above the roots can be cut, allowing more space for the nerve roots. After safeguarding and carefully retracting the nerve roots and neurologic structures, the bone spurs are visualised and removed. Pituitary rongeurs, kerrison rongeurs, and curettes are used to remove arthritic, hypertrophic bone spurs and ligamentum flavum. The morselized posterior parts were saved as a source of graft for interbody fusion. The nerve roots are then retracted to one side, and the disc area is cleansed of disc material.

Cage placement:

The disc space is distracted in order to restore normal disc height and to determine the appropriate size spacer to be used. The materix cage is packed with morcellised compacted bone (local autograft). The following stage is to place a locally obtained bone transplant into the intervertebral space, followed by an interbody cage with a bone graft within, into the disc space. (After carefully retracting the spinal nerves and neurologic structures, two tiny bone graft spacers are implanted in the classic PLIF surgery. A single PLIF cage was used in our study.)[7]. Two short metal rods are installed to connect the ipsilateral screws. The two vertebral bodies are compressed to ensure that the cage makes adequate contact with the bone. Two short metal rods are installed to connect the ipsilateral screws. X-rays are used to check the precise positioning of the spacer.

Closure:

The wound is carefully cleaned with saline. Absorbable sutures are used to seal the deep fascial layer and subcutaneous layers. For skin closure, non-absorbable sutures are employed. A sterile dressing is placed on the wound. The procedure takes about 2 to 4 hours.

Technique of posterior lumbar interbody fusion. (Fig1,2) Intraoperative prone position of patient and C-arm. (Fig 3,4) Drapping of patient (Fig5,6)Skin incision and Exposure in midline till tips of transverse process bilaterally. (Fig 7,8,9) Bilateral pedicle screw insertion. (Fig.10,11)Discectomy and distraction.(Fig.12) Interbody trial of cage size after discectomy. (fig.13) Bone graft for interbody cage. (Fig.14)) Final picture after cage and rod application with decompressed spinal canal.(Fig.15)Skin closure.

Figure-1

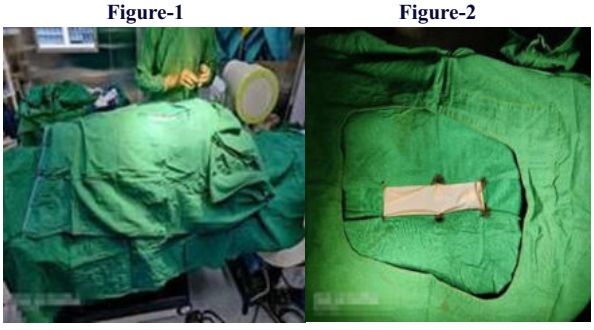


Figure-2

Figure-3

Figure-4

Figure-5

Figure-6

Figure-7

Figure-8

Figure-9

Figure-10

Figure-11

Figure-12

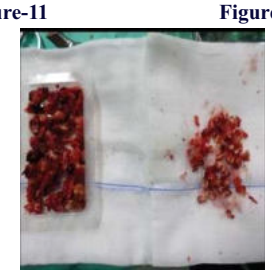


Figure-13

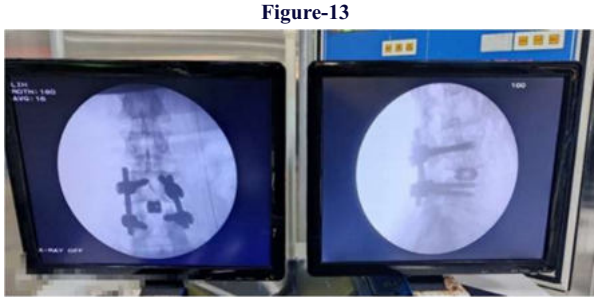


Figure-14

Figure-15

OBSERVATIONS AND ANALYSIS

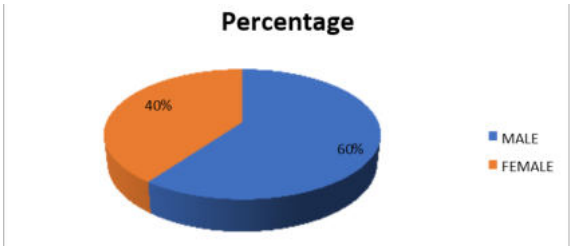
Post-Operative Care:

During the hospital stay, the wound dressing is changed on postoperative 2,5,7,10,12 days.Drains are removed within 24 to 48 hours. On the seventh day following surgery, the hamstrings and quadriceps were stretched. Suture removal was performed on the 14th postoperative day. Patients are normally discharged after suture removal on the 14th post-operative day. They are provided suitable guidelines and training for physical and occupational therapy. In the first 2-4 weeks, patients are instructed not to bend or twist at the waist or lift weights heavier than five pounds. They can do them after 4-6 weeks, when the pain has subsided and the muscles have strengthened.

Total 30 patients were included in the study. All 30 patients were available for follow-up by visits. All the patients were followed up at the interval of 1 month, 3 months, 6 month and 12 month. At the end of 1 month 6 month and 12 month, assessment was done of subjective and objective findings with ODI score and the rate of improvement (RI) was calculated.

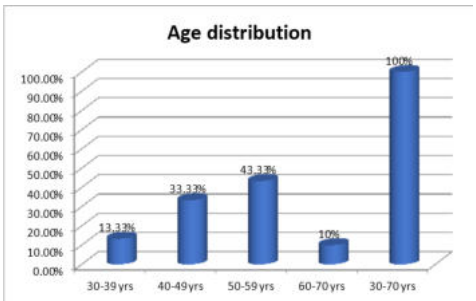
Pie chart-1 Gender

In our study 18 participants were of male gender and 12 were of female gender.



AGE DISTRIBUTION: In our study

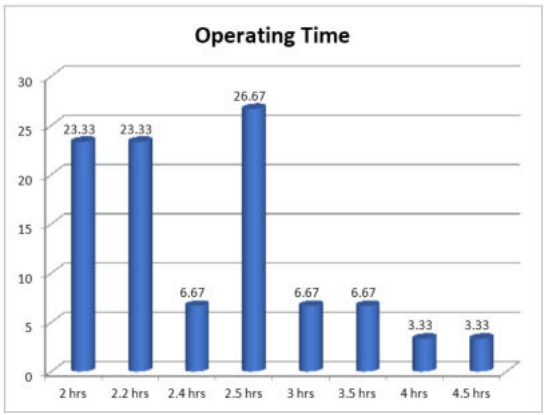
Age ranges from 30 years to 70 years. The mean age was 49 years. In males, age ranged from 30 to 70 years with a mean of 47.5 years. In females, age ranged between 34 and 70 years with a mean age of 50.5 years.



GRAPH-1

Operating time

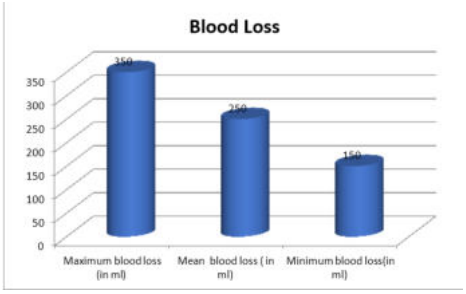
The calculation of operating time was from the surgical incision to wound closure and there was no significant change. Graph 2 shows the operating time. The mean was 2.5 hours.



GRAPH -2

Blood loss

The calculation of blood loss was from the number of surgical mops used (each corresponded to 50ml) and also from collection in suction apparatus after subtracting volume of saline used in wash. In our study mean blood loss was about 250 ml.



GRAPH -3

Complications:

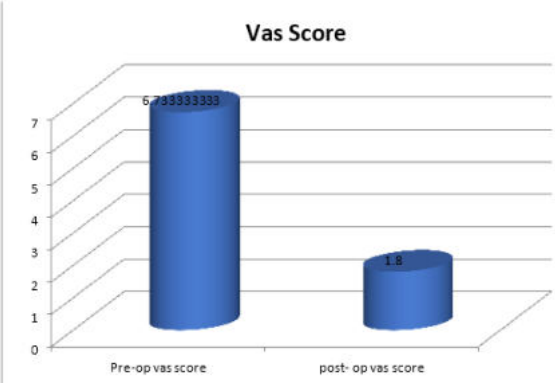
Out of the 30 patients, 4 patients developed complications with 2 being An intra-operative dural tear which was managed uneventfully. 1 patient had Stich ininfection.

Pain relief :
T-Test was used to compare the Pre and post op Visual Analogue Scale.
t-Test: Paired Two Sample for Means

Table 1

	Pre-op vas score	*post- op vas score*
Mean	6.733333333	1.8
Variance	0.96091954	0.165517241
Observations	30	30
Pearson Correlation	0.380442955	
Hypothesized Mean Difference	0	
df	29	
t Stat	29.78545256	
P(T<=t) one-tail	1.3446E-23	
t Critical one-tail	1.699127027	
P(T<=t) two-tail	2.68919E-23	
t Critical two-tail	2.045229642	

The table 1 shows pre operative VAS score versus post operative VAS score at 12th month indicates a ―p value < 0.000 1 and hence a significant comparison. The pain relief was drastic and significant.



GRAPH -4

Improvement in quality of life
The assessment was based on the T-Test comparing pre and post op Oswestry Disability index (ODI)

Table 2

	Pre-op ODI	*Post-op ODI*
Mean	63.4	5.066666667
Variance	50.52413793	3.995402299
Observations	30	30
Pearson Correlation	-0.016503695	
Hypothesized Mean Difference	0	
df	29	
t Stat	43.08652433	
P(T<=t) one-tail	3.80516E-28	
t Critical one-tail	1.699127027	
P(T<=t) two-tail	7.61032E-28	
t Critical two-tail	2.045229642	

There was statistically significant reduction in Oswestry Disabilityindex postoperatively, indicating significant improvement in the quality of life.

Radiological union
This table shows percentage of union in total

Table 3

	Union (radiological)		Total
	Yes	No	
No:of cases	20	10	30
% of cases	66.67	33.33	100.0%

RESULTS
In our prospective study of 30 patients, the follow-up period might last up to 12 months. There were no patients who were lost to follow-up. From surgical incision to wound closure, the average operating time was 2.5 hours. The average amount of blood lost was 250 mL. The radiological union percentage was discovered to be 66.67 percent. The improvement in the postop VAS score at 1 year, represented by a "p value" of 0.000 1, demonstrated that the post-op pain alleviation was extreme and significant. Improvement in quality of life, as assessed by the T-Test comparing pre and post-operative Oswestry Disability index (ODI), was statistically significant, suggesting a drop in Oswestry Disability index, indicating a significant improvement in quality of life.

The study concludes that patients who underwent fusion surgery perform better on the short term visual analogue scale and the Oswestry disability index.

Complications:
Various complications that occurred in our study are
1. Stich Infections
2. Dural tear

One patient had superficial infections, which was treated with a pus culture and sensitivity test, as well as suitable antibiotics. In two patients, a dural tear occurred. Both patients had their dural tears repaired.

DISCUSSION
Chronic low back pain, with or without radiculopathy, is a frequent condition. The cause of the pain is yet unknown and debatable. One of the greatest options for managing degenerative disc disease is posterior lumbar fusion surgery. From a biomechanical standpoint, it is superior because the graft is put in a location where 80 percent of the axial stress occurs, restoring disc height and sagittal balance. Because of the presence of highly vascular endplates adjacent to the bone transplant, the surgical approach also provides an excellent fusion situation.

The results of fusion were comparable to that obtained with other standard studies during the short follow up. The fusion rates after interbody arthrodesis have improved, from 66 % in first year (of 83 patients studied by Stauffer and Coventry [8.]) to two-year follow up of 91percent when Bagby and Kuslich titanium cage [9-11.] and 96 percent when Ray titanium cage was used.[12.] According to them, the fusion rates will be higher on further follow up.

Despite the fact that the percentage of union radiologically in our study was only 66.67%, the clinical outcome, as indicated by the improvement in socioeconomic and functional parameters as evidenced by the Oswestry Disability Index and score, was determined to be excellent. Because the interbody spaces have stronger vascular supply than the posterolateral spaces, there is better fusion. [13.] Furthermore, when unilateral posterolateral fusion is performed, the risk of deformity advancement is significant.

Our study's average operation duration was 2.5 hours, which was equivalent to typical research.[14.] The problems associated with prolonged surgery, such as initial bleeding, basal atelectasis, shock due to blood loss, postoperative wound infection, and paralytic ileus, will be reduced if the surgical period is reduced.

Our study's mean blood loss was 250 mL, which was equivalent to the 250 mL blood loss in a study by Curt Freudenberger et al.

The benefit of a pure PLIF operation over an anterior and posterior spine fusion surgery is that it provides anterior fusion between adjacent vertebrae without requiring a second incision.

The disadvantages of PLIF surgery are as follows:
- A posterior approach permits only a limited amount of disc space to be eliminated;
- An anterior approach provides for a more thorough evacuation of the disc space, and thus a larger surface area for fusing.
- An anterior technique enables for a significantly larger bone graft and/or spinal implant to be inserted.
- Reducing spinal abnormalities with only a posterior approach is more difficult (e.g. isthmic spondylolisthesis)
- A bone graft or cage implanted posteriorly may, in rare cases, retro pulse back into the canal, resulting in neural compression.

The cage with bone graft is implanted in the front region of the disc space during PLIF surgery. The anterior gutter has 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 stressed enough in posterolateral fusions. Because of these two factors, PLIF surgery has a higher success rate than posterolateral fusion.

The following are the risks and complications of PLIF surgery:

1. Fusion rates for non-union PLIFs should be comparable.

The following are the risk factors for non-unionization:

- Previous spinal surgery
- cigarette smoking Obesity.
- Surgery to fuse various levels of the spine - Cancer radiotherapy.

Even in the presence of radiological nonunion, a subsequent fusion treatment is not required if the joint is stable and the patient is symptomatically healthy.

2. Infection and bruising. (An occurrence of 1% to 3% is possible). (3.3 percent according to our study).
3. Persistent back pain despite successful spinal fusion

Posterior instrumentation provides immediate postoperative stability, and bony fusion was later established, resulting in no slip progression.

Patients with pedicle-screw instrumentation had a significantly higher fusion rate than those without instrumentation. [15] The success of employing instrumentation is based on establishing and maintaining disc space height, making it a better option for patients suffering from mechanical back pain, foraminal stenosis, and resulting radiculopathy. The biomechanics of a pedicle screw are as follows: it resists axial load by tightly buttressing the spine; due to the absence of load sharing by the anterior column, stress occurs at the screw plate or rod junction, resulting in screw fracture. Deformities are caused by the flexion and extension components of the applied moment arm. During axial loading, pedicle screw fixation may fail, resulting in parallelogram-like translation deformity, hardware failure, screw pull out, breakage, and toggling. To avoid difficulties, we must utilise an interbody cage.

CASE ILLUSTRATIONS

Case-1:-

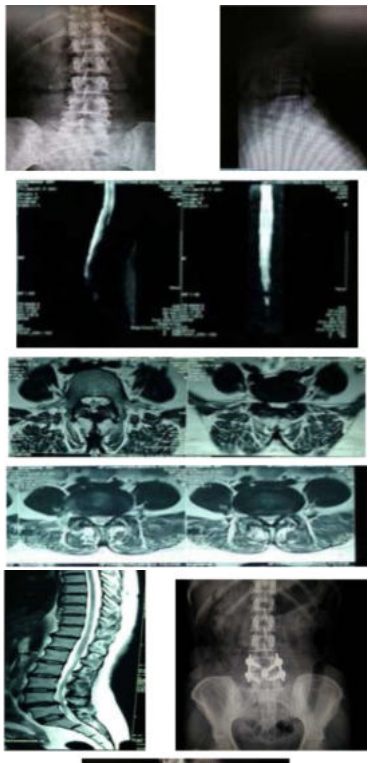
Pre-operative

Intra operative and Post-Operative x rays

Healed scar **lateral flexion**

SLR-Test

Case-2-pre-op,post – op and fallow up x-rays.



Lateralflexion **SLR**

Clinical photos

CONCLUSION

Patients with painful spinal diseases such as degenerative disc disease, spondylolisthesis, lumbar disc herniation, and others benefit from posterior lumbar interbody fusion with bone graft and titanium cage. In posterior lumbar interbody fusion, the functional outcome was better in group one graft with titanium cage. However, it takes a longer period of time to discover the superiority. The limitations in our study were the non-randomized assignment of patients to groups, implying that the choice of surgery was influenced by the surgeon or the patient's preferences. Another restriction is the average follow-up length of one year, which is insufficient for assessing patients' functional outcomes.

The key to success is accurate patient selection, which is the consequence of correctly identifying the etiopathogenesis, diagnosis, and natural history of low-back pain and its care (both non operative and operative). In conclusion, based on the findings and minimal complication rate, we believe that the PLIF approach combined with bone grafting is an appropriate technique for spondylolisthesis and degenerative disc disease.

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