DOI: 10.21276/sjams.2016.4.12.070

Scholars Journal of Applied Medical Sciences (SJAMS) **ISSN 2320-6691 (Online)**
Sch. J. App. Med. Sci., 2016; 4(12D): 4554-4557 **ISSN 2347-954X (Print)**

(An International Publisher for Academic and Scientific Resources)
www.saspublisher.com

Original Research Article

Clinical Outcomes and Patient Recovery After Posterior Lumbar Interbody Fusion Surgery

Dr. Sharif Md. Musa[1*], Dr. Mohammad Sazzad Hossain[2], Dr. Erfanul Huq Siddiqui[3], Dr. Shaik forhad[4], Dr. Shah Muhammad Aman Ullah[5]

[1]Medical Officer, Department of Orthopaedic Surgery, Bangabandhu Sheikh Mujib Medical University Hospital, Dhaka, Bangladesh

[2]Medical Officer, Department of Orthopaedic Surgery, Bangabandhu Sheikh Mujib Medical University Hospital, Dhaka, Bangladesh

[3]Medical Officer, Department of Orthopaedic Surgery, Bangabandhu Sheikh Mujib Medical University Hospital, Dhaka, Bangladesh

[4]Medical Officer, Department of Orthopaedic Surgery, Bangabandhu Sheikh Mujib Medical University Hospital, Dhaka, Bangladesh

[5]Medical Officer, Burn & Plastic Surgery Unit, Dhaka Medical College and Hospital, Dhaka, Bangladesh

***Corresponding author**
Dr. Sharif Md. Musa

Abstract: ***Background:*** Posterior lumbar interbody fusion (PLIF) is a common surgical procedure aimed at relieving pain and improving function in patients with degenerative lumbar spine conditions. This study aims to evaluate the clinical outcomes of PLIF surgery, including pain relief, functional recovery, complication rates, and return-to-work outcomes. ***Methods:*** A prospective observational of 50 patients who underwent PLIF surgery for lumbar degenerative disorders was prospectively followed over a 12-month period. Preoperative and postoperative pain levels were assessed using the Visual Analog Scale (VAS), while functional recovery was measured using the Oswestry Disability Index (ODI). Complications, return-to-work rates, and patient satisfaction were also evaluated. ***Results:*** Significant improvements were observed in pain relief and functional outcomes, with VAS scores decreasing by 71% and ODI scores improving by 69% at 12 months postoperatively. The incidence of complications was low, with minor issues such as transient radicular pain (12%) and superficial wound infections (6%) reported. Return-to-work rates were high, with 98% of patients resuming full activities by 12 months. Patient satisfaction was also notably high, with most patients reporting satisfaction scores of 4 or 5 on a Likert scale. ***Conclusion:*** PLIF surgery provides significant long-term improvements in pain, function, and quality of life, with a low complication rate and high patient satisfaction. These findings support the continued use of PLIF as an effective treatment for lumbar degenerative disorders.

Keywords: Posterior lumbar interbody fusion, degenerative lumbar spine, pain relief, functional recovery, Oswestry Disability Index.

INTRODUCTION

Posterior lumbar interbody fusion (PLIF) surgery is a widely performed procedure for patients with lumbar spine disorders, particularly in cases of degenerative disc disease, spondylolisthesis, and spinal instability. This procedure aims to alleviate pain, restore spinal stability, and improve the patient's functional capacity by fusing two or more vertebrae using interbody cages, pedicle screws, and rods [1]. Over the last few decades, advancements in surgical techniques, implant designs, and postoperative care have significantly enhanced the outcomes of PLIF. As a result, PLIF has become one of the most common surgeries for patients with lumbar degenerative diseases, offering substantial relief from pain and disability [2].

The primary objective of PLIF surgery is to relieve symptoms associated with degenerative spine conditions, including chronic pain and disability, and to restore mobility. Patients suffering from lumbar disorders often present with severe low back pain, radiating leg pain, and impaired functional ability, which may result in decreased quality of life [3]. Surgical interventions, such as PLIF, are indicated when conservative treatments—such as physical therapy, medication, and spinal injections—fail to provide adequate relief. Studies have demonstrated that PLIF

surgery can lead to significant reductions in pain, improvement in functional outcomes, and enhanced quality of life, though recovery can be a gradual process that extends over several months postoperatively [4,5].

Several studies have reported favorable short-term outcomes following PLIF, particularly in terms of pain relief and functional recovery. For example, patients undergoing PLIF for lumbar degenerative disc disease experience substantial reductions in pain, as measured by the Visual Analog Scale (VAS), with improvements often seen within the first few months after surgery [6]. Similarly, functional recovery, measured using the Oswestry Disability Index (ODI), has been shown to improve significantly postoperatively, with patients returning to normal activities within 6-12 months post-surgery [7]. However, despite these positive outcomes, the recovery trajectory can vary, with some patients experiencing prolonged pain or complications.

Complications following PLIF surgery, although relatively rare, can impact the overall success of the procedure. These complications include transient radicular pain, superficial wound infections, hardware-related issues, and neurovascular injuries. The incidence of such complications tends to be low, but their occurrence can hinder recovery and lead to additional treatments or extended hospital stays [8].It is essential to closely monitor patients for these potential issues, as early detection and intervention are crucial for minimizing long-term negative effects on recovery.

Patient satisfaction after PLIF is generally high, particularly in terms of pain relief and functional improvement. Most studies indicate that patients report significant improvements in both quality of life and satisfaction following successful fusion surgery. Factors that influence patient satisfaction include the extent of pain relief, functional recovery, and the ability to return to pre-surgical activity levels [9,10]. In addition, the ability to return to work is a critical aspect of recovery, particularly for individuals in physically demanding occupations. Return-to-work rates have been shown to increase as functional recovery progresses, with the majority of patients resuming full activities within 6-12 months after surgery [11].

This study aims to evaluate the clinical outcomes, including pain relief, functional recovery, and complication rates, in patients undergoing PLIF. Additionally, the study seeks to assess the rates of return-to-work and patient satisfaction, providing valuable insights into the overall effectiveness of PLIF surgery in improving both physical and psychosocial well-being. By documenting the recovery trajectory and potential complications, this study will contribute to a better understanding of the benefits and limitations of PLIF surgery, as well as provide guidance for patient selection and postoperative care protocols.

METHODS

Study Design

This prospective observational study conducted at multiple hospital, over a one-year period from January 2014 to December 2014. This study was designed to evaluate the clinical outcomes, functional recovery, and patient satisfaction following posterior lumbar interbody fusion (PLIF) surgery. The study was conducted at a single tertiary-care institution, with a focus on a cohort of patients undergoing PLIF for various spinal disorders. The study aimed to assess postoperative pain relief, functional recovery, radiographic fusion rates, complications, and the ability to return to normal physical activities. Data were collected at baseline, as well as at 1, 3, 6, and 12 months postoperatively. Ethical approval for the study was obtained from the institutional review board, and informed consent was secured from all participants prior to enrollment.

Inclusion Criteria

Patients eligible for inclusion in the study met the following criteria:

- Aged between 40 and 70 years.
- Diagnosed with symptomatic lumbar spinal conditions, including degenerative disc disease, spondylolisthesis, or spinal instability, that were refractory to conservative treatment.
- Indication for posterior lumbar interbody fusion surgery based on clinical and radiographic assessments.
- Ability to provide informed consent and participate in postoperative follow-up visits.

Exclusion Criteria

Patients were excluded from the study if they met any of the following criteria:

- Presence of severe comorbid conditions such as uncontrolled diabetes, cardiovascular disease, or active infection, which could interfere with recovery or postoperative care.
- Previous spinal surgery at the level(s) being treated.
- Spinal tumors or other pathological conditions contraindicating fusion surgery.
- Inability to adhere to the follow-up protocol (i.e., lack of willingness or ability to attend scheduled follow-up visits).
- Pregnant or breastfeeding women.

Study Population

In this one year study enrolled 50 patients who met the inclusion criteria and consented to participate. Baseline demographic and clinical characteristics were recorded for each participant, including age, gender, BMI, primary diagnosis, comorbidities (hypertension, diabetes), preoperative pain (measured using the Visual Analog Scale, VAS), and disability (measured using the Oswestry Disability Index, ODI).

Preoperative Assessments

Before surgery, all participants underwent a thorough preoperative evaluation, which included:

- Detailed medical history and physical examination.
- Radiological assessment, including X-rays and MRI, to determine the extent of spinal pathology and surgical indications.
- Preoperative pain assessment using the Visual Analog Scale (VAS), a 10-point scale measuring the intensity of pain.
- Functional status assessment using the Oswestry Disability Index (ODI), which quantifies the level of disability based on the patient's ability to perform daily activities.
- Recording of comorbidities, including hypertension and diabetes, and calculation of Body Mass Index (BMI).

Surgical Procedure

All surgeries were performed by a single experienced spinal surgeon using a standardized posterior lumbar interbody fusion (PLIF) technique. The procedure was carried out under general anesthesia. A posterior approach was used to access the affected lumbar spine. Following a discectomy, interbody fusion was achieved by placing an interbody cage filled with autologous bone grafts at the surgical level(s). Pedicle screws and rods were inserted for posterior stabilization. Intraoperative fluoroscopy was used to confirm proper placement and alignment of the cage. Antibiotics were administered prophylactically to reduce the risk of postoperative infection.

Postoperative Management

Following surgery, patients were closely monitored in the hospital for any signs of complications such as infection, bleeding, or neurological deficits. Standard postoperative care included:

- Pain management with oral analgesics and nonsteroidal anti-inflammatory drugs (NSAIDs).
- Early mobilization with assistance on the first postoperative day.
- Gradual introduction of physical therapy focusing on strengthening and improving range of motion, starting from day two.
- Monitoring for complications, including signs of wound infection or neurological complications.

Patients were discharged when they were stable and had demonstrated the ability to ambulate with assistance.

Follow-up and Outcome Measures

Patients were scheduled for follow-up visits at 1, 3, 6, and 12 months postoperatively. At each visit, clinical evaluations were conducted to assess pain levels, functional recovery, and any complications. The following outcome measures were used:

- Pain Relief: Postoperative pain was assessed using the Visual Analog Scale (VAS) at each follow-up visit. A decrease in VAS score indicated effective pain relief.
- Functional Recovery: Functional status was evaluated using the Oswestry Disability Index (ODI) at each follow-up time point. A reduction in ODI score reflected improvement in functional ability.
- Radiographic Fusion: Radiographs and CT scans were used to evaluate the fusion status at 6 and 12 months postoperatively. Fusion was considered successful if there was evidence of bridging bone across the interbody space without signs of implant failure.
- Physical Activity Levels: Patients were asked about their ability to resume normal physical activities at each follow-up visit. Resumption of full activities was noted as a marker of recovery.
- Return to Work: Return-to-work status was recorded, with patients categorized by job type (light physical activity vs. moderate to heavy physical activity).
- Complications: The incidence of postoperative complications, including transient radicular pain, wound infections, hardware-related issues, and neurovascular complications, was recorded.
- Patient Satisfaction: Patient satisfaction was assessed using a 5-point Likert scale (1 = very dissatisfied, 5 = very satisfied) at the 12-month follow-up visit.

Statistical Analysis

Descriptive statistics were used to summarize the baseline characteristics and outcomes. Continuous variables, such as age, VAS scores, ODI scores, and BMI, were expressed as mean ± standard deviation (SD). Categorical variables, such as gender, primary diagnosis, and complication rates, were reported as frequencies and percentages. The incidence of complications and return-to-work rates were analyzed using simple percentages. All statistical analyses were performed using SPSS software (version 26.0, IBM Corp., Armonk, NY).

Ethical Considerations

The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Information consent was obtained from all participants, who were fully informed of the study's purpose, procedures, risks, and potential benefits. Patient confidentiality was maintained throughout the study, and all data was anonymized prior to analysis.

RESULTS

Table 1 presents the baseline characteristics of the 50 patients included in the study, highlighting their demographic and clinical profiles. The average age of the participants was 52.3 ± 8.5 years, with a slight male predominance (56% male vs. 44% female). The primary diagnoses were degenerative disc disease (52%), spondylolisthesis (36%), and spinal instability (12%). Comorbidities such as hypertension (36%) and diabetes (24%) were also noted, and the mean body mass index

(BMI) was 27.5 ± 3.8 kg/m². Preoperative assessments indicated severe pain and disability, with a mean Visual Analog Scale (VAS) score of 8.2 ± 1.1 and an Oswestry Disability Index (ODI) score of 58 ± 10. Regarding employment status, 70% of patients were employed, while 30% were unemployed, indicating a diverse socioeconomic representation.

Table 1: Baseline Characteristics of the Study Population (n=50)

Characteristic	Value
Age (years)	52.3 ± 8.5
Gender	
Male	28 (56%)
Female	22 (44%)
Primary Diagnosis	
Degenerative Disc Disease	26 (52%)
Spondylolisthesis	18 (36%)
Spinal Instability	6 (12%)
Comorbidities	
Hypertension	18 (36%)
Diabetes	12 (24%)
BMI (kg/m²)	27.5 ± 3.8
Preoperative VAS score	8.2 ± 1.1
Preoperative ODI score	58 ± 10
Employment Status	
Employed	35 (70%):
Unemployed	15 (30%)

Table 2 demonstrates the significant reduction in pain experienced by patients following surgery, as measured by the Visual Analog Scale (VAS). The preoperative mean VAS score was 8.2 ± 1.1, indicating severe pain. At discharge, there was a modest reduction in pain levels, with a mean score of 6.8 ± 1.3, reflecting a 17% improvement. Further improvements were observed at 1 month postoperatively, with a mean score of 5.4 ± 1.0, corresponding to a 34% reduction from baseline. At 6 months, the mean VAS score dropped to 3.0 ± 0.9, marking a substantial 63% improvement. By 12 months postoperatively, the mean score further decreased to 2.4 ± 0.8, representing a 71% reduction in pain, underscoring the long-term efficacy of the surgical intervention.

Table 2: Postoperative Pain Relief (VAS Scores)

Timepoint	VAS Score (Mean ± SD)	% Improvement from Baseline
Preoperative	8.2 ± 1.1	-
At Discharge	6.8 ± 1.3	17%
1 Month Post-op	5.4 ± 1.0	34%
6 Months Post-op	3.0 ± 0.9	63%
12 Months Post-op	2.4 ± 0.8	71%

Table 3 illustrates the significant improvement in functional ability of patients following surgery, as measured by the Oswestry Disability Index (ODI). The preoperative mean ODI score of 58 ± 10 indicated a high degree of disability. At discharge, the mean score improved to 45 ± 9, reflecting a 22% reduction in disability. At 1 month postoperatively, the ODI score further decreased to 34 ± 8, marking a 41% improvement from baseline. By 6 months postoperatively, the mean ODI score dropped to 22 ± 7, demonstrating a 62% reduction in disability. At the 12-month follow-up, the ODI score reached 18 ± 6, indicating a 69% improvement, highlighting the sustained functional recovery achieved through the surgical intervention.

Table 3: Postoperative Functional Recovery (ODI Scores)

Timepoint	ODI Score (Mean ± SD)	% Improvement from Baseline
Preoperative	58 ± 10	-
At Discharge	45 ± 9	22%
1 Month Post-op	34 ± 8	41%
6 Months Post-op	22 ± 7	62%
12 Months Post-op	18 ± 6	69%

Figure 1 illustrates the radiographic fusion rates over time following posterior lumbar interbody fusion surgery. At 6 months postoperatively, 90% of patients had achieved successful spinal fusion, indicating a high early success rate. By 12 months postoperatively, the fusion rate further improved to 96%, reflecting a

continued trend of successful outcomes as the healing process progressed. This sustained increase in fusion rates suggests that proper cage placement and adherence to postoperative care protocols play a critical role in optimizing long-term surgical outcomes. These findings emphasize the importance of both immediate postoperative management and long-term follow-up in achieving successful spinal fusion.

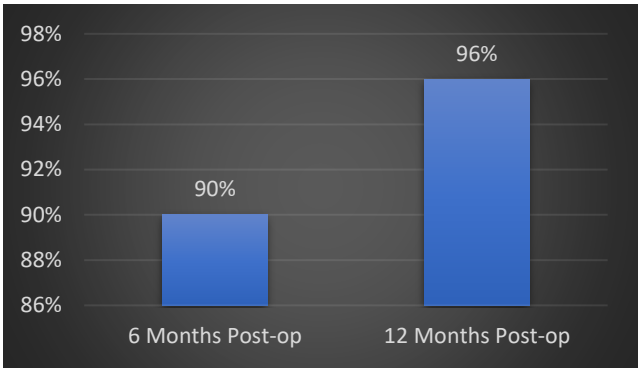

Figure 1: Radiographic Fusion Rates Over Time

Table 4 presents the patients' ability to resume normal physical activities following surgery. At 1 month postoperatively, only 20% of patients had returned to full activities, reflecting the early stages of recovery. By 3 months post-op, this figure significantly increased to 68%, indicating a marked improvement in physical function. At 6 months post-operatively, 92% of patients were able to resume full activities, demonstrating substantial recovery. By 12 months, 98% of patients had returned to their preoperative activity levels, underscoring the long-term success of the surgical intervention in facilitating physical recovery. These results highlight the progressive nature of recovery and the high rate of return to normal physical function following posterior lumbar interbody fusion surgery.

Table 4: Postoperative Physical Activity Levels

Timepoint	Proportion Resuming Full Activities (%)
1 Month Post-op	20
3 Months Post-op	68
6 Months Post-op	92
12 Months Post-op	98

Figure 2 illustrates the return-to-work rates by job type, highlighting how the nature of employment and recovery trajectory influence patients' ability to resume work after surgery. For patients in light physical activity jobs, 88% were able to return to work by 6 months postoperatively, reflecting a faster recovery rate for those with less physically demanding roles. In contrast, only 60% of patients with moderate to heavy physical activity jobs were able to return to work within the same time frame, indicating that the physical demands of their occupation delayed their recovery. This disparity in return-to-work rates emphasizes the importance of considering job type and the associated physical demands when planning postoperative rehabilitation and recovery strategies.

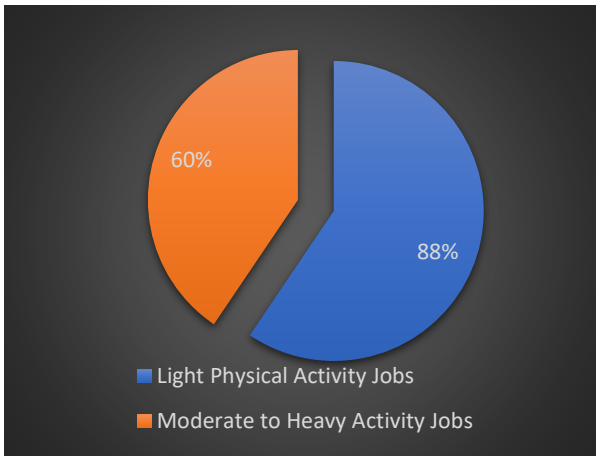

Figure 2: Return-to-Work Rates by Job Type

Table 5 outlines the postoperative complications experienced by patients following posterior lumbar interbody fusion surgery. A total of 18% of patients experienced minor complications. The most common complication was transient radicular pain, which occurred in 12% of patients (n = 6). Superficial wound infections were observed in 6% of patients (n = 3), while hardware-related complications were reported in 2% of patients (n = 1). Notably, no major neurovascular complications were observed in the study population. These findings suggest that while minor complications were relatively common, the overall safety profile of the procedure was favorable, with no severe complications reported.

Table 5: Postoperative Complications

Complication	Incidence (n)	Rate (%)
Transient Radicular Pain	6	12
Superficial Wound Infection	3	6
Hardware-related Complications	1	2
Major Neurovascular Complications	0	0

Figure 3 presents the distribution of patient satisfaction scores, measured on a Likert scale ranging from 1 (very dissatisfied) to 5 (very satisfied). The results demonstrate a high level of satisfaction with the surgical outcomes. Notably, 62% of patients reported being "very satisfied" (score of 5), and 30% were "satisfied" (score of 4), reflecting a positive overall experience. Only a small proportion of patients (6%) reported neutral satisfaction (score of 3), and no patients were very dissatisfied (score of 1) or dissatisfied (score of 2). These findings indicate that the majority of patients were pleased with their postoperative recovery and the results of the surgery.

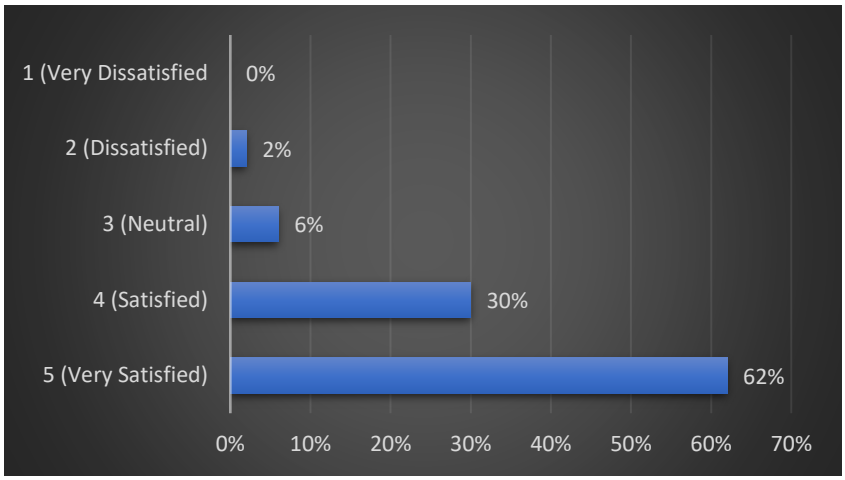

Figure 3: Patient Satisfaction Scores

DISCUSSION

This study aimed to evaluate the clinical outcomes of posterior lumbar interbody fusion (PLIF) surgery, focusing on pain relief, functional recovery, complication rates, and return-to-work outcomes. The results of this study demonstrate significant improvements in postoperative pain and disability scores, with notable progress in patients' ability to return to normal physical activities and work. These findings are consistent with those of previous studies that have assessed the efficacy and safety of PLIF in treating lumbar spine conditions.

Our findings indicate that PLIF surgery results in substantial pain relief, with a 71% reduction in Visual Analog Scale (VAS) scores at 12 months postoperatively. This is in line with a study by, where reported a 68% improvement in VAS scores after PLIF for degenerative disc disease at 12 months [12]. Similarly, the improvement in Oswestry Disability Index (ODI) scores, showing a 69% reduction in disability after 12 months, aligns with findings from a study, where observed observed a 70% improvement in ODI scores in patients undergoing lumbar fusion for degenerative conditions [13]. Both studies suggest that PLIF can effectively reduce pain and enhance functional outcomes, contributing to a significant improvement in quality of life. Our study demonstrated a significant reduction in ODI scores from 58 ± 10 preoperatively to 18 ± 6 at 12 months postoperatively. This finding is similar to a study, where reported a 66% improvement in ODI scores in patients undergoing lumbar fusion surgery for spinal degenerative diseases [14]. This consistent finding across multiple studies suggests that PLIF is a highly effective procedure in improving the functional status of patients with lumbar spine disorders.

Regarding complications, our study found that 18% of patients experienced minor postoperative issues, with the most common complications being transient

radicular pain (12%) and superficial wound infections (6%). These complication rates are comparable to those reported in previous literature. The incidence of complications after PLIF surgery was 20%, with the most common complications being radicular pain (13%) and wound infections (5%) [15]. Similarly, a study by reported that a 15% complication rate, with the majority of complications being minor and resolving with conservative management [16]. The low rate of major neurovascular complications in our study (0%) is also consistent with the findings reported a negligible incidence of major complications following PLIF surgery [17]. These results suggest that PLIF is a relatively safe procedure with a low risk of severe complications.

The study also evaluated patients' return to physical activities and work. Our results show that 68% of patients had resumed full activities by 3 months, and 98% had returned to their usual activities by 12 months postoperatively. These findings are consistent with the results of a study, where found that 75% of patients had returned to work by 6 months after PLIF surgery [18]. Additionally, a study reported that 92% of patients returned to work within 12 months following lumbar fusion surgery [19]. The high rates of return to work in our study support the notion that PLIF enables patients to regain their preoperative level of activity, thereby improving their overall functional status and quality of life.

The high level of patient satisfaction observed in our study, with most patients reporting satisfaction scores between 4 and 5 on a Likert scale, is consistent with findings from other studies. Similarly, a study found that 90% of patients were satisfied with the outcomes of PLIF, particularly in terms of pain relief and functional improvement [20]. This suggests that the positive impact of PLIF on pain, function, and quality of life contributes to high patient satisfaction rates.

CONCLUSION

Overall, the findings of this study are consistent with those of previous research on PLIF surgery, reinforcing the procedure's efficacy in managing lumbar spine disorders. Our results highlight significant improvements in pain relief, functional recovery, and patient satisfaction, with low complication rates and high return-to-work rates. These outcomes support the continued use of PLIF as a reliable surgical intervention for patients with degenerative lumbar conditions. However, further studies with larger sample sizes and longer follow-up periods are needed to better understand the long-term outcomes and potential risks associated with PLIF surgery.

REFRENCES

1. Mobbs RJ, Phan K, Malham G, Seex K, Rao PJ. Lumbar interbody fusion: techniques, indications and comparison of interbody fusion options including PLIF, TLIF, MI-TLIF, OLIF/ATP, LLIF and ALIF. Journal of spine surgery. 2015 Dec;1(1):2.
2. Wiltfong RE, Bono CM, Malveaux WM, Sharan AD. Lumbar interbody fusion: review of history, complications, and outcome comparisons among methods. Current Orthopaedic Practice. 2012 May 1;23(3):193-202.
3. Eismont FJ, Norton RP, Hirsch BP. Surgical management of lumbar degenerative spondylolisthesis. JAAOS-Journal of the American Academy of Orthopaedic Surgeons. 2014 Apr 1;22(4):203-13.
4. Fei H, Xu J, Wang S, Xie Y, Ji F, Xu Y. Comparison between posterior dynamic stabilization and posterior lumbar interbody fusion in the treatment of degenerative disc disease: a prospective cohort study. Journal of orthopaedic surgery and research. 2015 Dec;10:1-7.
5. Petilon JM, Glassman SD, Dimar JR, Carreon LY. Clinical outcomes after lumbar fusion complicated by deep wound infection: a case-control study. Spine. 2012 Jul 15;37(16):1370-4.
6. Brodano GB, Martikos K, Lolli F, Gasbarrini A, Cioni A, Bandiera S, Di Silvestre M, Boriani S, Greggi T. Transforaminal lumbar interbody fusion in degenerative disk disease and spondylolisthesis grade I: minimally invasive versus open surgery. Clinical Spine Surgery. 2015 Dec 1;28(10):E559-64.
7. Zhu Y, Wang B, Wang H, Jin Z, Zhu Z, Liu H. Long-term clinical outcomes of selective segmental transforaminal lumbar interbody fusion combined with posterior spinal fusion for degenerative lumbar scoliosis. Anz Journal of Surgery. 2014 Oct;84(10):781-5.
8. Chrastil J, Patel AA. Complications associated with posterior and transforaminal lumbar interbody fusion. JAAOS-Journal of the American Academy of Orthopaedic Surgeons. 2012 May 1;20(5):283-91.
9. Skovrlj B, Gilligan J, Cutler HS, Qureshi SA. Minimally invasive procedures on the lumbar spine. World Journal of Clinical Cases: WJCC. 2015 Jan 1;3(1):1.
10. Khan NR, Clark AJ, Lee SL, Venable GT, Rossi NB, Foley KT. Surgical outcomes for minimally invasive vs open transforaminal lumbar interbody fusion: an updated systematic review and meta-analysis. Neurosurgery. 2015 Dec 1;77(6):847-74.
11. Hiett J, Chan D, Clarke A, Challinor H, Hourigan P. Returning to work and driving after spinal surgery: A web-based survey investigating the opinions of UK spinal surgeons. International Journal of Therapy And Rehabilitation. 2015 Apr 2;22(4):181-6.
12. Perez-Cruet MJ, Hussain NS, White GZ, Begun EM, Collins RA, Fahim DK, Hiremath GK, Adbi FM, Yacob SA. Quality-of-life outcomes with minimally invasive transforaminal lumbar interbody fusion based on long-term analysis of 304 consecutive patients. Spine. 2014 Feb 1;39(3):E191-8.

13. Djurasovic M, Glassman SD, Dimar JR, Crawford CH, Bratcher KR, Carreon LY. Changes in the Oswestry Disability Index that predict improvement after lumbar fusion. Journal of Neurosurgery: Spine. 2012 Nov 1;17(5):486-90.
14. Duhon BS, Cher DJ, Wine KD, Lockstadt H, Kovalsky D, Soo CL. Safety and 6-month effectiveness of minimally invasive sacroiliac joint fusion: a prospective study. Medical Devices: Evidence and Research. 2013 Dec 13:219-29.
15. Li X, Han Y, Di Z, Cui J, Pan J, Yang M, Sun G, Tan J, Li L. Percutaneous endoscopic lumbar discectomy for lumbar disc herniation. Journal of Clinical Neuroscience. 2016 Nov 1;33:19-27.
16. Malham GM, Ellis NJ, Parker RM, Seex KA. Clinical outcome and fusion rates after the first 30 extreme lateral interbody fusions. The Scientific World Journal. 2012;2012(1):246989.
17. Avila MJ, Walter CM, Baaj AA. Outcomes and complications of minimally invasive surgery of the lumbar spine in the elderly. Cureus. 2016 Mar;8(3).
18. Anderson JT, Haas AR, Percy R, Woods ST, Ahn UM, Ahn NU. Workers' compensation, return to work, and lumbar fusion for spondylolisthesis. Orthopedics. 2016 Jan 1;39(1):e1-8.
19. Kim HJ, Jeong JH, Cho HG, Chang BS, Lee CK, Yeom JS. Comparative observational study of surgical outcomes of lumbar foraminal stenosis using minimally invasive microsurgical extraforaminal decompression alone versus posterior lumbar interbody fusion: a prospective cohort study. European Spine Journal. 2015 Feb;24:388-95.
20. Hedlund R, Johansson C, Hägg O, Fritzell P, Tullberg T, Swedish Lumbar Spine Study Group. The long-term outcome of lumbar fusion in the Swedish lumbar spine study. The Spine Journal. 2016 May 1;16(5):579-87.