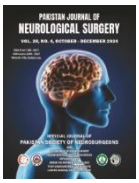

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Original Research

Role of Posterior Lumbar Interbody Fusion in the Management of Lumbar Instability in Low- and Middle-Income Countries

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ABSTRACT

Introduction:

Objective: This retrospective observational study aimed to determine the effectiveness of PLIF in the case of lumbar instability using the MacNab Criteria for functional recovery outcomes.

Materials and Methods: This retrospective observational study included a total number of 21 patients who underwent the PLIF procedure at the Ali Institute of Neuroscience, Irfan General Hospital. Using the MacNab criteria the recovery outcomes of patients were assessed with demographic data and comorbidities recorded. Descriptive statistics including mean, median, and percentages were used to analyze the data, due to the small sample size no advanced inferential statistics tests were conducted.

Results: The PLIF procedure showed great efficacy in correcting lumbar instability with 85% of patients reporting Good to Excellent recovery outcomes in terms of reduced lower back pain and lumbar instability. Leg pain has been improved in 90% of the cases while 9.5% of cases have reported delayed wound healing and foot drop. Overall, the complication rate was low with the PLIF procedure. These findings determine the effectiveness of PLIF in case of lumbar instability.

Conclusion: PLIF is a significant surgical option for the correction of lumbar instability with high efficacy and low complication rate especially in low and middle-income countries. Further research with large sample sizes is recommended to show the long-term effectiveness of PLIF and to compare its effectiveness with other fusion techniques.

Keywords: Posterior Lumbar Interbody Fusion (PLIF), Lumbar Instability, Spine Surgery, Low Back Pain, Neurosurgical Outcomes.

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INTRODUCTION

The condition Lumbar instability is a pathological condition that leads to lower back pain and

Sciatica, this condition often requires surgical intervention like Posterior lumbar Interbody fusion (PLIF). To correct the lumbar instability, particularly in the case of spinal rotation and translation, PLIF is a widely used surgical procedure but still, there exists some disparities in its effectiveness compared to other fusion techniques like ALIF and TLIF.[1] Lumbar Instability is considered to be an underlying cause for Low back pain and Sciatica leading to surgical decision for spinal fusion or decompression.[2] There are two associated conditions with this pathology one is Neurological Instability, which is due to the compression of a nerve root and is marked with Myelopathy and Radiculopathy.[3] The Clinical Instability is marked by Mechanical Instability that causes functional limitations and pain.[4] To treat lumbar instability historically external fixation procedures were used, with the arrival of transpedicular fixation in 1980 the surgical techniques started to advance. The Rod-and-Wire system which later on developed into a more complex Rod-and-Plate system was the first technique used for the correction of Lumbar Instability.[5] With these historic interventions it was made easier to create fusion procedures that direct distinct aspects of lumbar instability. For example, Extreme Lateral Interbody Fusion (XLIF) and Anterior Lumbar Interbody Fusion (ALIF).[6]

The evaluation of clinical outcomes determines how well a surgical procedure works to improve its functional status and relieve discomfort. A comprehensive study on lumbar spine surgery created a prediction model for patient outcomes offering precise forecasts of postsurgical improvements.[7] The assessment of pain, functional improvement, and spinal stability after surgery are used to determine these results. The efficacy of procedures such as Anterior lumbar interbody fusion (ALIF), Transforaminal interbody fusion (TLIF), and Posterior interbody fusion (PLIF) in achieving these goals has been studied extensively.[8] For example, PLIF is important for the management of translation and rotation of the spine which is important for maintaining lumbar spine stability.[9-10] Posterior Lumbar Interbody Fusion (PLIF) is a surgical procedure that fuses vertebrae from the posterior aspect for the stability of the lumbar spine. PLIF, when compared to other techniques like ALIF and TLIF is known for its simplicity and correction power specifically in the case of spinal translation and rotation.[11] PLIF being a frequently used surgical procedure its importance in comparison to other fusion procedures is yet unknown. According to the previous research, there exists conflicting findings in which some emphasized the importance of PLIF while others have questioned its relative importance.[12] Since the establishment of Transforaminal lumbar interbody fusion (TLIF) it has evolved significantly and it offers a less invasive alternative to (PLIF).[13] For the treatment of single-segment lumbar degenerative disease both PE-PLIF and MPLIF are effective surgical procedures, the PE-PLIF shows reduced intraoperative blood loss and quicker post-operative recovery.[14] According to a systematic review the cost of PLIF/TLIF techniques in the United States is around $31634 approximately. In contrast, the cost of the PLIF procedure in Pakistan is around $500 to $1300, this highlights its significance in terms of affordability in low-income countries. In Pakistan, it is 30 times cheaper in public and 25 times cheaper in private hospitals including the anesthesia and all other medical associated costs.[15]

This study seeks to clarify these disparities through an evaluation of PLIF results at our institution to enhance the procedure's wider adoption and its significance. The primary goal of this study is to evaluate the effectiveness of PLIF in treating lumbar instability. We have evaluated its significance in terms of reduced pain, enhanced function, and general spinal stability. The importance of this research is that it provides comprehensive, institution-specific data about the PLIF technique. This research seeks to enhance knowledge and application about PLIF by

addressing existing uncertainties and providing comprehensive outcome data which results in improved treatment methods for lumbar instability and better patient outcomes. This study includes a retrospective examination of PLIF results using our institution's patient record.

MATERIALS AND METHODS

Study Design and Setting

A retrospective observational study was conducted at Ali Institute of Neurosciences, Irfan General Hospital from the records of the past 2 years (Jan 2022 till December 2023) with the consent from the ethical committee of the Hospital.

Inclusion Criteria

All those patients included in our study were diagnosed with neurosurgical listhesis, degenerative listhesis, and post-discitis requiring PLIF.

Exclusion Criteria

Patients undergoing other surgical procedures were excluded from the study. Patients declining the consent to share their data were also excluded from our study. Patients with active infections (except post-discitis) severe osteoporosis or bone metabolic diseases, malignancies affecting the spine, or a history of lumbar fusion surgery are excluded from the study. Additionally, individuals with systemic illnesses, such as severe cardiovascular or pulmonary conditions, are generally excluded from the procedure due to the increased risks involved.

Data Collection

The MacNab criteria were used to evaluate the recovery outcomes of the patients following the PLIF procedure. According to the MacNab criteria patients were classified into four categories. An excellent outcome was characterized by complete relief of symptoms and allowing them to switch to normal activities without any restrictions. A good outcome indicated minimal pain with the ability to engage in most activities of daily life. A fair outcome indicated some improvement in symptoms but with continued limitations in daily activities. Poor outcomes indicated either worsening of the symptoms or no improvement. The percentage of patients in each recovery category was calculated and shown through the chart. Due to the small sample size of (n = 21) and the retrospective observational nature of the study, no advanced inferential statistical tests were conducted. The analysis focuses on descriptive statistics to provide a comprehensive understanding of the outcomes following the PLIF procedure.

Operative Technique

The surgical approach consists of 5P approaches. It began with thorough Preoperative planning which consists of detailed documentation, assessment of patient medical history, and review of imaging studies including MRI, and X-ray scans to see the spinal pathologies. Then the Preoperative blood work was completed which consists of virology and biochemical tests to ensure patient stability for the surgery. Then the anesthesia preparation was coordinated to see if the patient was fit for the surgical procedure. The patient was positioned in the prone because it allows the best possible access to the lumbar spine, the surgical area was then exposed with standard sterile draping. The skin incision was made at the desired location and the para-spinal muscles were exposed by cutting through the thoracolumbar fascia. To fully expose the operative site far lateral approach was performed. Then the surgical procedure began with wide decompression including bilateral foraminotomy to reduce pressure on the nerve roots. Transpedicular screws were placed above and below the desired spinal level for stabilization.

Next, the intervertebral disc was removed, initially using a straight disc shaver, followed by a curved shaver to remove any remaining disc material. A space was then created for the placement of two bullet cages, one on the right and one on the left, with careful attention to protect the proximal and distal nerve roots at the disc level. Before placing the cages, spinal reduction was performed to ensure proper alignment. During the spinal reduction, ligamentous structures, including the ligaments, were removed, and a foraminotomy and laminectomy were performed. The spinous process was also removed. A small rod was then inserted to maintain spinal lordosis. The wound was thoroughly irrigated with a sterile solution, and local antibiotics were applied to reduce the risk of infection.

Data Analysis

Demographic variables such as age, gender, and comorbidities were recorded on a proforma. Data was analyzed by SPSS version 25 using descriptive statistics. Descriptive statistics were used to summarize patient demographics, including age, gender, and comorbidities. Mean and median were used for the analysis of continuous variables while frequency and percentages were recorded for categorical data.

RESULTS

Patient Characteristics

The study included 21 patients who underwent the Posterior Lumbar Interbody Fusion (PLIF) procedure with 14 females (66.7%) and 7 males (33.3%). The patient's ages ranged from 12 to 73 years, with a mean age of 45.7 years and a median age of 51 years The age distribution showed that the majority of patients (42.9%) were in the 41-60 years age group, followed by 33.3% in the 21-40 years range. Additionally, 14.3% of the patients were between 61-73 years, while 9.5% were aged 12-20 years. The notable outliers included one female aged 24 years, one male aged 12 years, and one male aged 73 years. Among the female participants, 4 (28.6%) had comorbidities specifically diabetes and their condition was effectively managed during their treatment.

Main Findings

The PLIF procedure demonstrated significantly positive outcomes among the 21 patients. The majority of patients recovered well and responded positively to this fusion technique showing significant improvement in their symptoms, particularly in terms of lumbar stability and pain relief. No subgroup analysis was conducted in this study.

Statistical Analysis

Descriptive statistics were computed using SPSS (version 25) software to summarize the patient demographics and clinical outcomes using MacNab. The mean age of the patients was found to be approximately 45.7 years, with a median age of 51 years. Gender distribution showed that 33.3% (n = 7) of the patients were male, while 66.7% (n = 14) were female. Comorbidities were present in 14.3% (n = 3) of the female patients, all of whom had diabetes.

Results

Age Distribution

The study included 21 patients who underwent the Posterior Lumbar Interbody Fusion (PLIF) procedure, with 67% being female and 33% male. The age distribution showed that the majority of patients (42.9%) were in the 41-60 years age group followed by 33.3% in the 21-40 years range. Additionally, 14.3% of the patients were between 61-73 years, while 9.5% were aged 12-20 years. The notable outliers included one female aged 24 years, one male aged 12 years, and one male aged 73 years. Among the female participants, 2 to 3

were diabetic and their condition was effectively managed during their treatment.

Post-Operative Recovery Analysis

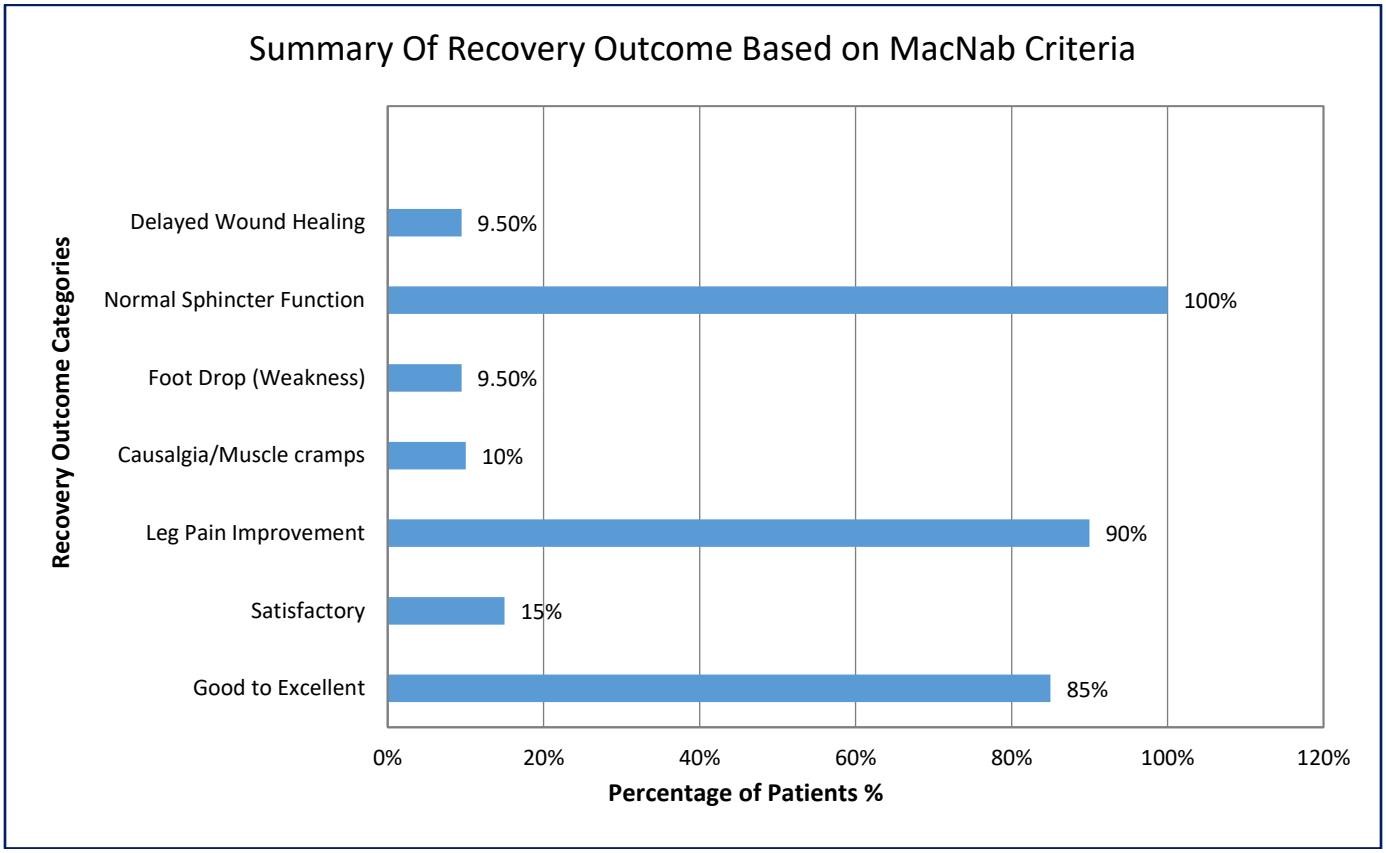

Figure 1: Recovery Outcome Based on MacNab Criteria.

The MacNab Criteria were used to assess the recovery outcomes of 21 patients who had undergone the PLIF operation. As shown in Fig. 1, the majority of patients (85%) experienced Good to Excellent improvement in their lower back pain, indicating that the surgery was effective. A smaller sample (15%) reported satisfactory results, indicating some improvement but with persistent problems. See Figure 1 for details.

In terms of leg discomfort, 90% of patients experienced great improvement, with only 10% experiencing ongoing problems such as causalgia or muscle cramps. Foot drop, a common surgical symptom, was noted in two female patients (9.5%). All of the patients who had undergone the PLIF procedure reported normal sphincteric function. Two of the patients (9.5%) suffered from delays in wound healing that took more than 4 weeks to recover completely. Regardless of these problems the overall recovery outcome of all the patients was extremely positive. The majority of the patients experienced significant improvements in their condition following the PLIF Procedure.

DISCUSSION

This retrospective observational study conducted on 21 patients with lumbar instability who underwent Posterior Lumbar Interbody Fusion (PLIF) procedures concluded highly favorable

results. Using the MacNab criteria 85% of patients reported (Good-Excellent) improvement in lower back pain while the remaining 15% reported satisfactory outcomes. Patients with leg pain reported 90% improvement while the remaining 10% reported residual issues such as causalgia or muscle cramps. Foot drop was observed in 9.5% of the patients, the sphincteric function remained normal in all cases, and 9.5% of patients experienced delayed wound healing. Therefore the overall results indicate that PLIF is effective in reducing pain and improving functional outcomes in patients with lumbar instability. The majority of the patients achieved significant clinical improvement while complications were minimal. 90% of patients reported significant improvement in leg discomfort, a result that matches with the existing literature on PLIF efficacy in improving functional outcomes in patients with lumbar instability.[9-10]

Historically PLIF has shown greater effectiveness in addressing mechanical aspects like spinal rotation and translation when compared to other fusion procedures as demonstrated in the previous research.[11] This retrospective observational study has supported the PLIF effectiveness while some studies have questioned the effectiveness of PLIF over techniques like Anterior lumbar interbody fusion (ALIF) and Transforaminal lumbar interbody fusion (TLIF).[12-13] There also exists some conflicting findings in the literature that suggest that TLIF is less invasive with fewer complications and offers comparable benefits.[13] Among these disparities this retrospective study with institutional-specific data strengthens the case for PLIF effectiveness in treating the lumbar instability especially where resources are limited. Additionally, this study was strengthened more with less complications rate such as 9.5% of patients experiencing delayed wound healing and also a similar percentage reporting foot drop. These results align well with previous literature that reports a low rate of severe complications.[10-14] However, Some minor complications such as delayed wound healing should be addressed with careful postoperative management.

One of the limitations of this study is its retrospective nature. Additionally, a small sample size (n=21) limits the generalisability of its results making it difficult to draw a conclusion that applies to broader populations. Future research with large sample sizes and randomized controlled trials would provide strengthened data and clarification for the effectiveness of PLIF compared to other lumber fusion techniques.[9-14] Moreover the lack of subgroup analysis prevents a deep understanding of the impact of factors such as age, gender, and comorbidities on recovery outcomes. Despite all these limitations this study focuses on real-world patient outcomes and provides valuable insight into the effectiveness of PLIF in low and middle-income countries where access to advanced surgical procedures like ALIF and TLIF may be limited, PLIF gives a practical solution for the treatment of lumbar instability.[5-6] PLIF being an effective and simple procedure combined with a low complications rate makes it a viable option for a wide range of patients. According to a systematic review, the cost of PLIF/TLIF techniques in the United States is around $31634. In contrast, the cost of the PLIF procedure in Pakistan is around $500 to $1300, this highlights its significance in terms of affordability in low-income countries. In Pakistan, it is 30 times cheaper in public and 25 times cheaper in private hospitals including the anesthesia and all other medical associated costs.[15] In conclusion, this study strengthens that PLIF is an effective surgical option for the treatment of lumber instability. PLIF for its low complication rate and high favorable outcomes enhances its utility in improving patient outcomes. Further studies are required to demonstrate the long-term effects of PLIF and to compare its effectiveness with other lumbar fusion techniques in different settings.[7-14]

Limitations

Limitation of this study includes retrospective analysis of data and a small sample size of 21 patients (n=21).

CONCLUSION

This study confirms that PLIF is an effective option for the treatment of Lumbar instability with 85% of patients reporting Good to Excellent recovery outcomes based on MacNab Criteria. Additionally, PLIF showed a low complication rate and sufficient improvement in both low back and leg pain. According to the above findings, it is therefore suggested that PLIF can be a useful surgical option, especially in low and middle-income countries. Future research with a large sample size is recommended to verify the long-term benefits of the technique.

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Additional Information

Disclosures: Authors report no conflict of interest.
Ethical Review Board Approval: This was a retrospective study. The study conformed to the ethical requirements.
Human Subjects: Consent was obtained by all patients/participants in this study.
Conflicts of Interest: In compliance with the ICMJE uniform disclosure form, all authors declare the following:
Financial Relationships: All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work.
Other Relationships: All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.
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AUTHORS CONTRIBUTIONS

Sr.#	Author's Full Name	Intellectual Contribution to Paper in Terms of:
1.	Mumtaz Ali & Ramzan Hussain	1. Study design and methodology.
2.	Mumtaz Ali & Yasir Ashraf	2. Paper writing.
3.	Muhammad Aneeq & Jabir Shah	3. Data collection and calculations.
4.	Hanif Ur Rehman & Ramzan Hussain	4. Analysis of data and interpretation of results.
5.	Yasir Ashraf & Jabir Shah	5. Literature review and referencing.
6.	Muhammad Aneeq & Hanif Ur Rehman	6. Editing and quality insurer.