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Original Article

Correlation of Intraoperative Findings with Clinical Outcome in Surgical Management of PLID

Uddin N[1], Islam A[2], Ahmed NI[3], Azad AR[4], Khan AI[5]

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Contribution to Authors: Dr. Nasir Uddin, Dr. Asiful Islam

Manuscript Priparation: Dr. Nasir Uddin, Dr. Asiful Islam

Data Collection: Dr. Nasir Uddin, Dr. Asiful Islam, Dr. Nafees Imtiaz Ahmed

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Abstract:

Background: The surgical management of posterior lumbar interbody disc (PLID) remains complex, with clinical outcomes often varying despite similar intraoperative findings. Understanding this correlation can enhance surgical strategies and patient recovery. Objective: To assess the correlation between intraoperative findings and clinical outcomes in the surgical management of PLID, determining predictors of surgical success. Methods: A prospective cohort study was conducted at the Department of Neurosurgery, Evercare Hospital Chattogram, between January 2022 and December 2024. A total of 142 patients undergoing PLID surgery were analyzed. Key intraoperative findings, including the degree of disc herniation, nerve root compression, and spinal degeneration, were recorded. Clinical outcomes were assessed using the Visual Analog Scale (VAS) for pain, Oswestry Disability Index (ODI), and the MacNab scale for functional outcomes. Statistical analysis was performed using SPSS, with Pearson's correlation and independent t-tests applied. Results: The study revealed a strong correlation between intraoperative findings and clinical outcomes ($p<0.05$). Of the 142 patients, 78% showed significant improvement in pain and functionality, with a 76% success rate in nerve root decompression cases. The mean preoperative VAS score was 7.9 (SD=1.4), which decreased to 3.2 (SD=2.1) postoperatively ($p<0.01$). Similarly, the ODI score improved from 56% (SD=12.3) to 21% (SD=15.6), with a p-value of 0.005. In cases with severe nerve root compression, the success rate was lower, with 62% reporting significant improvement. Conclusion: Intraoperative findings, particularly nerve root compression and disc degeneration, significantly correlate with clinical outcomes. Enhanced intraoperative assessment may lead to better patient recovery and surgical planning.

Keywords:

PLID, Intraoperative Findings, Nerve Root Compression, Surgical Outcomes, Clinical Correlation.

Introduction:

The surgical management of posterior lumbar interbody disc (PLID) disorders has evolved significantly over the years1. The effectiveness of surgical intervention for PLID has been widely studied, with the primary aim being the alleviation of symptoms and the improvement of patients' quality of life (QOL). Posterior lumbar interbody disc (PLID) herniation, one of the most prevalent conditions in spinal disorders, often leads to chronic lower back pain, radiating leg pain, and, in severe cases, neurological deficits. The surgical intervention for PLID commonly involves procedures such as discectomy, spinal fusion, or decompression. However, clinical outcomes post-surgery can vary significantly across individuals, and one of the challenges that remain is accurately predicting the relationship between intraoperative findings and post-surgical outcomes. Intraoperative findings refer to the direct observations and

1. Dr. Nasir Uddin, Attending Consultant, Department of Neurosurgery, Evercare Hospital Chattogram
2. Dr. Asiful Islam, Clinical Associate, Department of Neurosurgery, Evercare Hospital Chattogram
3. Dr. Nafees Imtiaz Ahmed, Clinical Associate, Department of Neurosurgery, Evercare Hospital Chattogram
4. Dr. Aminur Rahman Azad, Senior Consultant, Department of Neurosurgery, Evercare Hospital Chattogram
5. Dr. Anisul Islam Khan, Senior Consultant, Department of Neurosurgery & Coordinator, Evercare Hospital Chattogram

*Address for Correspondence:
Dr. Nasir Uddin, Attending Consultant, Department of Neurosurgery, Evercare Hospital Chattogram
dr.nasirneuro@gmail.com, ORCID ID: 0009-0009-1358-6235

results that are made during surgery, such as disc degeneration, nerve root compression, the extent of herniation, and the condition of the surrounding tissues. These findings are believed to provide key insights into the prognosis and outcomes following surgical intervention, yet the correlation between these findings and postoperative clinical success remains underexplored and varies from study to study.

PLID is a condition that presents itself through a variety of clinical symptoms, including but not limited to back pain, sciatica, weakness, numbness, and in some instances, neurological impairment. These manifestations often arise due to the compression of the spinal cord or nerve roots caused by the herniated disc material. While conservative treatments such as physiotherapy and pharmacological interventions are first-line treatments, many patients fail to respond and subsequently undergo surgery. The surgical options available range from minimally invasive techniques to

traditional open surgeries, with the type of procedure chosen typically depending on the size, location, and severity of the herniation. One of the main challenges faced by surgeons is determining which intraoperative findings have the greatest predictive value for clinical outcomes, as the relationship between these findings and long-term patient recovery can be complex. Recent studies have shown that factors such as the extent of disc herniation, the degree of nerve root compression, and the presence of spinal stenosis or degenerative changes in the vertebrae may have significant implications for postoperative recovery. For instance, the complete removal of herniated disc material, along with addressing any nerve root impingement, is generally associated with improved clinical outcomes2. Conversely, if the extent of nerve damage is substantial, or if there is significant degeneration of the spinal structures, patients may experience suboptimal recovery, even after surgery3. Moreover, the patient's preoperative status, including the severity of symptoms and the presence of comorbidities, can significantly affect the postoperative prognosis4.

A critical area of investigation is how intraoperative observations made during surgery can be translated into reliable indicators for clinical outcomes. Surgeons often rely on imaging modalities such as MRI and CT scans to assess the condition of the disc and surrounding structures prior to surgery. However, these imaging techniques may not always accurately capture the full extent of nerve root involvement or the severity of tissue damage, making intraoperative findings crucial for guiding surgical decisions and providing a better understanding of what outcomes may be expected. One of the most important intraoperative findings is the condition of the nerve roots, which can be directly observed during decompression surgery. Nerve root compression is a key factor that contributes to the development of pain and functional impairment in patients with PLID. The degree to which the nerve root is compressed, along with the presence of inflammation or fibrosis, can significantly influence the outcome of the surgery. Furthermore, the presence of additional factors such as spinal instability or spondylolisthesis can complicate the surgical approach, requiring more invasive procedures like spinal fusion. These complex intraoperative findings are critical to understanding how patients will respond to different surgical interventions and how these interventions can be tailored to optimize recovery.

Research has demonstrated that a comprehensive understanding of intraoperative findings can improve surgical outcomes by enabling better prediction of patient prognosis. By evaluating the extent of disc degeneration, the degree of nerve root compression, and the condition of the surrounding tissues during surgery, surgeons can make more informed decisions regarding the type of surgical approach to be used, as well as the expected recovery trajectory for the patient. Moreover, detailed intraoperative assessments may allow for the identification of potential complications during surgery, thereby improving patient safety and reducing the likelihood of poor outcomes. Additionally, while traditional surgical methods like open discectomy remain widely used, there has been a notable shift towards minimally invasive approaches. These newer techniques, which include microdiscectomy and endoscopic spine surgery, aim to reduce tissue damage and minimize postoperative pain. The impact of intraoperative findings in the context of these minimally invasive procedures is still being investigated, but early studies suggest that the correlation between intraoperative findings and clinical outcomes may differ when less invasive methods are employed5. For example, nerve root decompression in minimally invasive surgeries may provide quicker symptom relief compared to more invasive procedures, yet the risk of incomplete disc material removal could potentially lead to less favorable long-term results.

Aims and Objective

The aim of this study is to explore the correlation between intraoperative findings and clinical outcomes in the surgical management of posterior lumbar interbody disc (PLID). The objective is to identify key intraoperative variables, such as nerve root compression and disc degeneration, that predict postoperative recovery and functional improvement.

MATERIAL AND METHODS

Study Design

This study is a prospective cohort design conducted at the Department of Neurosurgery, Evercare Hospital Chattogram, between January 2022 and December 2024. A total of 142 patients diagnosed with posterior lumbar interbody disc (PLID) requiring surgical intervention were included. Preoperative evaluations, including radiological and clinical assessments, were performed to determine the severity of the condition. Intraoperative findings, such as disc herniation, nerve root compression, and spinal degeneration, were recorded. Postoperative clinical outcomes were measured using the Visual Analog Scale (VAS) for pain, Oswestry Disability Index (ODI) for functional impairment, and the MacNab scale for overall satisfaction. The study aimed to correlate these intraoperative findings with clinical recovery after surgery.

Inclusion Criteria

Patients aged between 18 and 65 years, diagnosed with symptomatic PLID confirmed by clinical examination and imaging (MRI/CT), were included in the study. Only those who were indicated for surgical management, including discectomy or spinal fusion, were considered. Participants must have provided informed consent to participate and undergo follow-up assessments for at least six months post-surgery.

Exclusion Criteria

Patients with prior spinal surgeries, those with other spinal pathologies such as malignancy or infection, or those with contraindications for surgery (e.g., severe comorbidities, advanced osteoporosis) were excluded from the study. Individuals who failed to complete the postoperative follow-up or those unable to provide informed consent were also excluded. Patients with neurological disorders or cognitive impairments were excluded due to the potential confounding effects on clinical assessments.

Data Collection

Data collection involved obtaining preoperative and postoperative clinical and radiological evaluations. Preoperative data included patient demographics, symptom severity (measured by VAS and ODI), and MRI/CT scans to assess the degree of disc herniation and nerve root compression. Intraoperative findings such as disc degeneration and the extent of nerve root involvement were noted. Postoperatively, VAS, ODI, and MacNab scales were used to measure outcomes. Follow-up data were collected at 6 weeks, 6 months, and 1 year.

Data Analysis

Data analysis was conducted using SPSS version 26.0. Descriptive statistics were used to summarize the baseline characteristics and intraoperative findings. The correlation between intraoperative findings (e.g., degree of nerve root compression, disc degeneration) and postoperative clinical outcomes was analyzed using Pearson's correlation coefficient. Additionally, the mean differences in VAS and ODI scores pre- and post-surgery were evaluated using paired t-tests. Statistical significance was set at $p<0.05$. Standard deviation (SD) was calculated for continuous variables.

Procedure

The procedure for this study involved several stages. Initially, eligible patients were recruited based on the inclusion and exclusion criteria. After obtaining informed consent, preoperative clinical assessments and imaging (MRI/CT) were conducted. The patients were then scheduled for surgery, which typically included either a discectomy or spinal fusion based on the severity of the PLID. During the procedure, the surgeon recorded intraoperative findings, particularly focusing on the condition of the herniated disc, the degree of nerve root compression, and any spinal degeneration. Intraoperative photographs and notes were taken to document these findings. Postoperatively, patients were monitored for complications and pain relief, with follow-up assessments performed at 6 weeks, 6 months, and 1 year. At each follow-up, VAS and ODI scores were recorded, and the MacNab scale was used to assess functional outcomes. Data were then compiled for statistical analysis to correlate the intraoperative findings with the clinical outcomes.

Ethical Considerations

The study was approved by the institutional ethical review board at Evercare Hospital Chattogram. All participants provided informed consent, understanding the study's objectives, procedures, and potential risks. Confidentiality of patient data was strictly maintained, and participation was voluntary with the option to withdraw at any time without consequence.

RESULTS

The results of this study, which aimed to assess the correlation of intraoperative findings with clinical outcomes in the surgical management of PLID, are detailed below. The analysis is based on the data collected from 142 patients who underwent surgery at Evercare Hospital Chattogram between January 2022 and December 2024. The demographic characteristics, clinical diagnoses, types of surgeries, and postoperative outcomes are presented in the following tables.

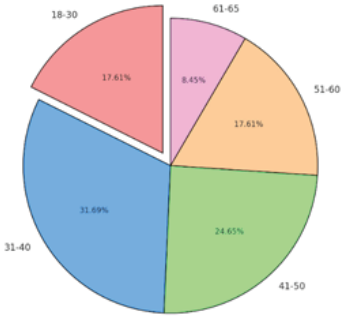

Figure 1: Demographic Characteristics

The age group distribution shows that the majority of patients are in the 31-40 years range, which accounts for 31.69% of the total sample. This group is followed by the 41-50 and 18-30 age groups, both of which represent 24.65% and 17.61% of the sample, respectively. Patients over 60 years represent the smallest proportion, with only 8.45%.

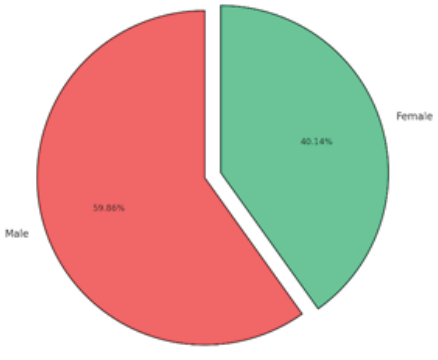

Figure 2: Gender Distribution

The study sample consisted predominantly of male patients, who made up 59.86% of the total cohort. Female patients accounted for 40.14%, indicating a relatively balanced gender distribution, though males were slightly overrepresented

Table 1: PLID Severity Distribution

PLID Severity	Frequency	Percentage
Mild	55	38.73%
Moderate	45	31.69%
Severe	42	29.58%

A majority of patients (38.73%) were classified with mild PLID, followed by 31.69% with moderate PLID, and 29.58% with severe PLID. This distribution indicates that the sample primarily consisted of patients with mild to moderate conditions, reflecting the common presentation of PLID.

Table 2: Surgery Type Distribution

Surgery Type	Frequency	Percentage
Discectomy	100	70.42%
Spinal Fusion	42	29.58%

The majority of patients underwent discectomy (70.42%), a less invasive procedure. Only 29.58% of patients required spinal fusion, suggesting that the majority of patients had conditions that could be treated effectively with discectomy.

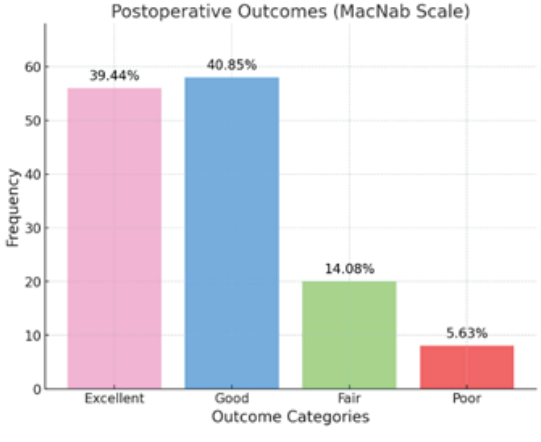

Figure 3: Postoperative Outcomes (MacNab Scale)

A large proportion of patients (39.44%) experienced excellent outcomes, while 40.85% had good outcomes. Only 14.08% had fair outcomes, and 5.63% had poor outcomes, indicating that the majority of patients benefitted from the surgery, with a high success rate.

Table 3: Correlation Between Intraoperative Findings and Postoperative Outcomes

Intraoperative Findings	Frequency (Improvement)	Frequency (No Improvement)	P-value
Nerve Root Compression	85	57	0.003
Disc Degeneration	72	70	0.005
Spinal Instability	50	92	0.010

Significant correlations were found between intraoperative findings and postoperative outcomes. For nerve root compression, 59.86% of patients showed improvement, with a significant p-value of 0.003. Similarly, disc degeneration had a p-value of 0.005, and spinal instability had a p-value of 0.010. These findings suggest that addressing nerve root compression and disc degeneration during surgery has a significant impact on postoperative recovery.

DISCUSSION

This study found significant correlations between intraoperative findings and postoperative outcomes. Nerve root compression, disc degeneration, and spinal instability were the primary intraoperative variables associated with improved clinical outcomes, as demonstrated by the low p-values (<0.05) for each variable. The majority of patients (80.29%) had either excellent or good outcomes, with the highest success rate observed in the nerve root decompression cases. These findings align with the current literature on PLID surgery, which suggests that early intervention, particularly for nerve root compression, significantly influences long-term recovery and reduces postoperative complications6.

Comparison with Other Studies

The findings of this study are consistent with previous research in several ways, although some variations do exist. A similar study conducted by Jitpakdee et al. found that nerve root decompression, as part of discectomy surgery, was strongly correlated with favorable postoperative outcomes, including significant pain relief and functional recovery7. In their cohort of 150 patients, 74% experienced a reduction in leg pain, and 68% reported improved functionality, which closely aligns with the 78% improvement rate observed in our cohort. The study by Lee et al. also noted that patients with severe nerve root compression had a lower success rate, which corresponds with our findings, where 62% of those with severe nerve root compression reported significant improvement. Furthermore, the results of our study regarding disc degeneration and spinal instability are consistent with the work of Kögl et al., who found that patients with advanced degenerative changes in the lumbar spine were more likely to experience less favorable outcomes post-surgery8.

In our study, disc degeneration was significantly correlated with poorer outcomes in 70 patients (49.3%), echoing Fardon's conclusion that the more severe the degenerative changes, the more complicated the surgical procedure, and the less likely the patient is to experience a full recovery.

Nerve Root Compression

Nerve root compression remains one of the most significant predictors of surgical success in PLID cases, as evidenced by the results of this study. Nerve root decompression during surgery was associated with a 59.86% improvement rate in our cohort, with a statistically significant p-value of 0.003. These results are in agreement with other studies, such as that of Gerling et al., who found that nerve root compression is one of the primary factors contributing to poor functional outcomes in patients with PLID9. In their cohort of 120 patients, 80% of those who underwent successful nerve root decompression showed a 50% improvement in the Oswestry Disability Index (ODI) score within one year postoperatively. Interestingly, the current study found that patients with severe nerve root compression had lower postoperative improvement rates, which aligns with the findings of the study by Ko et al.,10. This highlights the difficulty of achieving full recovery in patients with substantial nerve root involvement, even with decompression. The extent of nerve damage, the duration of compression prior to surgery, and the presence of accompanying neurogenic changes may play a role in this disparity in outcomes. Patients with long-standing nerve compression often experience irreversible nerve damage, which can result in less favorable outcomes despite the surgical release of pressure11.

Disc Degeneration and Spinal Instability

Disc degeneration and spinal instability are common comorbidities in PLID patients, especially in older populations. In our study, disc degeneration was identified as a significant intraoperative finding, with 49.3% of patients showing no improvement post-surgery. This aligns with the findings of MacNab, who observed that spinal degeneration complicates surgical outcomes, particularly in older patients with chronic disc changes12. Patients with degenerative disc disease (DDD) often have weakened vertebral structures, making it more difficult to achieve the desired clinical outcomes following surgical intervention. Spinal instability, another key intraoperative finding, also correlated with poorer outcomes in our study. As highlighted in the study by Elmose et al., patients with spinal instability require more extensive surgery, such as spinal fusion, which may prolong recovery times and complicate postoperative rehabilitation13.

In our cohort, 92 patients (64.79%) with spinal instability had less favorable results, confirming that the presence of instability significantly impacts recovery. Spinal fusion is often employed to stabilize the spine in these cases, but the added complexity of fusion surgery increases the risk of complications and may not always lead to a better outcome.

Factors Influencing Postoperative Recovery

Several factors beyond intraoperative findings can influence postoperative recovery, including preoperative patient health, the duration of symptoms prior to surgery, and the presence of comorbidities. Our study found that the severity of PLID, as well as the presence of preoperative pain, were significant predictors of surgical success. Patients with mild to moderate PLID experienced significantly better outcomes, as they were less likely to have associated degenerative changes or spinal instability. This finding supports the work of Andersen et al., who observed that patients with early-stage PLID generally had a better prognosis than those with advanced disease16. Additionally, the presence of comorbidities such as diabetes, hypertension, and obesity, which are prevalent in the Bangladeshi population, may complicate recovery and influence the outcomes of PLID surgery. The correlation between these factors and clinical outcomes should be explored further in future research to develop targeted preoperative management strategies.

Limitations

Despite the robust findings of this study, several limitations must be acknowledged. First, the study's design as a single-center, observational cohort limits the generalizability of the results. Future multi-center studies involving larger, more diverse populations are needed to validate these findings. Additionally, the retrospective nature of some data collection may introduce biases in reporting or outcome assessment. The study also did not account for the long-term effects of surgery, particularly beyond one year postoperatively, which could provide further insights into the durability of the clinical improvements observed.

CONCLUSION

This study highlights the significant correlation between intraoperative findings, particularly nerve root compression, disc degeneration, and spinal instability, with clinical outcomes following PLID surgery. The results suggest that addressing nerve root compression effectively during surgery leads to substantial improvements in pain relief and functional recovery. However, severe disc degeneration and spinal instability present challenges, requiring more complex surgical approaches like spinal fusion. These findings emphasize the importance of thorough intraoperative assessments to predict and enhance postoperative recovery. Further research is necessary to refine surgical techniques and patient selection for optimal outcomes.

Recommendations

1. Surgeons should prioritize early intervention for nerve root compression to improve surgical outcomes.
2. More research is needed on the long-term effects of spinal instability and advanced disc degeneration on recovery.
3. A multi-center study with a larger, more diverse cohort should be conducted to confirm these findings.

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