

ORIGINAL ARTICLE

Efficacy & Reliability of Posterior Decompression & Transforaminal Lumbar Interbody Fusion (TLIF) Using Both Cage and Bone Graft in Patients with Spondylolisthesis – An Observational Study

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ABSTRACT

Background: Spondylolisthesis, a condition characterized by the slippage of one vertebral body over another, significantly impacts patient quality of life and poses challenges in spinal surgery. This study aimed to evaluate the efficacy and reliability of posterior decompression and transforaminal lumbar interbody fusion (TLIF) using both cage and bone graft in patients with spondylolisthesis. **Methods & Materials:** In this prospective observational study, 15 patients with spondylolisthesis underwent posterior decompression and TLIF at NITOR, Dhaka, Bangladesh, from January 2020 to December 2021. Key parameters assessed included slip angle, percentage of slip, mean disc space height, pain levels (using the Visual Analog Scale), motor function, fusion rate, and functional outcomes. Data were analyzed pre-operatively, at 6 months, and 1-year post-surgery. **Results:** Significant improvements were observed post-surgery. The mean slip angle reduced from $15.2 \pm 1.32^\circ$ to $7.73 \pm 1.03^\circ$, and the percentage of slip decreased from $27.37 \pm 1.87\%$ to $12.79 \pm 0.96\%$ ($p < 0.05$). Mean disc space height increased from 7.33 ± 1.05 mm to 11.1 ± 1.77 mm. VAS scores for back and leg pain showed significant reductions. Motor deficits improved, with 93.33% of patients showing no deficits at the 1-year follow-up. The fusion rate was 86.67%, and 73.33% of patients reported 'Excellent' functional outcomes based on Macnab criteria. **Conclusion:** The study demonstrates that posterior decompression and TLIF using cage and bone graft are effective in treating spondylolisthesis, significantly improving spinal alignment, reducing pain, enhancing motor function, and achieving high fusion rates. These findings suggest that this surgical approach can substantially improve the quality of life for patients with spondylolisthesis.

Keywords: Posterior Decompression, Transforaminal Lumbar Interbody Fusion, Spondylolisthesis

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INTRODUCTION

Spinal disorders, encompassing a spectrum of degenerative, traumatic, and congenital conditions, significantly impact patient quality of life and pose substantial challenges to healthcare systems worldwide (1,2). Among these, spondylolisthesis, characterized by the anterior or posterior displacement of a vertebral body relative to the adjacent segment, is particularly noteworthy due to its clinical complexity and prevalence. This condition predominantly affects the lower lumbar spine and is more common in adults, with a higher incidence in females, especially in the obese population (3,4). The prevalence of spondylolisthesis varies, with estimates suggesting 6 to 7% in adolescents and up to 18% in adults undergoing lumbar spine MRI (5). The pathophysiology involves weakened vertebral supports, leading to mechanical pain or radicular symptoms due to nerve root compression. The historical management of spondylolisthesis has evolved significantly over the years. Initial approaches focused on conservative management, including physical therapy and pain management. However, as understanding of the condition deepened, surgical interventions, particularly spinal fusion techniques, gained prominence. These techniques aim to stabilize the affected spinal segments, thereby alleviating symptoms and preventing further slippage (6,7). Transforaminal Lumbar Interbody Fusion (TLIF) and posterior decompression have emerged as pivotal surgical interventions for spondylolisthesis. TLIF involves the removal of a portion of the bone from the back of the spine (lamina) to relieve nerve compression, followed by the fusion of the vertebrae using a cage and bone graft (8,9). This technique is designed to restore spinal stability and alignment while minimizing trauma to spinal structures. Posterior decompression, on the other hand, focuses on relieving pressure on spinal nerves. These methods have been observed to enhance neurological recovery, reduce pain, and improve patient functionality (10). Recent studies have underscored the efficacy and safety of TLIF and posterior decompression in treating spondylolisthesis. For instance, a study demonstrated significant reductions in slip angle and pain scores post-operation, with an 86.66% fusion rate achieved using TLIF combined with stabilization (11). However, despite these advances, gaps remain in current research, particularly regarding long-term outcomes and the comparative effectiveness of different surgical techniques. The rationale for this observational study is anchored in these research gaps. By focusing on the clinical and functional outcomes of TLIF using cage and bone graft combined with stabilization, this study aims to provide deeper insights into the effectiveness of these surgical interventions. The potential impact of these findings is substantial, offering the possibility of refining treatment protocols and improving patient outcomes in spondylolisthesis management. The objectives of this study are to evaluate the efficacy and reliability of posterior decompression and TLIF in patients with spondylolisthesis, specifically assessing pain reduction, functional recovery, and fusion rates. By doing so, the study aims to contribute valuable data to the existing body of knowledge, aiding in the

optimization of treatment strategies for this prevalent spinal disorder.

METHODS & MATERIALS

This prospective observational study was conducted at the National Institute of Traumatology and Orthopedic Rehabilitation (NITOR) in Dhaka, Bangladesh, from January 2020 to December 2021. The study aimed to evaluate the efficacy of posterior decompression and transforaminal lumbar interbody fusion (TLIF) using both cage and bone graft in patients with spondylolisthesis. A purposive sampling technique was employed, selecting 15 patients based on a calculated sample size formula considering a 95% confidence interval and a 10% allowance for missing values. The inclusion criteria were patients over 40 years of age with degenerative lumbar spondylolisthesis of grade I or II, radiologically proven instability, and severe back or leg pain unresponsive to medical treatment for three consecutive months or progressive neurological deficit. Exclusion criteria included severe systemic disease, spondylolisthesis due to neoplastic, traumatic, infective conditions, dysplastic spondylolisthesis, and high-grade spondylolisthesis (Grade III, IV, and V). The surgical procedure involved pre-operative evaluation of patients, followed by surgery and a post-operative regimen of antibiotics. Patients were discharged on the 4th post-operative day and followed up at 2 weeks, 3 months, 6 months, and 1-year. During each follow-up, radiological, clinical, and functional assessments were conducted. The follow-up was performed clinically using the visual analog scale (VAS) and Oswestry Disability Index (ODI) Questionnaires, and the overall outcome was measured using Macnab criteria (12,13). Data were collected using a structured questionnaire and analyzed using SPSS version 23.0. The study received approval from the Institutional Review Board of NITOR, and ethical considerations included obtaining written informed consent from each patient, ensuring voluntary participation, and maintaining confidentiality.

RESULTS

Table – I: Distribution of participants by baseline characteristics (n=15)

Variables	n	%
Age		
40-44	5	33.33%
45-49	6	40.00%
50-54	4	26.67%
Gender		
Male	6	40.00%
Female	9	60.00%
Level of Spondylolisthesis		
L1/L2	0	0.00%
L2/L3	0	0.00%
L3/L4	0	0.00%
L4/L5	9	60.00%
L5/S1	6	40.00%

Age distribution among the participants showed a relatively even spread across the middle-aged group. Participants aged between 40-44 years constituted 33.33% (n=5) of the sample. The largest age group was 45-49 years, representing 40.00% (n=6) of the participants, while those aged 50-54 years comprised 26.67% (n=4) of the study population. Regarding gender distribution, the study had a higher representation of females, with 60.00% (n=9) of the participants being female, compared to 40.00% (n=6) who were male. The level of spondylolisthesis among the participants was concentrated in the lower lumbar region. None of the participants had spondylolisthesis at the L1/L2, L2/L3, or L3/L4 levels. The majority of the cases were found at the L4/L5 level, accounting for 60.00% (n=9) of the cases. The remaining 40.00% (n=6) of the participants had spondylolisthesis at the L5/S1 level.

Table – II: Changes in slip-angle pre-operatively and at 1-year follow-up (n=15)

Timeframe	Mean ± SD	p-value
Degree of slip-angle		
Pre-operative	15.2 ± 1.32°	<0.05
1-year after surgery	7.73 ± 1.03°	
Percentage of slip-angle		
Pre-operative	27.37±1.87%	<0.05
1-year after surgery	12.79±0.96%	

Regarding the degree of slip-angle, the mean pre-operative slip-angle was 15.2 ± 1.32 degrees. This value significantly decreased to 7.73 ± 1.03 degrees at the 1-year post-operative follow-up. The reduction in the slip-angle demonstrates the effectiveness of the surgical intervention in correcting spinal alignment. The statistical significance of this improvement is indicated by a p-value of less than 0.05. Similarly, the percentage of slip-angle also showed a notable decrease following surgery. Pre-operatively, the mean percentage of slip-angle was recorded at 27.37 ± 1.87%. This value reduced to 12.79 ± 0.96% at the 1-year follow-up. The decrease in the percentage of slip-angle further corroborates the positive impact of the surgical procedure on spinal stability. The statistical significance of this change is also supported by a p-value of less than 0.05.

Table – III: Mean disc space height pre-operatively and 1-year after surgery (n=15)

Timeframe	Mean ± SD	p-value
Pre-operative	07.33±1.05	<0.05
1-year after surgery	11.1±1.77	

Pre-operatively, the mean disc space height was recorded at 7.33 ± 1.05 mm. This measurement significantly increased to 11.1 ± 1.77 mm at the 1-year post-operative follow-up. The increase in disc space height is indicative of the effectiveness of the surgical intervention in restoring the normal anatomy of the spine. The statistical significance of this improvement is underscored by a p-value of less than 0.05.

Table – IV: Comparison of pain evaluation by VAS-score pre-operatively and at 1-year follow-up (n=15)

Timeframe	Mean ± SD	p-value
Back-pain		
Pre-operative	7.1±0.46	<0.05
Six months after surgery	2.2±0.56	
Leg-pain		
Pre-operative	6.6±0.51	<0.05
1-year after surgery	1.27±0.46	

For back pain, the mean pre-operative VAS score was 7.1 ± 0.46, indicating a high level of pain experienced by the patients prior to the surgery. At the 1-year post-operative follow-up, there was a significant reduction in the mean VAS score for back pain, which decreased to 2.2 ± 0.56. This substantial decrease in the VAS score for back pain, with a p-value of less than 0.05, signifies the effectiveness of the surgical intervention in alleviating back pain symptoms. Similarly, the mean pre-operative VAS score for leg pain was 6.6 ± 0.51, reflecting considerable discomfort in the patients. Post-surgery, at the 1-year follow-up, the mean VAS score for leg pain significantly reduced to 1.27 ± 0.46. This marked improvement in leg pain, also statistically significant with a p-value of less than 0.05, demonstrates the positive impact of the surgical procedure on reducing leg pain symptoms.

Table – V: Motor Function Assessment Pre-operatively and at 1-year follow-up (n=15)

Motor status	n	%
Pre-operatively		
Motor Deficit Present	5	33.33%
Motor Deficit Absent	10	66.67%
1-year after surgery		
Motor Deficit Present	1	6.67%
Motor Deficit Absent	14	93.33%

Pre-operatively, motor deficits were present in 33.33% (n=5) of the patients. This initial assessment indicates that a significant proportion of the study population experienced motor function impairment prior to the surgical intervention. In contrast, the majority of the patients, 66.67% (n=10), did not exhibit any motor deficits before the surgery. At the 1-year post-operative follow-up, there was a notable improvement in motor function among the patients. The percentage of patients with motor deficits decreased substantially to 6.67% (n=1), indicating a significant recovery in motor function post-surgery. Conversely, the proportion of patients without motor deficits increased to 93.33% (n=14), demonstrating a marked improvement in motor function outcomes following the surgical procedure.

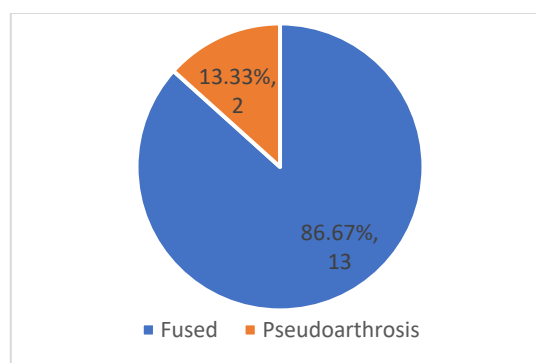


Figure – 1: Fusion status at 1-year follow-up (n=15)

At the 1-year post-operative mark, a significant majority of the patients, 86.67% (n=13), achieved successful spinal fusion. This high fusion rate indicates that the surgical procedure was effective in achieving spinal stability and promoting bone growth, which are essential for the long-term success of TLIF and posterior decompression in treating spondylolisthesis. However, 13.33% (n=2) of the patients developed pseudoarthrosis, a condition where the bone graft does not fuse completely, leading to a non-union. This outcome highlights the challenges and complexities associated with spinal fusion surgeries.

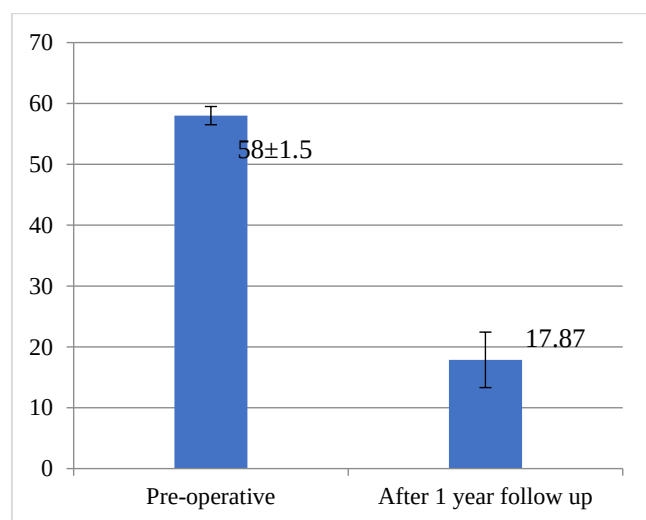


Figure – 2: Functional Outcome by ODI (%) Pre-operatively and 1-year After Surgery

Pre-operatively, the mean ODI score was 58 ± 1.5 , indicating a significant level of disability and impact on daily activities due to back pain. This high score reflects the severe functional impairment experienced by patients prior to undergoing the surgical procedure. At the 1-year post-operative follow-up, there was a notable improvement in the functional outcome, with the mean ODI score significantly decreasing to 17.87 ± 4.56 . This substantial reduction in the ODI score, with a p-value of less than 0.05, signifies a marked improvement in the patients' functional abilities and a decrease in the impact of back pain on their daily activities.

Table – VI: Functional outcome at final follow-up (n=15)

Outcome	n	%
Excellent	11	73.33%
Good	3	20.00%
Fair	1	6.67%
Poor	0	0.00%

At the final follow-up, a significant majority of the patients, 73.33% (n=11), reported an 'Excellent' outcome. This high percentage indicates that the majority of the patients experienced substantial improvement in their condition, likely reflecting significant relief from symptoms, improved mobility, and a return to normal daily activities without major limitations. Additionally, 20.00% (n=3) of the patients rated their outcome as 'Good.' This rating suggests that these patients experienced notable improvements in their symptoms and functionality, albeit with some minor limitations or residual symptoms. A smaller proportion of the study population, 6.67% (n=1), reported a 'Fair' outcome. This category typically indicates moderate improvement with some lingering symptoms or functional limitations that may still affect the patient's quality of life. Notably, none of the patients (0.00%) reported a 'Poor' outcome, which suggests that there were no cases where the condition remained unchanged or worsened following the surgery.

Table – VII: Observed complications at final follow-up (n=15)

Complications	n	%
Superficial infection	2	13.33%
Urinary tract infection	2	13.33%
No Complications	11	73.33%

At the final follow-up, a majority of the patients, 73.33% (n=11), did not experience any complications. This high percentage of patients without complications indicates a favorable safety profile for the surgical procedure, suggesting that it is generally well-tolerated and carries a low risk of adverse events. However, complications were observed in a minority of the patients. Superficial infections were reported in 13.33% (n=2) of the cases. Superficial infections, typically involving the skin or subcutaneous tissue near the surgical site, are relatively common post-operative complications but are generally manageable with appropriate medical intervention. Similarly, urinary tract infections (UTIs) were also reported in 13.33% (n=2) of the patients. UTIs are not uncommon following surgical procedures, particularly those involving the lower spine, and can be effectively treated with antibiotics.

DISCUSSION

In our study, we meticulously evaluated the outcomes of posterior decompression and transforaminal lumbar interbody fusion (TLIF) using both cage and bone graft in patients with spondylolisthesis. Our findings, which resonate with contemporary research in this domain, underscore the efficacy of this surgical approach. A major highlight of our

study was the significant reduction in the degree of slip-angle, from a pre-operative mean of 15.2 ± 1.32 degrees to 7.73 ± 1.03 degrees at the 1-year follow-up, with a statistically significant p-value of <0.05 . This finding is crucial as it directly reflects the success of the surgical intervention in rectifying spinal alignment, a key objective in spondylolisthesis management. Similarly, the percentage of slip-angle showed a notable decrease from a pre-operative mean of $27.37 \pm 1.87\%$ to $12.79 \pm 0.96\%$ post-surgery, also with a significant p-value of <0.05 . These improvements in spinal alignment are consistent with the results reported by few other studies who observed significant reductions in slip angle and VAS scores for back and leg pain post-operation (14,15). Our study also revealed a substantial increase in the mean disc space height, from 7.33 ± 1.05 mm pre-operatively to 11.1 ± 1.77 mm at the 1-year follow-up, indicating successful restoration of spinal anatomy ($p < 0.05$). This increase is critical for alleviating symptoms associated with spondylolisthesis, such as nerve compression and pain. Pain reduction, a primary concern for patients, was significantly achieved in our study. The mean VAS score for back pain decreased from 7.1 ± 0.46 pre-operatively to 2.2 ± 0.56 at the 1-year follow-up, and for leg pain, from 6.6 ± 0.51 to 1.27 ± 0.46 , both with p-values of <0.05 . These findings align with the outcomes observed in other studies, emphasizing the pain-alleviating effect of TLIF and posterior decompression (16,17). The improvement in motor function was another significant outcome, with the proportion of patients with motor deficits decreasing from 33.33% pre-operatively to 6.67% post-operatively. This improvement in neurological function is a testament to the efficacy of the surgical approach. Our study's high fusion success rate of 86.67% at the 1-year follow-up further corroborates the effectiveness of TLIF and posterior decompression in achieving spinal stability. This rate is in line with the findings of other studies, such as that by Jung S et al., which examined fusion rates in different spinal segments (18). In terms of functional outcomes, a majority of our patients reported 'Excellent' or 'Good' outcomes, with 73.33% achieving an 'Excellent' outcome and 20.00% a 'Good' outcome. These results highlight the potential of this surgical approach in enhancing patient quality of life, a finding echoed in the literature (19). However, our study also noted the presence of minor complications, such as superficial infections (13.33%) and urinary tract infections (13.33%), underscoring the importance of vigilant post-operative care. In conclusion, our study provides robust evidence supporting the use of TLIF and posterior decompression in treating spondylolisthesis, demonstrating significant improvements in spinal alignment, pain reduction, motor function, and overall functional outcomes. The high fusion rate and positive functional outcomes further reinforce the benefits of this surgical approach. However, the presence of minor complications calls for careful post-operative management. These findings, in conjunction with comparative literature, offer a comprehensive understanding of the surgical management of spondylolisthesis, guiding future clinical practices and research.

Limitations of The Study

The study was conducted in a single hospital with a small sample size. So, the results may not represent the whole community.

CONCLUSION

In conclusion, our study provides compelling evidence for the efficacy and reliability of posterior decompression and transforaminal lumbar interbody fusion (TLIF) using both cage and bone graft in the treatment of spondylolisthesis. The significant improvements observed in spinal alignment, as evidenced by the reduction in slip angle and percentage, coupled with the increase in disc space height, underscore the anatomical efficacy of this surgical approach. Furthermore, the marked reduction in pain levels and the improvement in motor function highlight the clinical benefits for patients undergoing this procedure. The high fusion rate observed at the 1-year follow-up reinforces the procedure's effectiveness in achieving spinal stability. While minor complications were noted, they were manageable, emphasizing the importance of vigilant post-operative care. Overall, our findings suggest that TLIF and posterior decompression offer a promising surgical option for patients with spondylolisthesis, aiming to improve their quality of life by alleviating pain, restoring function, and enhancing spinal stability.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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