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ORIGINAL ARTICLE

Outcome of Posterior Lumbar Interbody Fusion in Spondylolisthesis with Cage and Bone Graft

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ABSTRACT

Background: *Spondylolisthesis is a common cause of low back pain and neurological symptoms, with approximately 10–15% of patients requiring surgical intervention after failure of conservative treatment. Posterior lumbar interbody fusion (PLIF) with cage and bone graft is a well-established technique that provides spinal stability, high fusion rates, and satisfactory clinical outcomes in appropriately selected patients.* ***Objective:*** *The aim of the study was to evaluate the clinical, radiological, and functional outcomes of posterior lumbar interbody fusion with cage and bone graft in patients with spondylolisthesis.* ***Methods & Materials:*** *This prospective interventional study was conducted in the Department of Orthopaedic Surgery, Dhaka Medical College Hospital (DMCH), Dhaka, Bangladesh, from January 2019 to December 2020. Twenty patients with clinical and radiological spondylolisthesis were included based on predefined criteria. Outcomes assessed included VAS, ODI, MRC grading, Modified Macnab criteria, Hackenberg fusion status, and complications. Patients underwent standard surgical management and were followed for at least 6 months. Data were analyzed using SPSS version 26, with paired t-test applied ($p < 0.05$).* ***Results:*** *Among the 20 patients, the mean age was 42.80 ± 12.10 years, and 12 (60.0%) were female. Significant postoperative improvements were observed in VAS scores, ODI, and motor function, with motor deficits decreasing from 9 (45.0%) to 2 (10.0%). Solid fusion was achieved in 18 (90.0%) patients, superficial surgical site infection occurred in 3 (15.0%), and no cases of pseudarthrosis or implant failure were observed. According to the Modified Macnab criteria, 16 (80.0%) patients had excellent and 4 (20.0%) had good functional outcomes.* ***Conclusion:*** *Posterior lumbar interbody fusion with cage and bone graft is a safe and effective surgical technique that provides significant pain relief, neurological and functional improvement, a high fusion rate, and satisfactory clinical outcomes in patients with spondylolisthesis.*

Keywords: *Posterior Lumbar Interbody Fusion, Spondylolisthesis, Bone Graft, Interbody Cage, Functional Outcome*

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INTRODUCTION

Spondylolisthesis refers to displacement of a vertebral body on the one below, most commonly the lowest lumbar vertebra on the sacrum [1]. The term is derived from the Greek words "Spondylo" meaning spine and "Olisthesis" meaning slip, and it was first described in 1782 by Belgian obstetrician Dr. Herbinaux [2]. On the basis of aetiology, spondylolisthesis is classified into six types: congenital, isthmic, degenerative, traumatic, pathological, and post-surgical [3].

The prevalence of spondylolisthesis in the adult population is approximately 5% [4]. Among these patients, 85–90% respond to conservative treatment, while 10–15% fail non-operative management and require surgical intervention [5]. Compared with non-operative treatment, surgical management of degenerative spondylolisthesis with associated spinal stenosis provides significantly greater pain relief and functional improvement [6].

Spondylolisthesis causes lumbar canal stenosis, leading to compression of spinal nerve roots, which results in intermittent claudication, pain, numbness, and sensory deficits. This compression has been shown to cause neurophysiological dysfunction, degeneration, and reduced blood flow in nerve roots, contributing to neurogenic intermittent claudication [7].

Radiological evaluation is essential in diagnosis, with plain radiographs including anteroposterior, lateral, and oblique views being the initial imaging modality. Although oblique views are most sensitive for diagnosis, lateral views are optimal for assessing the degree of slippage [8].

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Lumbar spinal fusion is an established treatment modality for appropriately selected patients with degenerative lumbar spinal disorders presenting with low back and leg pain. The primary goal of spinal fusion is to achieve solid arthrodesis of unstable segments, thereby relieving pain and restoring spinal function.

Several interbody fusion techniques have been described, including posterior lumbar interbody fusion (PLIF), transforaminal lumbar interbody fusion (TLIF), anterior lumbar interbody fusion (ALIF), oblique lumbar interbody fusion (OLIF), extreme lateral lumbar interbody fusion (XLIF), and circumferential 360° fusion [9]. Among these, PLIF with instrumentation is considered one of the most biomechanically stable and widely used techniques for achieving fusion [10].

Posterior lumbar interbody fusion (PLIF) was first described by Cloward in 1940 and later modified by Lin. PLIF is performed through a posterior approach and has become widely used for segmental lumbar instability [11]. It provides wide surgical exposure, allows adequate decompression, and is suitable for bilateral symptoms. With instrumentation and posterolateral fusion, reported fusion rates range from 90% to 100%, with satisfactory clinical outcomes [12].

Transforaminal lumbar interbody fusion (TLIF), first described by Harms and Rolinger in 1982, is a modern alternative approach to spinal fusion. It involves removal of the intervertebral disc and insertion of a cage and bone graft via a unilateral approach, minimizing dural and nerve root retraction. By removing one facet joint, it allows safer access to the disc space and is particularly suitable for patients with unilateral symptoms, reducing the risk of nerve injury and muscle disruption [11].

In spinal fusion procedures, various bone graft materials have been used. Autologous iliac crest bone graft is widely used due to its strong osteogenic potential, but it may be associated with donor site morbidity, including pain, increased operative time, blood loss, and infection. Alternatively, local bone obtained from decompression procedures can be used without additional morbidity and provides good fusion potential [13].

Posterior lumbar interbody fusion with cage and autogenous bone graft, combined with posterior stabilization using pedicle screws and rods, is performed through a posterior approach. The aim of the present study was to evaluate the clinical and functional outcomes of posterior lumbar interbody fusion with cage and bone graft in patients with spondylolisthesis.

OBJECTIVE

To evaluate the clinical, radiological, and functional outcomes of posterior lumbar interbody fusion with cage and bone graft in patients with spondylolisthesis.

METHODS & MATERIALS

This prospective interventional study was conducted in the Department of Orthopaedic Surgery, Dhaka Medical College Hospital (DMCH), Dhaka, Bangladesh, over a period of 24 months from January 2019 to December 2020. A total of 20 patients with clinical and radiological evidence of spondylolisthesis were included in the study based on predefined inclusion and exclusion criteria to evaluate the outcomes of posterior lumbar interbody fusion with cage and bone graft.

Inclusion Criteria

- Age between 20–70 years
- Symptomatic spondylolisthesis after at least 3 months of conservative treatment
- Progressive neurological deficit
- Radiologically proven spinal instability

Exclusion Criteria

- Previous lumbosacral spinal surgery
- Severe radiological osteoporosis
- Associated spinal pathology such as tumor, infection, or other lesions

Variables Studied

Demographic Variables:

- Age
- Gender

Clinical Variables:

- Low back pain and leg pain
- Level of spondylolisthesis
- Type of spondylolisthesis
- Grade of spondylolisthesis

Outcome Variables:

- Pain assessment using Visual Analogue Scale (VAS)
- Functional disability using Oswestry Disability Index (ODI)
- Motor power using Medical Research Council (MRC) grading
- Functional outcome using Modified Macnab criteria
- Fusion status using Hackenberg criteria
- Postoperative complications (superficial surgical site infection, pseudarthrosis, implant failure)

Operational Definitions

Low back pain was defined as pain between the costal margin and inferior gluteal fold, with or without leg pain. Spondylolisthesis refers to anterior or posterior displacement of a vertebral body relative to the adjacent inferior vertebra. Posterior lumbar interbody fusion (PLIF), transforaminal lumbar interbody fusion (TLIF), anterior lumbar interbody fusion (ALIF), oblique lumbar interbody fusion (OLIF), and extreme lateral lumbar interbody fusion (XLIF) are established spinal fusion techniques. A C-arm is a mobile fluoroscopic imaging device used intraoperatively for guidance. Motor strength was assessed using the Medical Research Council (MRC) grading system (0–5). Pseudarthrosis refers to failure of bony fusion within one year following spinal fusion surgery. Implant failure refers to mechanical failure of spinal instrumentation such as rods or pedicle screws.

Ethical Consideration

Ethical approval was obtained from the Ethical Committee of Dhaka Medical College prior to study commencement. Informed written consent was obtained from all patients after explaining the study objectives in the local language. Patient confidentiality was strictly maintained. Patients were informed about the cost of imaging and implants, which was borne by the patients themselves. No external financial support was received, and no financial incentives were provided.

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Data Collection and Procedure
Data were collected using a pretested structured questionnaire, including patient history, clinical examination, radiological findings, and perioperative details. Patients were selected from the outpatient department and emergency unit after radiological evaluation and subsequently admitted for surgery. After obtaining informed consent, preoperative data were recorded. Surgical intervention was performed using a standard technique. Postoperative and follow-up data were collected over a minimum period of 6 months, including clinical, radiological, and functional assessments.

Outcome Evaluation
Outcomes were assessed using:

- Visual Analogue Scale (VAS) for pain
- Medical Research Council (MRC) grading for motor power
- Hackenberg criteria for fusion status
- Modified Macnab criteria for functional outcome
- Oswestry Disability Index (ODI) for disability

Data Processing and Analysis
Data were compiled and analyzed using SPSS version 26. Quantitative variables were expressed as mean ± standard deviation, and qualitative variables as frequency and percentage. A paired t-test was used to compare preoperative and postoperative outcomes. A p-value < 0.05 was considered statistically significant.

RESULTS
Table I presents the baseline demographic and clinical characteristics of the study patients. The mean age was 42.80 ± 12.10 years (range, 23–65 years). The largest age group was 41–50 years comprising 8 (40.0%) patients. Females constituted 12 (60.0%) of the study population, while males accounted for 8 (40.0%). The L4–L5 level was involved in 14 (70.0%) patients, and L5–S1 in 6 (30.0%) patients. Lytic spondylolisthesis was the most common type, observed in 10 (50.0%) patients, followed by degenerative in 9 (45.0%) and dysplastic in 1 (5.0%) patient. Grade II spondylolisthesis was present in 11 (55.0%) patients, whereas Grade I was present in 9 (45.0%) patients.

Table I: Baseline Demographic and Clinical Characteristics of the Study Patients (*n* = 20)

Variable		Frequency (n)	Percentage (%)
Age (years)	21–30	4	20.0
	31–40	4	20.0
	41–50	8	40.0
	51–60	3	15.0
	61–70	1	5.0
	Mean ± SD (years)	42.80 ± 12.10	
	Age range (years)	23–65	
Sex	Male	8	40.0
	Female	12	60.0
Level of Listhesis	L4–L5	14	70.0
	L5–S1	6	30.0
Type of Spondylolisthesis	Lytic	10	50.0
	Degenerative	9	45.0
	Dysplastic	1	5.0
Grade of Spondylolisthesis	Grade I	9	45.0
	Grade II	11	55.0

Table II compares the preoperative and postoperative clinical outcome measures of the study patients. The mean VAS score for back pain significantly decreased from 6.80 ± 0.49 preoperatively to 2.30 ± 0.57 postoperatively ($p < 0.001$). Similarly, the mean VAS score for leg pain improved from 6.73 ± 0.55 to 1.35 ± 0.49 ($p < 0.001$). The mean ODI score also showed a significant reduction from 57.70 ± 2.18 preoperatively to 16.60 ± 3.36 postoperatively ($p < 0.001$).

Table II: Comparison of Preoperative and Postoperative Clinical Outcome Measures of the Study Patients (*n* = 20)

Outcome Measure	Preoperative Mean ± SD (Range)	Postoperative Mean ± SD (Range)	p value
VAS for back pain	6.80 ± 0.49 (6.0–8.0)	2.30 ± 0.57 (1.0–3.0)	<0.001
VAS for leg pain	6.73 ± 0.55 (6.0–8.0)	1.35 ± 0.49 (1.0–2.0)	<0.001
ODI	57.70 ± 2.18 (54–62)	16.60 ± 3.36 (12–25)	<0.001

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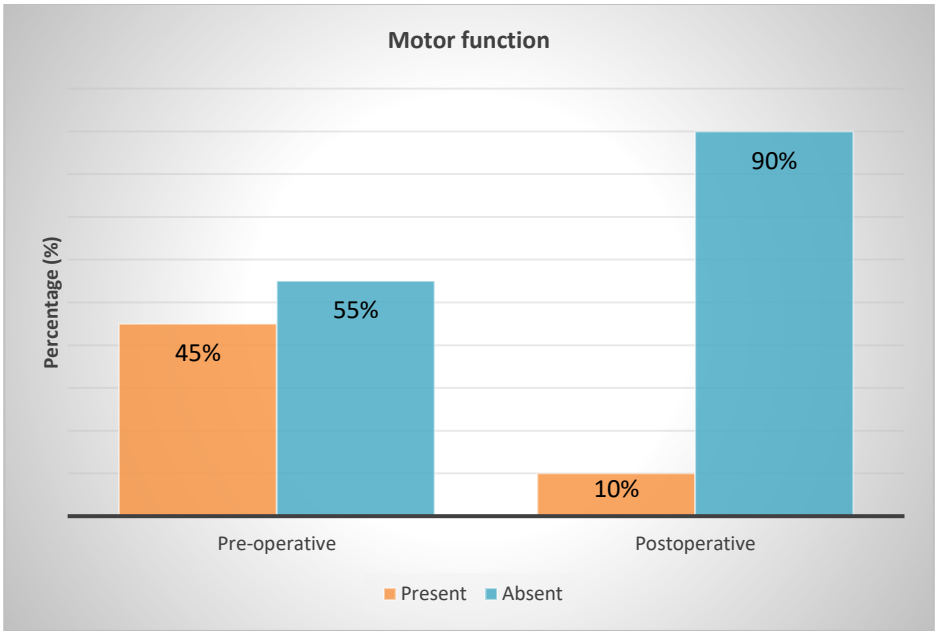

Figure 1: Comparison of Preoperative and Postoperative Motor Function Among the Study Patients (*n* = 20)

Figure 1 compares the motor function of the study patients before surgery and at six months postoperatively. Preoperatively, 9 (45.0%) patients had motor deficits, as assessed using the Medical Research Council (MRC) grading system, which decreased to 2 (10.0%) patients at the six-month follow-up.

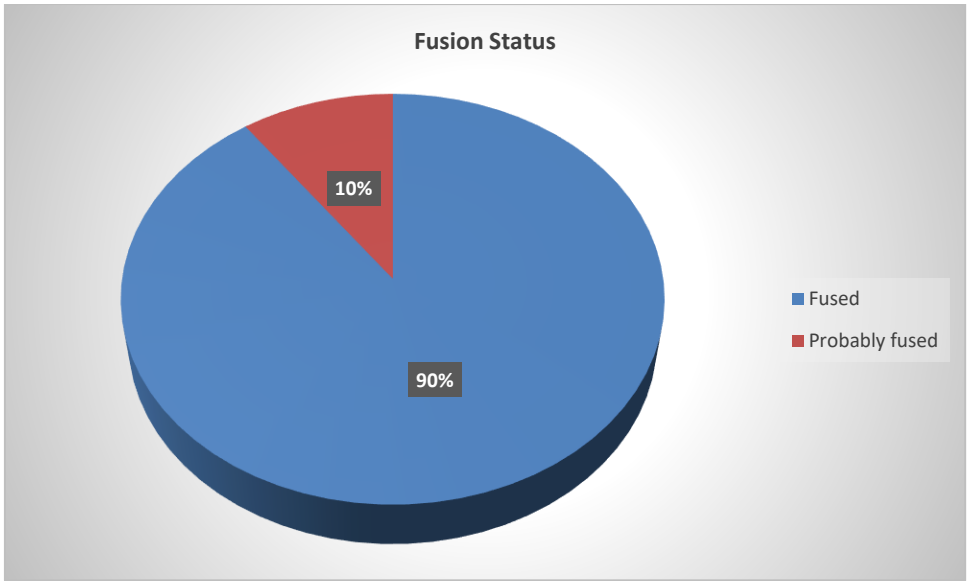

***Figure 2*: Postoperative Fusion Status of the Study Patients (*n* = 20)**

Figure 2 illustrates the postoperative fusion status of the study patients. Solid fusion was achieved in 18 (90.0%) patients, while 2 (10.0%) patients were categorized as probably fused.

Table III presents the postoperative complications among the study patients. Overall, 17 (85.0%) patients experienced no postoperative complications, whereas 3 (15.0%) patients developed superficial surgical site infection. No cases of pseudarthrosis or implant failure were observed.

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Table III: Postoperative Complications Among the Study Patients (*n* = 20)

Complication	Frequency (n)	Percentage (%)
No complication	17	85.0
Superficial surgical site infection	3	15.0
Pseudarthrosis	0	0.0
Implant failure	0	0.0
Total	20	100.0

Table IV presents the functional outcomes of the study patients according to the Modified Macnab criteria. At the final follow-up, 16 (80.0%) patients achieved an excellent outcome and 4 (20.0%) patients achieved a good outcome. No patients had fair or poor functional outcomes.

Table IV: Functional Outcome According to Modified Macnab Criteria Among the Study Patients (*n* = 20)

Modified Macnab Criteria	Frequency (n)	Percentage (%)
Excellent	16	80.0
Good	4	20.0
Fair	0	0.0
Poor	0	0.0
Total	20	100.0

DISCUSSION

In this study, posterior lumbar interbody fusion (PLIF) with cage, bone graft, and pedicle screw instrumentation for the treatment of spondylolisthesis resulted in significant clinical and functional improvement. The procedure achieved satisfactory fusion and spinal stability and was associated with low rates of intraoperative and postoperative neural complications.

Regarding age and gender distribution, Alam et al. reported a mean age of 56.6 years, with 6 male and 22 female patients [14]. Another study by Alam et al. reported that, among a total of 82 patients, 51 were female and 31 were male, with a mean age of 59 years (range, 41–76 years) [15]. The age and gender distribution observed in the present study are comparable with those reported in the above-mentioned studies.

Sahoo et al. reported that the L4–L5 level was the most common site of slip, accounting for 55% of cases [16]. Grade I spondylolisthesis was observed in 60% of patients, Grade II in 35%, and Grade III in 5%, which is comparable to the findings of the present study. Gupta et al. reported that, among 18 patients, the most commonly affected level was L4–L5 (55.6%), followed by L5–S1 (44.4%) [17]. Similarly, Park et al. reported that, among 40 patients, 32 had Meyerding Grade I spondylolisthesis, whereas 8 had Grade II slippage [18]. These findings are comparable with those of the present study.

Regarding the type of spondylolisthesis, Rezk et al. demonstrated that, among 46 patients, 58.7% had degenerative and 41.3% had isthmic spondylolisthesis [19]. Elsayed et al. reported that, among 21 patients, 6 had lytic and 4 had degenerative spondylolisthesis [20]. In the present study, lytic spondylolisthesis was the most common type, which is comparable with the findings of these studies.

Both Yan et al. and Sakeb et al. reported significant improvement in VAS scores for both back pain and leg pain during the postoperative follow-up period [13, 20]. In the former study, VAS scores improved from 7.18 ± 1.09 to 1.84 ± 0.91 for back pain and from 6.88 ± 1.21 to 1.34 ± 0.97 for leg pain [13]. In the latter study, VAS scores improved from 7.25 ± 1.04 to 2.25 ± 0.55 for back pain and from 5.25 ± 0.52 to 1.75 ± 0.79 for leg pain [20]. These findings are comparable with those of the present study. The improvement in back and leg pain following surgery may be attributed to adequate decompression of the stenosed neural elements and stabilization of the affected spinal segment through instrumentation.

Regarding the Oswestry Disability Index (ODI), the mean preoperative score in the present study was 57.70 ± 2.18, which improved to 16.60 ± 3.36 after six months of follow-up. This improvement is comparable with the findings of several previous studies and may be attributed to pain relief, early postoperative mobilization, and physiotherapy. Elsayed et al. reported that the mean ODI improved from 65.4 ± 11.1 before surgery to 30.8 ± 6.3 after six months of follow-up [20]. Hackenberg et al. demonstrated that, among 52 patients, the mean ODI improved from 41.6 preoperatively to 17.9 after six months [21]. Similarly, Sakeb et al. reported a highly significant improvement in ODI from 60.75 ± 11.37 to 11.25 ± 2.91, which is also comparable with the findings of the present study [20].

Regarding fusion status, Alam et al. and Chaoliang et al. reported results similar to those observed in the present study [14, 22]. In the former study, bony fusion occurred in 82.14% of patients, while fibrous union occurred in 2 of 28 patients [14]. In the latter study, bony fusion was achieved in 94.05% of patients (79 of 84) [22]. In the present study, solid fusion was achieved in 90% of patients. This favorable fusion rate may be attributed to packing the anterior disc space with autogenous bone graft before cage insertion, thereby promoting successful interbody fusion.

Regarding postoperative complications, 15% of patients in the present study developed superficial surgical site infection, which was successfully managed with regular wound dressing and appropriate antibiotic therapy. Sahoo et al. reported that 9% of patients developed postoperative infection that responded well to antibiotic treatment, while one patient developed transient postoperative foot drop, which resolved during follow-up [16]. Nayak et al. reported significant postoperative complications in 5.4% of 56 patients [23]. These included one case of wound infection that resolved after five days of intravenous antibiotic therapy, one case of deep vein thrombosis, and one case of cauda equina syndrome resulting from inadvertent intraoperative retraction of the dural sac.

Pseudarthrosis is one of the most common complications of interbody fusion, with a reported incidence ranging from 5% to 45%. In the present study, no cases of pseudarthrosis were observed. However, diagnosis of pseudarthrosis generally requires a follow-up period of at least 12 months. Similarly, Mehta et al. reported pseudarthrosis in two (2.60%) patients [24]. Sakeb et al. reported pseudarthrosis in five patients who underwent PLIF and in two patients who underwent TLIF [20].

The overall functional outcome was assessed using the Modified Macnab criteria, which evaluate relief of back and leg pain, return to work, restriction of physical activities, and the requirement for analgesics following lumbar spine fusion. In the present study, 80% of patients achieved an excellent outcome, while the remaining 20% achieved a good outcome. The favorable clinical outcome may be attributed to stabilization of the motion segment, adequate neural decompression, restoration of disc height, and maintenance of sagittal alignment achieved through this surgical procedure. Periasamy et al. reported 85.3% excellent, 12.0% fair, and 2.7% poor outcomes, which are comparable with the present findings [25]. Similarly, Sahoo et al. reported that 80% of patients had excellent, 15% had good, and 5% had poor outcomes [16]. Alam et al. also reported excellent outcomes in 84% of patients, good outcomes in 6%, fair outcomes in 5%, and poor outcomes in 5%, which are comparable with the results of the present study [15].

LIMITATIONS

There are some limitations in this study.

- This study had a relatively short follow-up period.
- Patient follow-up was challenging due to the COVID-19 pandemic.
- The study was conducted at a single center, and the sample represented only a specific population group of the country.

CONCLUSION

The present study demonstrated significant improvements in postoperative outcomes, including low back pain, leg pain, motor deficit, functional disability, radiological fusion, and overall functional outcome after a minimum follow-up of six months. Significant reductions were observed in the mean preoperative and postoperative VAS scores for low back and leg pain, as well as in the ODI score. Motor deficits improved markedly following surgery, and radiological fusion was achieved in the majority of patients. The overall functional outcome, assessed using the Modified Macnab criteria, was satisfactory and comparable with that reported in previous studies. The rate of postoperative complications was low, with only superficial surgical site infections observed. These findings suggest that posterior lumbar interbody fusion with cage and bone graft is an effective and safe surgical technique that provides anatomical, clinical, and functional recovery, relieves pain, and facilitates early rehabilitation.

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CONFLICTS OF INTEREST

There are no conflicts of interest.

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