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Functional & Clinical Outcomes of Posterior Decompression & Transforaminal Lumbar Interbody Fusion (TLIF) Using Cage and Bone Graft Combined with Stabilization in Lumbar Spondylolisthesis

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Abstract **Original Research Article**

Introduction: Posterior decompression and transforaminal lumbar interbody fusion (TLIF) using cage and bone graft is a surgical technique for treating lumbar spondylolisthesis. This procedure aims to relieve spinal pressure and stabilize the affected vertebral segments. ***Aim of the study:*** The aim of this study was to assess the clinical and functional outcomes of posterior decompression & transforaminal lumbar interbody fusion (TLIF) using cage and bone graft combined with stabilization in lumbar spondylolisthesis. ***Methods:*** This prospective observational study was carried out at NITOR, Dhaka, Bangladesh, during the period from January 2020 to December 2021. Total 15 patients with degenerative lumbar spondylolisthesis were included in this study. ***Result:*** The study assessed 15 patients undergoing surgery for spondylolisthesis, primarily aged 40-49, with a mean age of 46.4 years. Gender distribution was 40% male, 60% female. Pre-operative spondylolisthesis was mostly at L4/L5 (60%) and L5/S1 (40%). Post-op data showed significant reductions in slip angle and VAS scores for back and leg pain (all $P<0.05$). Foraminal and disc space height increased. Fusion rate was 86.66% per Hackenberg criteria. Motor deficit improved from 33.3% to 6.7% post-op. According to Macnab criteria, 73% had excellent functional outcomes and 26.66% experienced minor complications; no major complications were recorded. ***Conclusion:*** As observed from the result of this study, degenerative lumber spondylolisthesis can be treated with posterior decompression and transforaminal lumbar interbody fusion by using cage and bone graft with spinal stabilization. This method enhances neurological recovery, reduces pain and makes the patients able to return to work comfortably.

Keywords: Functional & Clinical Outcomes, Posterior Decompression, Transforaminal Lumbar Interbody Fusion (TLIF), Cage & Bone Graft Combined, Stabilization, and Lumbar Spondylolisthesis.

I. INTRODUCTION

Spondylolisthesis is known as an anatomical defect, commonly seen in the lower lumbar vertebrae. It is the anterior displacement of one vertebra relative to the subjacent vertebra. This defect mostly happens at levels L4–L5 and L5– S1 [1]. In 1989, Wiltse and Rothman [2], separated the post-surgical type from the pathologic type producing 6 different classifications that is congenital, isthmic, degenerative, traumatic, pathologic and post-surgical, which is the common form used today. Degenerative and isthmic spondylolisthesis are the most common in adults. Both can lead to compression and instability, which result in radicular and low back pain [3]. The prevalence of spondylolisthesis and

spondylolysis in general population is 6%. [4]. Among them, in 85%-90% cases can be treated conservatively and the remaining 10-15% requiring surgical intervention [5]. Controlled clinical studies comparing conservative and surgical treatment are rare and there are few reports on long-term results. The outcome of those studies favors surgical management over conservative treatment [6]. When conservative treatment fails, surgical procedures may include decompression, posterior, anterior or circumferential arthrodesis, and rigid or semi-rigid instrumentation [7]. Decompression primarily relieves radicular symptoms and neurogenic claudication whereas fusion primarily relieves back pain by elimination of instability [8]. The main objective of surgery in degenerative spondylolisthesis is to improve neurologic functional symptoms. As symptoms are directly related to radicular compression, decompression seems the logical attitude. However, hypermobility and slippage aggravate compression and stabilization of the involved level with decompression may also be considered [9]. Surgical fusion is a crucial method for stabilizing the spine in cases of lumbar spondylolisthesis; it is used to reduce the pain in patients with chronic low back pain [3]. Several procedures have been described for interbody fusion with or without instrumentation: posterior lumbar interbody fusion (PLIF), anterior lumbar interbody fusion (ALIF), circumferential 360o fusion (front and back) and more recently, the transforaminal lumbar interbody fusion (TLIF) [10]. Both the posterior (PLIF) and the anterior (ALIF) approaches for lumbar interbody fusion have been reported to be associated with specific problems. ALIF procedures require a trans- or retroperitoneal approach to the spine. This is associated with the risk of retrograde ejaculation, injury of large vessels and a longer rehabilitation period [11]. The PLIF procedures are limited to the segments L3–S1 because of the risk of spinal cord damage during necessary retraction maneuvers. Per-operative nerve root injury, dural injury, high rates of epidural blood loss, Postoperative arachnopathy, peridural fibrosis are being reported with PLIF procedures [12]. The transforaminal lumbar interbody fusion (TLIF) represents an alternative surgical technique avoiding both the anterior approach and the approach through the spinal canal. Similar to the previously performed PLIF and ALIF the indications for the TLIF included isthmic and degenerative spondylolistheses irresponsive to conservative treatment [13].

In TLIF procedure, restoration of the segmental stability by adequate neural decompression, fusion, and stabilization helps to improve clinical symptoms and achieve normal spinal anatomy. Failure of restoration spinal stability can result in inadequate clinical improvement potentially leading to poor long term results [14]. The increased foraminal height and disc height, which can be achieved successfully by TLIF procedure, effectively decompresses the nerve roots and restores lumbar lordosis which ultimately maintains the lumbar sagittal profile [15]. Restoration of local and regional lordosis ultimately achieves clinical and biomechanical stability [16]. TLIF approaches the disc space through far lateral portion of the vertebral foramen, which ultimately reduces the thecal manipulation and the chances of complications [13]. Aim of the presented study is to evaluate whether the TLIF with cage and instrumentation is effective regarding clinical and functional outcome, fusion rate, structural restoration and complications in treatment of spondylolisthesis.

II. OBJECTIVES

To see the clinical and functional outcomes of posterior decompression & transforaminal lumbar interbody fusion (TLIF) using cage and bone graft combined with stabilization in lumbar spondylolisthesis.

III. METHODOLOGY & MATERIALS

This prospective observational study was carried out at NITOR, Dhaka, Bangladesh**,** during the period from January 2020 to December 2021. Total 15 patients with degenerative lumbar spondylolisthesis were included in this study. Consent of the patients and guardians were taken before collecting data. After collection of data, all data were checked and cleaned. After cleaning, the data were entered into computer and statistical analysis of the results being obtained by using windows-based computer software devised with Statistical Packages for Social Sciences version 22. After compilation, data were presented in the form of tables, figures and charts, as necessary. Numerical variables were expressed as mean and standard deviation, whereas categorical variables were count with percentage. Quantitative data among groups were analyzed by ANOVA test followed by exploration of significant difference between all possible paired group means by Bonferroni test. P value of less than 0.05 was considered statistically significant.

Inclusion Criteria:

1. Age more than 40 years.
2. Degenerative lumbar spondylolisthesis
3. Spondylolisthesis grade I and II.
4. Radiologically proven instability.
5. Severe low back or leg pain or both not responding to medical treatment for consecutive 3 months
6. Progressive neurological deficit

Exclusion Criteria:

1. Severe systemic disease
2. Spondylolisthesis due to neoplastic conditions
3. Spondylolisthesis due to traumatic conditions
4. Spondylolisthesis due to Infective conditions
5. Dysplastic spondylolisthesis
6. High grade spondylolisthesis (Grade III, IV and

V)

IV. RESULT

Table I presents the demographic characteristics of the study patients. Out of 15 patients, 5(33.33%) was 40-44 years old, 6(40%) was 45-49 years old, 4(26.7%) was 50-54 years old and 4(26.7%) was 45-49 years old. The mean age was 46.4±4.2561 years and the lowest and highest ages were 40 and 53 years respectively. Regarding the gender distribution of the study patients, male was found in 6 (40%) cases and female was found in 9 (60%) cases. Table II shows the level of spondylolisthesis. Regarding the pre-operative level of spondylolisthesis grading of the study patients, 9 patients were found at L4/L5which was 60%. Six patients found spondylolisthesis level at L5/S1 which was 40%. Chart 1 demonstrates the slip angle pre-operatively and 1yr after surgery. Slip angle of the patients pre- operatively was 15.2±1.32.1 year after operation, it came down to 7.73±1.03 degree. P value is <0.05. Chart 2 shows that mean disc space height of the patients pre-operatively was 07.33±1.05mm. 1yr after surgery, it increased to 11.1±1.77mm. Chart 3 shows that Foraminal height of the patients pre-operatively was 12.93±0.79mm. 1 yr after surgery, it increased to 14.6±0.91mm. Table III shows the fusion status at last follows up. Fusion was assessed at last follow up according to Hackenberg criteria (2005). According to the criteria, all of the 13 (86.66%) cases had fused & 2(13.34%) cases develop pseudoarthrosis. Table III shows that pain evaluation by VAS pre-operatively and 1yr after surgery. Evaluating the pre- operative and post-operative (1 yr after operation) mean visual analog score (VAS) for back pain, the VAS has come down from 7.1±0.46 to 2.2±0.56. Here, the P value is <0.05. In the study, the pre-operative VAS for leg pain is 6.6±0.51 and after 1 yr follow up is 1.27±0.46. Again, the p value is <0.05. Table IV demonstrates the motor function assessment pre-operatively and 1yr after surgery. Pre-operatively, 5 (33.3%) patient had motor deficit (assessed clinically according to MRC grading). After 1 year of operation, it reduced to 1 (6.7%). Table V presents the final functional outcome and complication of the study subjects (N=15). Regarding the Macnab criteria of the study patients, 11 (73%) was found excellent, 3 (20%) were found good and 1 (7%) was fair at last follow up. In terms of complications, 04 (26.66%) of the patients developed minor complications and none of the patients developed major complication.

Table I: Demographic characteristics of the study patients (N=15).

Characteristics		Frequency	Percentage
Age	40-44	5	33.33
	45-49	6	40
	50-54	4	26.7
	Mean ±SD	46.4±4.26	
	Range	40-53	
Sex	Male	6	40
	Female	9	60

Table II: Level of spondylolisthesis (N=15).

Level of Spondylolisthesis	Frequency	Percentage
L1/L2	0	0
L2/L3	0	0
L3/L4	0	0
L4/L5	9	60
L5/S1	6	40

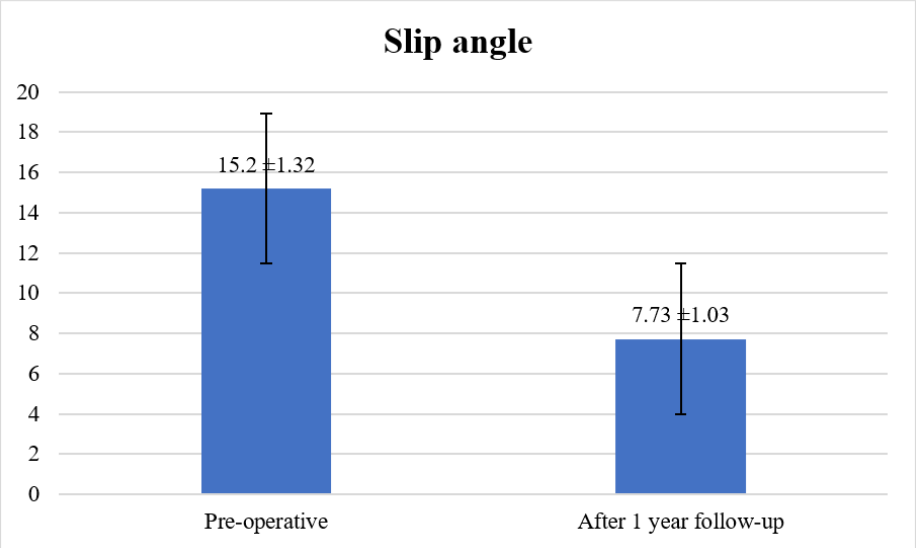

Chart 1: Slip angle pre-operatively and 1yr after surgery (n=15)

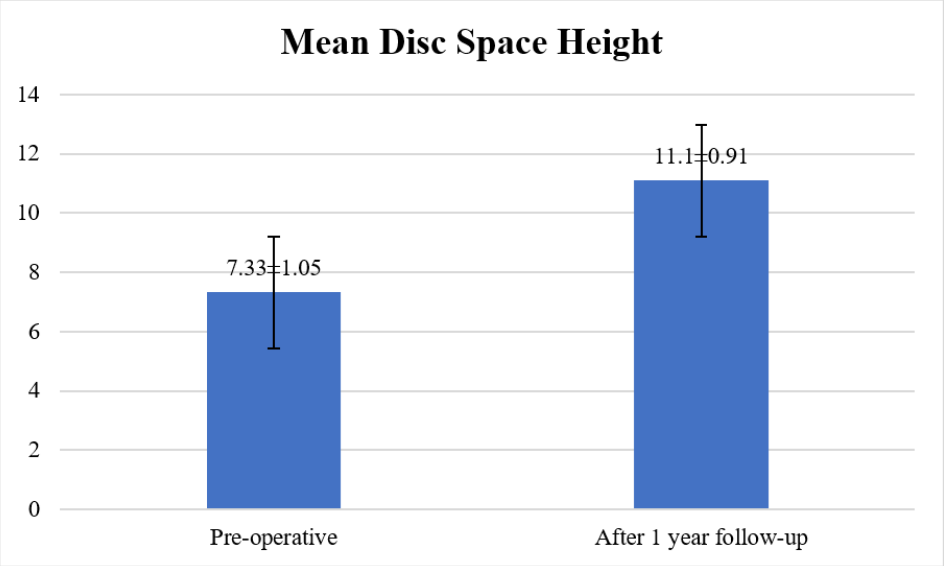

Chart 2: Mean Disc Space Height pre-operatively and 1yr after surgery (n=15)

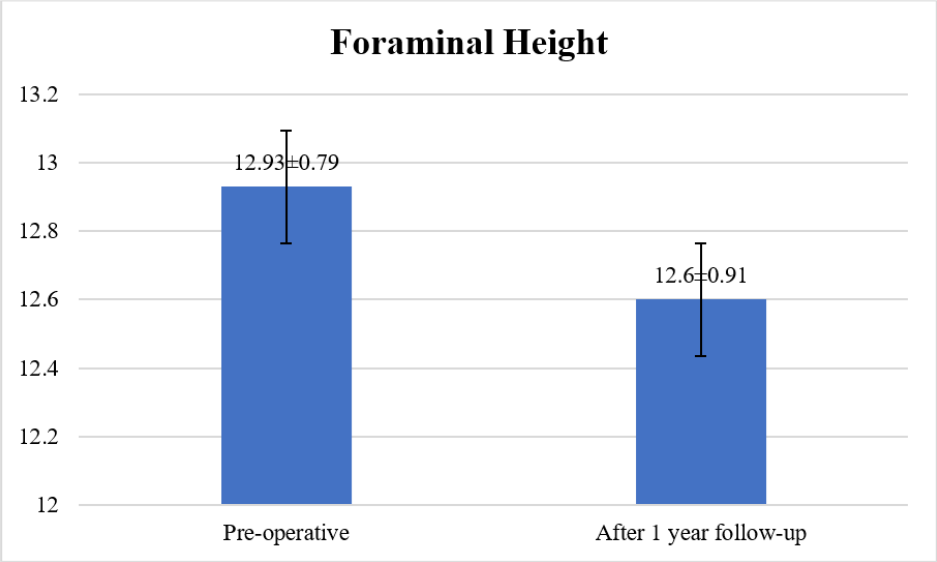

Chart 3: Foraminal Height pre-operatively and 1yr after surgery (n=15)

Table III: Fusion status at last follows up (N=15).

Fusion status	Frequency	Percentage
Fused	13	86.67
Pseudoarthrosis	2	13.34
Total	15	100

Table IV: Pain evaluation by VAS pre-operatively and 1yr after surgery (N=15).

Parameter	VAS score		P-value
	Pre-operative	1 year after surgery	
Back pain	7.1±0.46	2.2±0.56	<0.0001
Leg pain	6.6±0.51	1.27±0.46	<0.0001

Table V: Motor function assessment pre-operatively and 1yr after surgery (N=15).

Parameter	Motor deficit Present	Motor deficit Absent
Pre-operative	5 (33.3%)	10 (66.7%)
1 yr after operation	1 (6.7%)	14 (93.3%)

Table VI: Final functional outcome and complication of the study subjects (N=15).

Parameter		Frequency	Percentage
Final functional outcome	Excellent	11	73
	Good	3	20
	Fair	1	7
	Poor	0	0
Complications	**Minor complication**	**4**	**27**
	Superficial infection	2	13
	Urinary tract infection	2	13
	Major complication	**0**	**0**

V. DISCUSSION

The mean age was 46.4±4.256 years and the lowest and highest ages were 40 and 53 years respectively. In the study of Ali Y [3], mean age of his patients was a 38.7±11.8 year which is comparable to the present study. Regarding the gender distribution of the study patients, male patients were found in 6 (40%) cases and female patients were found in 9 (60%) cases. Degenerative spondylolisthesis is more common in female than in male [17]. In a large retrospective study by Austevoll, *et al.*, [17], they found 69% of their study patients were female which is congruent to the findings of present study. Interbody cages are used to restore the disc height, foraminal height and stabilize the affected segment [18]. These parameters have significant correlation regarding structural restoration and

maintenance of stability [15]. From this study, a significant increase of disc and foraminal height as well as neurological improvement was found. The correction of forward slip restores sagittal alignment and physiological transmission of weight. Inadequate restoration and abnormal lordosis is the primary predisposing factor for adjacent segment degeneration results in chronic low back pain [19]. The percentage of correction of slip in this study had been significant ($P < 0.05$) from 27.37±1.87% to 12.79±0.96%. This study revealed a significant ($P < 0.05$) rise of mean disc height from 07.33±1.05 to 11.1±1.77mm. The mean foraminal height (MFH) increase was recorded from 12.93±0.79 to 14.6±0.91mm, which was also significant ($P < 0.05$). In Sakeb & Ahsan [20], mean disc height (MDH) raised from 07.76 ± 02.77 to 12.24 ± 01.89 mm and mean foraminal height (MFH) increase was recorded from 13.30 ± 1.55 to 17.50 ± 01.87 mm in their 26 patient series, which is comparable to this study. The increased foraminal height effectively decompresses the nerve roots and restores lumbar lordosis which ultimately maintains the lumbar sagittal profile [15]. Restoration of local and regional lordosis ultimately achieves clinical and biomechanical stability [16]. Autografts had been the gold standard for achieving fusion. Placement of autografts anteriorly and impacted before the introduction of cage in all the cases of TLIF with a theoretical background of anterior column load transmission (80%) and enhancement of fusion [21]. The biomechanical concept of "fusion stability" is assessed postoperatively to determine the achievement of stability of fusion area and biomechanically stable spine is achieved only when solid fusion is achieved [22]. Development of pseudarthrosis is one of the most common (range, 05-45%) complications of interbody fusion. In this study after 1 yr follow up period ,13patients 86.67% achieved fusion & 2 (13.34%) patients develop pseudoarthrosis, by using Hackenberg criteria which is comparable to Mehta, *et al.,* [23], where Pseudarthrosis was present in two (2.60%) patients in their TLIF series. In this series improvement of pain status measured by Visual Analog Score (VAS) is, back pain improvement from 07.1 ± 0.46 to 02.2 ± 0.56 and leg pain improvement from 06.6 ± 0.51 to 01.27 ± 0.46, p value of both of which is <0.05 which is statistically significant. In initial series of Yan, *et al.,* [24], the improvement of VAS score of back pain was 07.18 ± 01.09 to 01.84 ± 0.91 and leg pain improvement was 06.88 ± 01.21 to 01.34 ± 0.97, both of which is comparable to this study. According to Audat, *et al.,* [25], excellent outcome had been observed around 70% cases in TLIF by using Macnab criteria, which was also comparable to this study where excellent outcome is 73%, 20% is good and 7% is fair. The overall satisfactory clinical outcome was not measured by the same criteria in different literatures but even then, the overall outcome had also been similar [20]. TLIF approaches the disc space through far lateral portion of the vertebral foramen, which ultimately reduces the thecal manipulation and the chances of complications [13]. In this study, there was no iatrogenic durotomy and root injury or other major complications. Two cases (26.67%) had superficial wound infection that had been managed with intravenous antibiotics following culture sensitivity (*Staphylococcus aureus*) and regular dressing, and the wound was later healed with secondary intention. These complications are comparable with the Sakeb & Ahsan [20], in their series there was also only two case superficial wound infection managed accordingly without compromise the functional outcome.

Limitations of the Study

This is a single centered study with only 1 year follow up. As a result, long term complications like pseudarthrosis requiring revision, adjacent segment degeneration and implant failure could not be evaluated. Foraminal widening and fusion assessment needs CT evaluation, but was ignored due to patients' financial constraints. T2-weighted kinetic MRI and three-dimensional CT reconstruction had been recommended for a precise diagnosis of lumbar spinal instability, but these could not be performed due to unavailability of expertise. Due to COVID 19 pandemic situation, follow-up could not be done properly. Patients from long distance residence often lost follow up timely

VII. CONCLUSION AND RECOMMENDATIONS

As observed from the result of this study, degenerative lumber spondylolisthesis can be treated with posterior decompression and transforaminal lumbar interbody fusion by using cage and bone graft with spinal stabilization. This method enhances neurological recovery, reduces pain and makes the patients able to return to work comfortably.

From the study, it can be recommended that posterior decompression and transforaminal lumbar interbody fusion procedure may be safely implemented in our setting like NITOR for low grade degenerative lumber spondylolisthesis. A randomized controlled trial can be done with long term follow up, larger sample and should include advance imaging technology.

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