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Case Series

Posterior lumbar interbody fusion with single cage and bonegraft substitute for the management of spondylolisthesis: A prospective study

Sameerchaitanya Sahini[1]*

[1]Dept. of Arthroscopy, Dr. NTR University of Health Sciences, Vijayawada, Andhra Pradesh, India

Abstract

Purpose: Posterior lumbar interbody fusion (PLIF) is one of the surgical treatment options for spondylolisthesis. We assess the results of spondylolisthesis treated by PLIF with single cage and bone graft substitute (calcium phosphate granules of master graft, MEDTRONICS) in terms of radiological union, relief of previous symptoms like back pain & radiating pain and return to daily activities.

Materials and Methods: A total of 30 patients were studied from December 2017 to January 2022, out of which 09 were male and 21 were female. The range of age between 40 to 60 years was included in this prospective study. All patients were followed-up for a period of 5 years. Eighteen (60%) patients had degenerative spondylolisthesis, 12 (40%) had isthemic spondylolisthesis. According to Meyerding criteria there were 19(63.33%) cases of grade II, 11 (36.66%) cases of grade III spondylolisthesis.

Results: Clinical score assessed by Oswestry low back pain disability questionnaire, Prolo score and VAS score. Oswestry disability index score improved from mean value of 29.33 points to 9.63 points, Prolo score improved from mean of 3.2 to 8.3 and VAS score improved from mean value of 8.42 to 1.14 at 5 years follow-up period. The radiological assessment of the intervertebral disc height, pre-operatively it was 16.93 (mean) and at follow up it was 24.64. Clinical assessment shows excellent results in 7 patients (23.33%), 20 patients (66.66%) got good results, 3 patients (10%) belonged to the fair group. 93.33% of radiological spinal fusion observed in this study according to Stauffer and Coventry criteria.

Conclusion: Posterior lumbar interbody fusion (PLIF) with single titanium cage and bone graft substitute (calcium phosphate granules of master-graft, MEDTRONICS) is a better method in the treatment of spondylolisthesis because it provides a good spinal fusion, minimal surgical time and fewer complications with satisfactory clinical outcome.

Level of evidence: Level IV, therapeutic case series.

Keywords: Spondylolisthesis, Posterior lumbar interbody fusion, Single cage and bone graft substitute, Spinal instrumentation.

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1. Introduction

Spondylolisthesis[1,2] is the subluxation of a vertebral body over another in the sagittal plane. Pathophysiology can be traumatic, ligamentous laxity, a defect in the pars interarticularis, previous spine surgery. Surgical treatment is indicated for cases with severe low back pain with failed of conservative management, presence of neurological symptoms with radiological instability, worsening of the spondylolisthesis and spondyloptosis. Cloward[1] first introduce the posterior lumbar interbody fusion (PLIF) for degenerative disorders of the lumbar spine, the procedure has seen varying degrees of acceptance and there have been numerous adaptations and innovations. The principle is to stabilize the motion segment, decompression of roots & cord, maintain the disc space height and correction of sagittal plane translational and rotational malalignment. The interbody fusion technique[3] restricts motion by placing the graft bone in the centre of the segmental movement. Lumbar interbody fusion is the most reliable technique currently practicing for the lumbar spine. These constructs are biomechanically[4] stronger and they provide axial support.Comparing[5,6] to those with posterolateral arthrodesis, PLIF produces a better biologic fusion in lordotic alignment. The graft[7] material options are autograft from lamina or facet, iliac bone autograft, allograft spacer, or a spacer cage filled with osteoinductive graft material. There are also some reports about the use of bone substitutes[8,9] like rh-BMP2 (Bone

*Corresponding author: Sameerchaitanya Sahini
Email: sameerchaitanyasahini@gmail.com

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Morphogenic Protein) and calcium carbonate or phosphate derivatives. PLIF[10,11] has steep learning curve and technical difficulty. Present study is to assess the functional results of PLIF using single cage[12,13] filled with autograft from lamina and bone graft substitute (calcium phosphate granules of master graft, MEDTRONICS) in 30 patients.

2. Materials and Methods

A prospective study from December 2017 to January 2022, total of 30 patients underwent posterior lumbar interbody fusion (PLIF) with single cage and master graft bone grafting for the management of spondylolisthesis were included in this study and followed for a minimum period of 5 years. Among 30 patients 09 were male and 21 were female and the range of age was 40 to 60 years (mean age 49.6 years). Duration of symptoms was 4.2 years (range: 2 to 6.5). 11 (36.66%) patients had isthmic spondylolisthesis, 19(63.33%) patients had degenerative spondylolisthesis. According to Meyerding grading criteria 19(63.33%) cases were in grade II, 11 (36.66%) cases were in grade III in present study. Inclusion criteria of this study was severe low back or leg pain or both with failed conservative management, degenerative disc disease, spinal stenosis, spondylolisthesis (all grades and all types). The exclusion criteria were post discectomy syndrome, tumours, trauma, infection and fusion of more than 3 levels, revision surgeries and patients treated by alternative techniques like anterior lumbar interbody fusion (ALIF), transforaminal lumbar interbody fusion (TLIF). Preoperative radiographic imaging antero-posterior (AP), lateral, flexion and extension views of lumbosacral spine (**Figure 1**) and also magnetic resonance imaging (MRI) (**Figure 2**) taken in all cases. Posterior lumbar interbody fusion was performed at the L4/L5 level in 19 cases, L5/S1 level in 8 cases, in 3 cases at L3/L4 level. The mean duration of surgery was 2.4 hours. The mean hospital stay was 6.5 days (range: 4 to 12). The graft material used was master graft (calcium phosphate granules, Medtronics) along with autogenous bone harvested from lamina combined with single titanium interbody cage in all patients. They were followed up for a period of 5years. All patients had a clinical and radiological (**Figure 3 and Figure 4**) assessment at 3, 6 and 12 months and further annually. The assessment done by recording of any residual back/leg pain, any change in neurological condition, and any surgical complications.

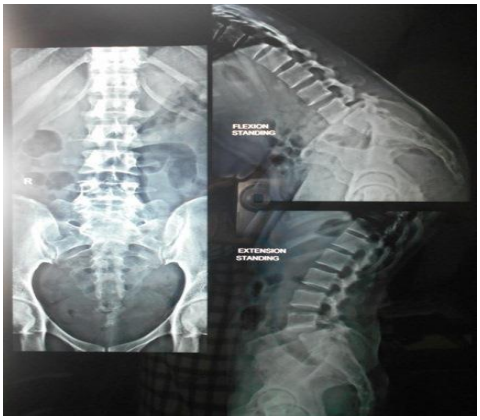

Figure 1: Pre-op x-ray image

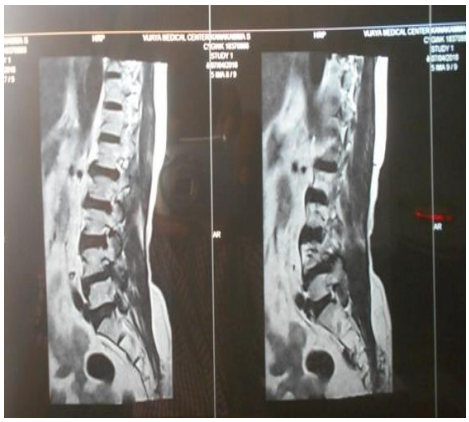

Figure 2: Pre-op MRI image

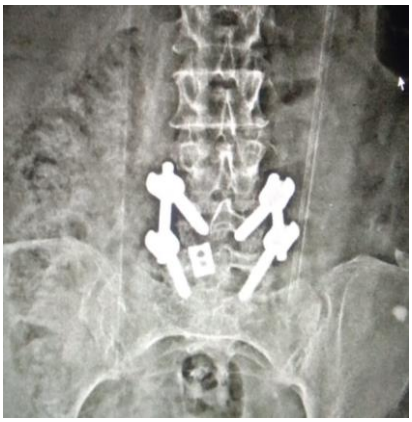

Figure 3: 1 year follow-up x-ray AP view

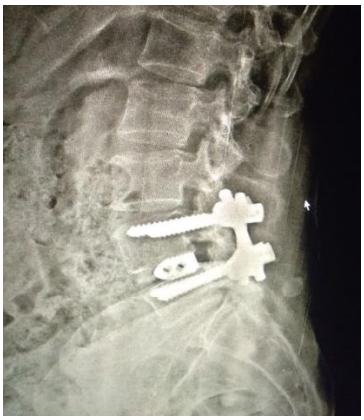

Figure 4: 1 year follow-up x-ray lateral view

2.1. Surgical technique

Under general anaesthesia in prone position on a roll placed beneath the pelvis to obtain a physiological lordosis. Skin incision in mid-line, superficial and deep fascia incised the paraspinal muscles were spread for a standard bilateral interlaminar exposure. Under C-ARM guidance operated level was identified. By intersection method pedicle entry points created with k wires checked under C-arm then pedicle probing and sounding done once the walls are intact all around pedicle then 6.5mm polyaxial screws inserted, one side rod kept and distracted to create working space. Laminectomy done, thickened flavum excised, compressed nerve roots and the thecal sac were completely dissected free from any scar tissue, and discectomy done until the nerve roots were freely mobilized. The endplates were prepared with reamers and curettes to remove any cartilage. PLIF cage trial sizes were placed and checked under fluoroscopy. Artificial bone graft[12] (master graft) was used to pack the disc space and proper single titanium cage with packed bone graft was inserted in the intervertebral disc space. Correct placement of the cage was confirmed by C-ARM (**Figure 5**). On either side rods kept and compressed before final tightening of screws (**Figure 6**).

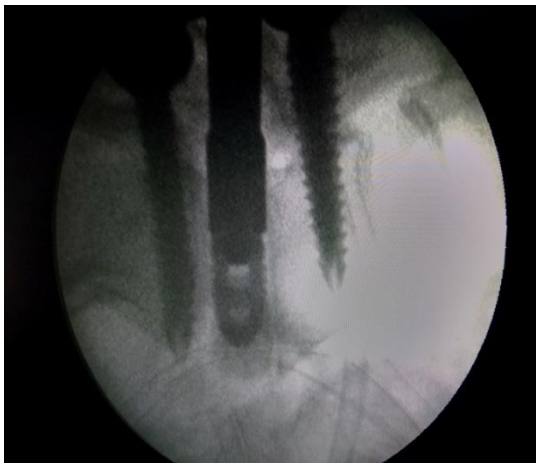

Figure 5: Intra-op image with single cage & master graft

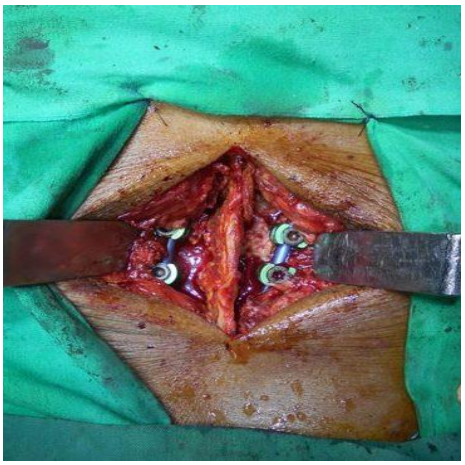

Figure 6: After final tightening of screws

3. Results

Among 30 patients 09 were male and 21 were female **(Figure 7**) and the range of age was 40 to 60 years (mean age 49.6 years) (**Figure 8**). According to Meyerding criteria 19 patients with grade II and 11 patients with grade III listhesis (**Figure 9**). 11 (36.66%) patients had isthmic type, 19(63.33%) patients had degenerative type (**Figure 10**). Clinical score assessed by Oswestry low back pain disability questionnaire,[14] Prolo score[15] and VAS score. The preoperative and 5 years follow-up values of the VAS (Visual Analogue Scale) Pain Score for the 30 patients showed a clear reduction in claudication pain perception. Oswestry disability index score improved from mean value of 29.33 points to 9.63 points and VAS score also improved from mean value of 8.42 to 1.14 at follow-up **(Figure 11**). The radiological[16] restoration of the intervertebral disc height was used as a criterion for a successful PLIF instrumentation. According to the Stauffer and Coventry[17] evaluation criteria were assessed on relief of back and leg pain, return of employment, restriction of physical activities, the clinical outcome (**Figure 12**) was reported as excellent in 7 patients (23.33%), good in 20 patients (66.66%) and fair in three patients (10%) and spinal fusion 93.33% obtained. Pre-operatively the mean value of disc space height was 16.93 and at 5 year follow up it were 24.64 (**Figure 13**). Among 30, two patients (6.6%) got superficial infection which was treated by regular dressing and Intravenous (IV) antibiotics. No patient had any complications like cerebrospinal fluid (CSF) leakage and neurological deficits post-operatively. Statistical analysis (**Table 1**) shows p value of 0.00003 (< 0.05) and paired sample t test shows t value of 4.991.

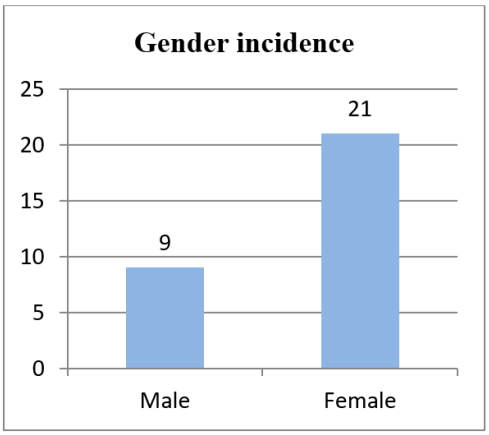

Figure 7: Showing gender incidence

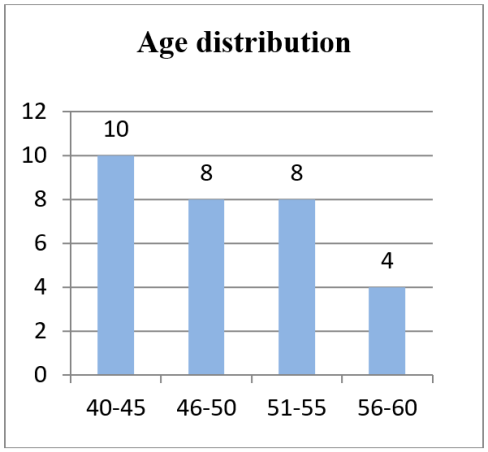

Figure 8: Showing age distribution

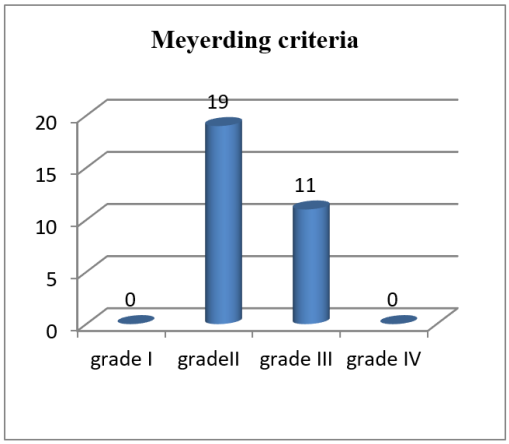

Figure 9: Meyerding criteria distribution

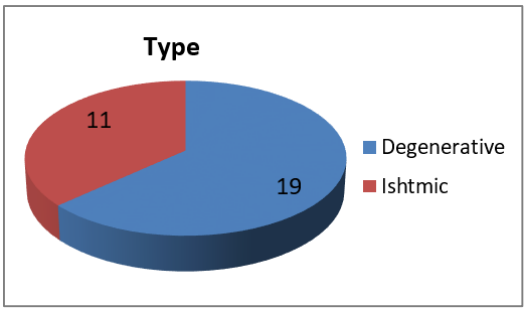

Figure 10: Type of spondylolisthesis

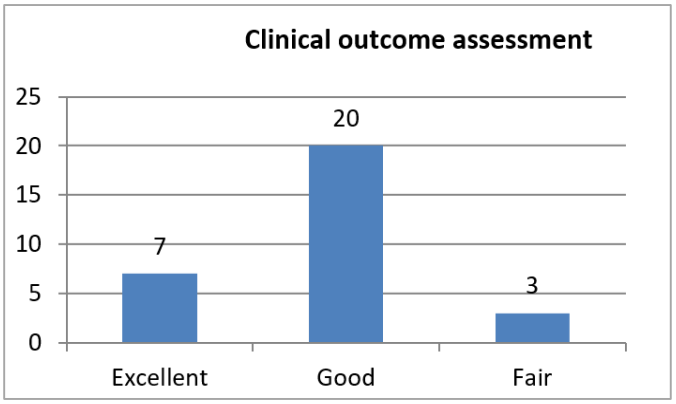

Figure 11: Clinical outcome distribution

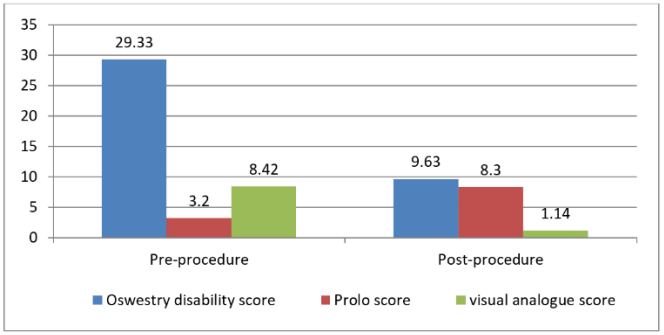

Figure 12: Showing functional results assessed by Oswestry low back pain disability score, Prolo score and VAS score

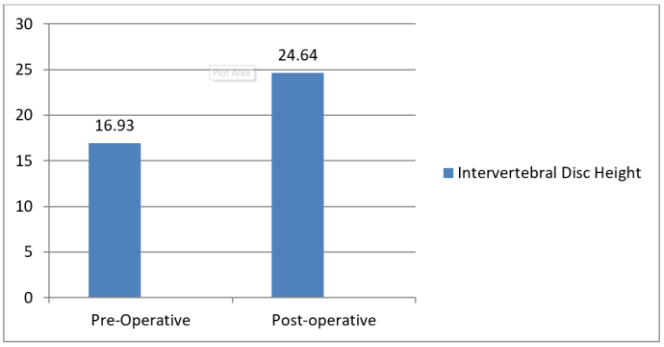

Figure 13: Showing pre-operative and post-operative radiological disc space height values

Table 1: showing statistical analysis, IVDH- intervertebral disc space height

Paired Samples Statistics						
		Mean	**N**	**Std. Deviation**	**T Test**	**p Value**
Paired Sample T Test	Pre-IVDH	16.93	30	7.30	4.991	0.00003 (<0.05)
	Post-IVDH	24.64	30	4.17		

4. Discussion

The surgical treatment of choice for the management of Spondylolisthesis remains a matter of controversy. PLIF was first attempted by Cloward[1] and later revised by Lin.[2] The technique requires bone resection, careful nerve root retraction, and meticulous haemostasis. Vigorous nerve root retraction or disc space distraction may lead to neural injury.[3] Excessive bleeding impairs visualisation, places the dura and nerve roots at further risk, and may even predispose to epidural fibrosis.[5] According to some studies[8,9] posterior lumbar interbody fusions (PLIF) had high complication rate and technical difficulty particularly with regard to neural injury. Complications[10,11] often observed in association with PLIF includes neural injury, dural laceration, excessive bleeding, graft migration and graft collapse.

Brodke et al and Lund et al[12] found that the combination of cage and posterior pedicle screw instrumentation was the stiffest on biomechanical testing, as compared to a standalone[18] PLIF procedure. Liu et al[19] a meta-analysis study reported that lumbar interbody fusion using one cage has an equal fusion rate and is safer compared with using two cages.

Kroppenstedt et al[20] study in 46 patients with 7 years follow-up reported that there was no difference between single and double cages usage regarding segmental stability, change in segmental height, foramen height and segmental lordosis. Lee et al[21] study of 88 patients with follow-up of 2years shows radiological fusion rate of 91.2% in single cage usage group.

Suh et al[22] study reported single cage fusion at l5-s1 & l4-5 in 30 and 17 patients respectively with 15 months follow-up period had fusion rate of 87% and clinical success rate of 89.4% (excellent-10, good-32, fair-5), complications observed was transient nerve palsy in one case, deep infection in another case.

Fogel et al[23] study reported excellent results in 3 cases, good results in 9 cases, fair results in 11 cases and poor results in 3 cases with radiological fusion rate of 88% and pseudo arthrosis of 11.53% in 2years follow-up period. Zhao et al[24] study reported single cage fusion in 13 patients with 18 months follow-up shows excellent results in 7 patients, good results in 4, and fair results in 2 patients with radiological fusion rate of 91.7% with complications like dural tear in one case.

In present study group the commonest level involved was L4-L5 (19 cases, 63.33%) of the total cases followed by L5-S1 level (08 cases, 26.66%) and L3-4 level (3 cases, 3.10%). Out of 30 patients excellent results obtained in 7 patients (23.33%), good results in 20 patients (66.66%) and three patients (10%) belonged to the fair group in view of clinical success. Stauffer and Coventry criteria[17] evaluate the spinal fusion; there was 93.33% of spinal fusion observed. There was no implant failure in this study. Complication like wound infection occurred in two cases (6.66%), which was superficial and managed with intravenous antibiotics and dressings. There was no neural injury, graft migration, cage migration and graft collapse in 5years followup period.

Table 2: Showing comparison of different studies

Study	**Radiological union**	**Infection**	**Implant failure**
Lee et al[21]	92.9%	-	None
Suh et al[22]	87%	2.12%	None
Fogel et al[23]	88%	-	None
Zhao et al[24]	91.7%	7.6%	None
Our study	93.33%	6.66%	None

5. Conclusion

Posterior lumbar interbody fusion (PLIF) with single titanium cage and bone graft substitute (calcium phosphate granules of master-graft, MEDTRONICS) is a better method in spondylolisthesis management, as it provided good spinal fusion, minimal surgical time and fewer complications with satisfactory clinical outcome.

6. Source of Funding

None.

7. Conflict of Interest

None.

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