

## Original Research Article

# Low-grade spondylolisthesis: is transforaminal lumbar interbody fusion superior to posterolateral fusion

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## ABSTRACT

**Background:** Spondylolisthesis is anterior translation of the cephalad vertebra relative to the adjacent caudal segment. Both posterolateral fusion (PLF) and transforaminal lumbar interbody fusion (TLIF) and have shown high fusion rates with good clinical outcomes. But it is not clear which treatment leads to better outcomes, as limited studies have been done to compare PLF and TLIF in low grade spondylolisthesis. Our objective is to determine whether PLF or TLIF was associated with better clinical and radiological outcomes in patients with low grade spondylolisthesis.

**Methods:** Forty patients were enrolled and assigned into PLF (n=20) or TLIF (n=20) group. The outcome measures were: clinical outcomes as assessed with a visual analogue scale and the modified Oswestry disability index, the fusion rate based on radiographs.

**Results:** The improvement of visual analog score (VAS) of low back pain was greater in TLIF than in PLF (89.6% versus 88.7%,  $p=0.79$ ). The improvement of VAS of leg pain was greater in TLIF than in PLF (96.5% versus 94.8%;  $p=0.27$ ). The improvement of Oswestry disability index (ODI) was greater in TLIF than in PLF (71.7% vs 69.8%,  $p=0.32$ ). The fusion rate was 85% in TLIF and 75% in PLF ( $p=0.43$ ). Overall outcome was excellent in 80% in TLIF compared to 65% in PLF ( $p=0.29$ ).

**Conclusions:** Fusion rates are higher in TLIF and average functional outcomes (VAS and ODI) were better in TLIF compared to PLF. Larger and longer studies may provide a significant outcome. Based on our results and literature review, we conclude that TLIF is superior to PLF.

**Keywords:** Spondylolisthesis, Fusion, PLF, TLIF, Oswestry disability index

## INTRODUCTION

Posterior instrumentation with fusion is the currently recommended surgical procedure for the treatment of Lumbar Spondylolisthesis. Fusions may be of the form of posterolateral fusion (PLF) or interbody fusion.<sup>1</sup> PLF is a widely used procedure which improves biomechanics of the spine by restoring sagittal alignment with superior fusion rates.<sup>2</sup> Interbody fusion restores lordosis, disc height and sagittal balance resulting in better functional outcomes. Transforaminal lumbar interbody fusion (TLIF) creates circumferential fusion with significant fusion

rates.<sup>3,4</sup> Recent studies have compared PLF and TLIF showing high fusion rates with good clinical outcome.<sup>5-9</sup> But, there remains considerable debate for the best operative technique. We aim to compare clinical and radiological outcome of these two procedures in low grade spondylolisthesis.

## METHODS

The study was conducted following institutional guidelines and after ethical committee approval in the

Department of Orthopaedics, Vydehi Institute of Medical Sciences and Research Centre, Whitefield, Bangalore.

### Patient demographics

The study was a prospective study, with 20 patients in each group. Inclusion criteria included; patients between ages 18-70 years, single level low grade spondylolisthesis (Meyerding grade I or II) and failed conservative therapy. Patients with, failed back syndrome, infections, bedridden/non ambulatory patients and cognitively impaired patients were excluded from the study. The study was conducted between 2016 and 2019 with a follow up of 2 years. Age, sex and levels of lesion is both the groups is summarized in Table 1.

### Surgical procedure

PLF and TLIF procedures have been performed using standard techniques.<sup>10</sup> Dissection was carried down the lamina bilaterally to the level of the facet joints and transverse processes.

Transverse processes were decorticated in PLF, which will act as bed for bone graft. Segmental, bilateral polyaxial pedicle screw fixation was done at all levels treated, by free hand technique. Reduction screws are used selectively as per preoperative planning. Final screw position is confirmed using image intensifier. In cases with adjacent segment degenerative changes, fixation was extended to one more level.

Decompression was performed for PLF. Bone grafts were harvested from iliac crest and/or local bone (laminectomy bone chips) and placed posterolaterally between the facets and transverse processes of the vertebrae. In cases of TLIF, only a unilateral facetectomy for the symptomatic side was generally performed. A discectomy was then performed and a titanium interbody cage packed with bone graft was inserted.

### Outcomes measures

Visual analogue scale (VAS) of low back pain, VAS of leg pain and Oswestry disability index (ODI) were assessed pre-operatively, 3 months after operation, 1 year after operation, 2 years after operation. Comparisons were made between preoperative and 2 years follow up scores. Radiographic fusion was assessed using plain radiographs by Lenke classification for PLF and by Brantigan, Steffee, Fraser (BSF) classification for TLIF group.<sup>11</sup>

### Statistical analysis

Descriptive statistics were used. Data is analysed using the independent student t test. JASP (version 0.10.2, university of Amsterdam) software was used for analysis and plots. P value less than 0.05 is considered statistically significant. Numerical values are expressed as mean  $\pm$  standard error of mean.

## RESULTS

Clinical and radiographic outcomes are summarized in Table 2. The mean pre-operative VAS scores low back ache in PLF and TLIF groups are  $7.85 \pm 0.15$  and  $7.9 \pm 0.16$  respectively. The mean VAS scores at two years follow up for PLF and TLIF are  $0.9 \pm 0.16$  and  $0.85 \pm 0.17$  respectively. There is no statistical difference in pain scores at both time points (Figure 1A). The percentage improvement within both the groups is statistically significant ( $p < 0.0001$ ), but the difference between groups is not significant ( $p = 0.8$ ).

The mean pre-operative VAS scores for radiating pain in PLF (N=13) and TLIF (N=15) groups are  $5.5 \pm 0.27$  and  $5.6 \pm 0.25$  respectively. The mean VAS scores at two years follow up for PLF and TLIF are  $0.31 \pm 0.13$  and  $0.27 \pm 0.12$  respectively. There is no statistical difference in pain scores at both the time points (Figure 1B). The percentage improvement within both the groups is statistically significant ( $p < 0.0001$ ), but the difference between groups is not significant ( $p = 0.27$ ).

The mean pre-operative ODI scores in PLF and TLIF groups are  $64.8 \pm 0.7$  and  $64.5 \pm 0.74$  respectively. The mean ODI scores at two years follow up for PLF and TLIF are  $19.5 \pm 0.63$  and  $18.2 \pm 0.77$  respectively. There is no statistical difference in ODI scores at both the time points (Figure 1C). The percentage improvement within both the groups is statistically significant ( $p < 0.0001$ ), but the difference between groups is not significant ( $p = 0.32$ ).

**Table 1: Patient demographics.**

Variables	PLF	TLIF
Mean age (years)	50.85	42.25
Male	11	13
Female	9	7
Level of lesion		
L3-L4	1	0
L4-L5	12	13
L5-S1	7	7
Grade of slip (Myerding classification)		
Grade 1	10	8
Grade 2	10	12

Table 1, shows summary of mean age of patients, number of male and female patients, level of lesion, and Myerding grade of slip in PLF and TLIF groups.

At 2 years assessment, 15 patients (75%) in PLF group and 17 (85%) patients in TLIF group had fusion on radiographs. There is 10% difference in fusion rates between the groups, but the difference between groups is not significant ( $p = 0.43$ ) (Figure 2). (Figures 3 and 4) shows pre-operative, post-operative and 2 years follow up radiographs of PLF and TLIF respectively. In PLF, solid fusion mass can be seen posterolaterally (Figure 3D, yellow arrow). In TLIF, at 2 years follow up, there is

osteointegration of interbody cage with superior and inferior end plates, indicating fusion (Figure 4D, yellow arrow).

Overall outcome was assessed based on ODI score at 2 years follow up (Figure 5). There was excellent outcome in 80% patients in TLIF group compared to 65% in PLF group ( $p=0.29$ ).

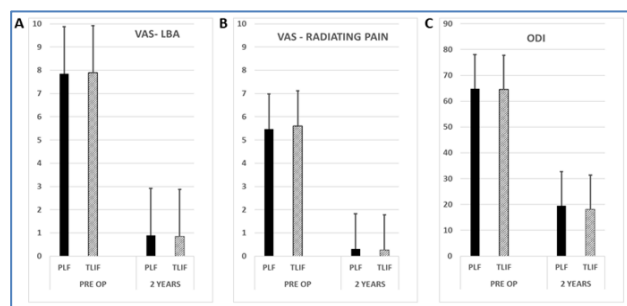
There was no incidence of infections in either of the groups. In TLIF group, one patient had a dural tear, that was repaired during the surgery. Patient did not have any neurological deficits post-surgery. There was one case of screw back out and one case of loss of disc height in PLF group. Re-operative rate at two years follow up was zero.

**Table 2: Clinical and radiographic outcomes.**

Variables	PLF	TLIF	Statistics
<b>Visual analog scale-low back ache</b>			
Pre-operative	7.85±0.15	7.9±0.16	P=0.85
2 years follow up	0.9±0.16	0.85±0.17	P=0.86
Percentage improvement	88.76%	89.6%	P=0.78
<b>Visual analog scale-radiating pain</b>			
Pre-operative	5.5±0.27	5.6±0.25	P=0.64
2 years follow up	0.31±0.13	0.27±0.12	P=0.34
Percentage improvement	94.8%	96.5%	P=0.27
<b>Oswestery Disability Index Score</b>			
Pre-operative	64.8±0.7	64.5±0.74	P=0.78
2 years follow up	19.5±0.63	18.2±0.77	P=0.25
Percentage improvement	69.8%	71.7%	P=0.32
<b>Fusion-PLF Lenke classification</b>			
Grade A*	6	-	
Grade B*	9	-	
Grade C	5	-	
Grade D	0	-	
<b>Fusion-TLIF BSF classification</b>			
Grade 1	0		
Grade 2	3		
Grade 3*	17		
<b>Overall outcome</b>			
Excellent (ODI 0-20)	13	16	P=0.29
Good (ODI 21-40)	7	4	

\*Grades indicate fusion.

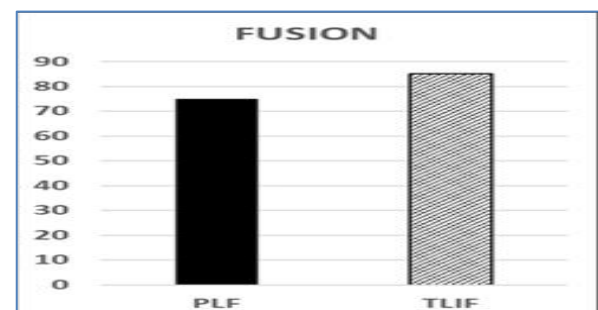
Table 2, shows summary of VAS scores, ODI scores, fusion rates and overall outcome in PLF and TLIF groups.



**Figure 1: Functional outcomes of PLF and TLIF.**

(A) Quantification of VAS for low back ache. VAS scores compared between PLF and TLIF groups pre operatively and at 2 years follow up, (B) quantification of VAS for radiating pain. VAS scores compared between PLF and TLIF groups pre-operatively and at 2 years follow up, (C) quantification of ODI scores. ODI scores compared between PLF and TLIF groups pre

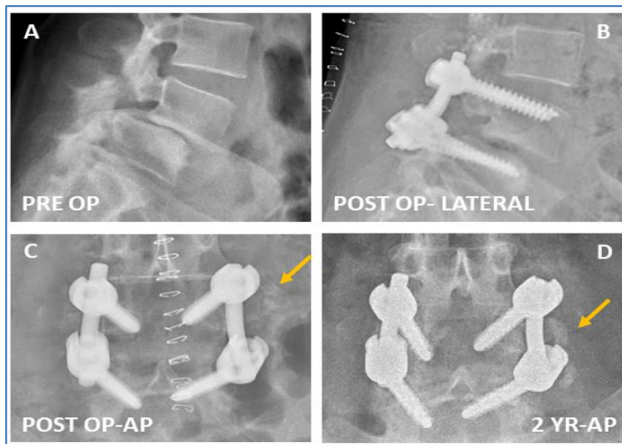
operatively and at 2 years follow up. Statistically significant difference was not identified between PLF and TLIF groups at any time point in all the three functional assessments.



**Figure 2: Percentage of fusion in PLF and TLIF groups.**

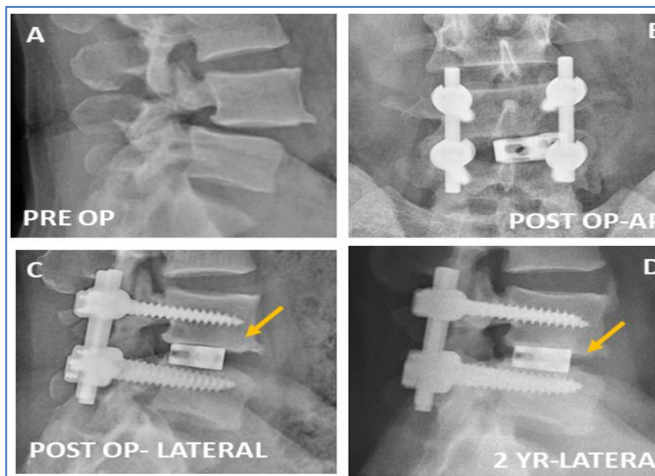
Quantification of percentage of patients that achieved fusion at 2 years follow up. TLIF patient group had higher

percentage of fusion compared to PLF group. There was no statistically significant difference between PLF and TLIF groups.



**Figure 3: Radiographs of PLF.**

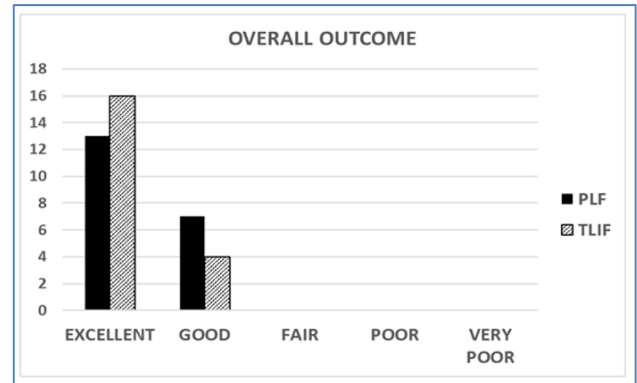
(A) Pre-operative radiograph showing grade 2 spondylolisthesis of L4-L5, (B) day 1 post-operative lateral radiograph showing pedicle screw fixation and reduction, (C) day 1 post-operative Antero posterior radiograph showing pedicle screw fixation and cancellous bone graft posterolaterally (yellow arrow), (D) 2 years follow up Antero posterior radiograph showing fusion mass posterolaterally (yellow arrow).



**Figure 4: Radiographs of TLIF.**

(A) Pre-operative radiograph showing grade 2 spondylolisthesis of L4-L5, (B) day 1 post-operative Antero posterior radiograph showing pedicle screw fixation and interbody cage, (C) day 1 post-operative lateral radiograph showing pedicle screw fixation and Interbody cage. Radiolucency can be seen above and below the graft (yellow arrow), (D) 2 years follow up lateral radiograph showing integration of interbody cage with superior and inferior end plates indicating fusion (yellow arrow).

Quantification of overall outcome at 2 years follow up. TLIF patient group had higher number of patients with excellent outcome compared to PLF group. There was no statistically significant difference between PLF and TLIF groups.



**Figure 5: Overall outcome in PLF and TLIF.**

## DISCUSSION

Spondylolisthesis is a condition that is radio-graphically verifiable and instability is revealed by motion in lumbar segments. Distinguishing specific symptoms of spondylolisthesis from other types of low back pain and sciatica is of utmost importance. Only a small minority of affected individuals ever have symptoms, but this proportion increases with severity of slip.

In our study we examined cases of low grade (1 and 2, Myerding classification) lumbar spondylolisthesis. Despite the conservative treatment previously received by these patients, their symptoms had not been resolved. Dynamic radiological examinations revealed lumbar instability. Failed conservative management is one of the main indications for surgery in this study. Fusion is the currently recommended surgical procedure for the treatment of spondylolisthesis. The goal of the surgical treatment of spondylolisthesis includes: the stabilization of the motion segment, the decompression of neural elements, the reconstitution of disk space height, and the restoration of sagittal plane translational and rotational alignment.

Meta-analysis studies showed that the mean age of the patients being treated for spondylolisthesis has ranged from 39.5 years to 57.4 years, with range being 21 years to 70 years.<sup>12</sup> We have recruited 40 patients, with 20 patients in PLF group and 20 patients in TLIF group. The mean age of patients in our study is 50.85 years for PLF and 42.25 years for TLIF group, which is in accordance with available literature.

The prevalence of spondylolisthesis shows a female predominance, with studies showing a female: male (F:M) prevalence ratio of 1.3:1.<sup>13</sup> In our study of 40 patients, we observed a higher male predominance. 24 patients (60%) were male and 16 patients (40%) were female. Though we have operated a greater number of patients, we included only those available with two year follow up, which might have skewed the predominance towards male.



L4-L5 and L5-S1 are the most common levels involved in spondylolisthesis. Degenerative spondylolisthesis is more common at L4-L5 level and isthmic spondylolisthesis is more common at L5-S1 level.<sup>14,15</sup> In our study we have included all cases of spondylolisthesis within age group of 18-70. Of all the patients, 12 in PLF group and 13 in TLIF group has spondylolisthesis at L4-L5 level and, 7 patients had disease at L5-S1 level in both PLF and TLIF groups. One patient in PLF group had spondylolisthesis at L3-L4 level. Overall incidence is 62.5% for L4-L5 and 35% for L5-S1 level.

Challier et al 2017, in a randomized controlled trial (RCT) compared 30 cases of TLIF and 30 cases of PLF with a 24 month follow up.<sup>16</sup> They reported that VAS back pain improved by 3.8 in the PLF group and 3.3 in the TLIF group ( $p=0.65$ ) and VAS leg pain improved by 3.4 in the PLF group and 4 in the TLIF group ( $p=0.65$ ). Etemadifar et al 2016, performed a RCT between 25 PLF and 25 TLIF patients with two years follow up.<sup>17</sup> They reported that the TLIF group had significantly lower VAS scores for back pain and leg pain. Carreon et al 2016, in a retrospective study, reported that at 12-month follow-up, VAS back pain improved by an average of 3.5 in the PLF group and 4.2 in the TLIF group, VAS leg pain improved by 3.7 in the PLF group and 4.6 in the TLIF 21 group.<sup>18</sup> In our study, we also observed 88.76% and 89.6% improvement in VAS scores for back pain, 94.8% and 96.5% increase in VAS for leg pain in PLF and TLIF groups respectively. Higher percentage of improvement was seen in TLIF patients, though the difference between the groups is not statistically significant.

Functional outcome was assessed by ODI scores. We assessed percentage improvement in ODI at two years follow up. Challier et al, in their RCT, reported that ODI scores improved by 19 in the PLF group and 30 in the TLIF group ( $p=0.08$ ).<sup>16</sup> Etemadifar et al, in their RCT, observe that ODI improved by 53.2 in the PLF group and 56.7 in 13 the TLIF group. Carreon et al.,<sup>18</sup> reported that the TLIF group made significantly greater improvements in ODI (21.1 in the PLF group vs. 30.4 in the TLIF group;  $p=0.001$ ).<sup>17</sup> Ghasemi 2016, in a retrospective cohort study, reported that at 24 months follow-up, TLIF patients had significantly less disability as measured by ODI ( $p<0.05$ ).<sup>19</sup> Our data matches the trends in recent literature. In our study, we observed 71.7% improvement in TLIF group compared to 69.8% in PLF group. The overall outcome based on ODI scores was excellent in 80% TLIF patients, compared to 65% in PLF.

Fusion is an important end point outcome measurement in our study. We assessed radiological fusion based on plain radiographs. Challier et al, RCT reported a significantly higher fusion rate of 56.7% in the PLF group and 96.7% in the TLIF group.<sup>16</sup> Levin et al 2018, in their meta-analysis of 2 RCT's and 5 cohort studies, reported that the pooled fusion success rate was 84.7% in the PLF group and 94.3% in the TLIF group.<sup>20</sup> In our study, we observed 75% (15/20) fusion rate in PLF and 85% (17/20) fusion rate in

TLIF. Our result is consistent with the recent available studies.

Limitations are inherent with all research studies. Our study had two important limitations that must be considered while interpreting the results. Our sample size is 40, 20 per group, which is relatively small when compared to many prospective studies. Our duration of follow up is 2 years and long-term outcomes may vary. All the results are favorable towards TLIF, but an increased sample size and longer follow up could show statistically significant values support the trend. Apart from this our operative technique and analysis of results are consistent with the standard literature.

## CONCLUSION

Our results, in combination with the available literature, strongly support that TLIF is superior to PLF with regards to achieving radiographic fusion. Although TLIF was associated with greater improvements in ODI and VAS scores in our study, no clear statistical advantage over PLF could be elucidated. Based upon the theoretical advantages of anterior column support, indirect foraminal decompression, restoration of lumbar lordosis and results of our study, we conclude that TLIF can be considered a better and superior procedure in achieving better clinical outcomes and a solid fusion.

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*Conflict of interest: None declared*

*Ethical approval: The study was approved by the institutional ethics committee*

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