The Egyptian Journal of Hospital Medicine (July 2019) Vol. 76 (2), Page 3437-3445

Evaluation of Transforaminal Lumbar Interbody Fusion and Posterolateral Lumbar Fusion In Treatment Of Degenerative Lumbar Disorders With Instrumentation

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ABSTRACT

Background: degenerative lumbar disorders affect millions of people causing low back pain, which can restrict mobility and daily activities. Lumbar fusion operations are used as a treatment of degenerative lumbar disorders. However, the better choice among fusion techniques is still controversial.

Objective: to compare the clinical and radiological outcome of Transforaminal Lumbar Interbody Fusion (TLIF) and Posterolateral fusion (PLF) in the treatment of degenerative lumbar spine stenosis and degenerative spondylolisthesis.

Patients and Methods: a prospective study was conducted on 40 patients with degenerative lumbar spondylolisthesis and degenerative lumbar spine stenosis. Twenty patients underwent transforaminal lumbar interbody fusion and 20 patients underwent posterolateral fusion. Patients were followed up using the visual analogue scale (VAS) for back and leg pain and Oswestry Disability Index (ODI). Final fusion assessment was done according to Bridwell criteria.

Results: ODI and VAS of leg and back pain improved in the two groups with no significant differences between the two groups whether after six or twelve months of follow up. TLIF group shows a high grade of fusion according to Bridwell grading criteria for spinal fusion and significantly better than the PLF group of patients either in six-month follow up ($p=0.045$) or twelve-month follow up ($p=0.04$).

Conclusion: both TLIF and PLF provide improvement of disability and pain in patients with degenerative lumbar disorders. TLIF is superior to PLF with regard to achieving radiographic fusion. There is no significant clinical or functional outcome to support the use of TLIF over PLF in the treatment of degenerative lumbar disorders.

Keywords: TLIF, PLF, Spinal Fusion, Degenerative lumbar disorders.

INTRODUCTION

Degenerative lumbar disorders are relatively common cases of people over the age of 50 and are more common in females. Patients with constellation of symptoms include back pain, radiology, and/or neurogenic claudication[(1)].

In the absence of progressive neurological deficit and/or symptoms of cauda equina syndrome, treatment begins with a series of nonoperative interventions that include physical therapy, nonsteroidal anti-inflammatory medications, and epidural injections[(1)].

Regarding surgical options, there are retrospective studies in the literature that maintain positive results can be achieved following decompression alone (without arthrodesis) in the setting of low-grade degenerative spondylolisthesis. For an elderly patient with multiple comorbidities and low functional activity, decompression alone may be a viable option[(2)].

However, higher-quality data demonstrates superior and more durable results which can be achieved when arthrodesis is performed in addition to decompression in the setting of degenerative lumbar disorders. This is reflected in the North American Spine Society (NASS) clinical guideline for degenerative spondylolisthesis and canal stenosis, where a stronger recommendation is made for both decompression and arthrodesis as compared to decompression alone[(3)].

AIM OF THE STUDY

It is to compare the clinical and radiological outcome of Transforaminal Lumbar Interbody Fusion (TLIF) and Posterolateral fusion (PLF) in the treatment of degenerative lumbar spine stenosis and degenerative spondylolisthesis with instrumentation.

PATIENTS AND METHODS

Study design:

This is a prospective study that was conducted on patients with degenerative lumbar spondylolisthesis and degenerative lumbar spine stenosis who were admitted to Neurosurgical departments of Al-Hussein University hospital and Arab Contractors' Medical Center and underwent lumbar spine fixation with either transforaminal interbody fusion or posterolateral fusion from February 2017 to February 2019.

The patients were divided into two groups according to the operative procedure done for each group:

- **Group A** (20 patients): included patients who underwent transforaminal lumbar interbody fusion with transpedicular screws instrumentation.
- **Group B** (20 patients): included patients who underwent posterolateral fusion with transpedicular screws instrumentation.

Received:10/4/2019
Accepted:9/5/2019

Patients` inclusion criteria:

- Patients having degenerative lumbar spine stenosis or degenerative spondylolisthesis grade 1 or 2.
- Patients aged between 20 to 60 years.
- All such patients complained of low back pain with sciatica or neuroclaudication and had failed a trial of conservative therapy for at least 3 months.

Patients` exclusion criteria:

- Those requiring more than-single level fusions.
- Patients having spondylolisthesis grade 3 or 4.
- Patients with spinal deformities.
- Extremity of age (Above 60).
- Patients with osteoporosis.

- **Preoperative assessment:**

1) History of present illness: duration of symptom, onset, precipitating and relieving factors. Evaluation of intensity back and leg pain using the visual analogue scale (VAS).
2) Functional assessment: Oswestry Disability Index (ODI).
3) Routine preoperative laboratory investigations.
4) Imaging studies: Lumbosacral Spine MRI. Static (Anterior-posterior and lateral), dynamic (flexion-extension) and oblique (right and left) lumbosacral spine plain x-rays.

- **Follow up:**

Patients were followed up immediately, after 6 months and after 12 months postoperatively for:

- Clinical and functional assessment using the VAS for back and leg pain and ODI. They were obtained during the preoperative visit and immediately, after 6 months and after 12 months postoperatively.
- Radiological assessment was performed using lumbosacral spine plain X-ray radiographs immediate postoperative, after six months and twelve months. Final fusion assessment was done according to Bridwell[4] criteria.

Table (1): Bridwell grading criteria for spinal fusion[4].

Interbody fusion grades	
Grade 1	Fused with remodeling and trabeculae
Grade 2	Graft intact, not fully remodeled or incorporated, though no lucencies
Grade 3	Graft intact, but definite lucency at the top or bottom of the graft
Grade 4	Definitely not fused with resorption of the graft and with collapse
Posterolateral fusion grades	
Grade 1	Solid trabeculated transverse process and facet fusion bilaterally
Grade 2	Thick fusion mass on one side, difficult to visualize on the other side.
Grade 3	Suspected lucency or defect in fusion mass
Grade 4	Definite resorption of graft with fatigue of instrumentation

Ethical approval:

The study was approved by the Ethics Board of Al-Azhar University.

Statistical analysis

The data were collected, tabulated, and analyzed by SPSS (statistical package for social science) version 17.0.

Two types of statistics were done:

Descriptive statistics [e.g. percentage (%), mean (x) and standard deviation (SD)].

Analytic statistics: which include the following tests: Chi-square test ($\chi 2$), Fisher's Exact test, t-test, Mann Whitney U test and The Wilcoxon signed-rank test.

P-value of <0.05 was considered statistically significant.

RESULTS

Table 2: Socio-demographic data between the studied groups:

	Group A (N = 20)		Group B (N = 20)		Test	P value
Age (years): Mean ±SD Range	 54.55±4.26 48 – 60		 54.15±4.17 45 – 60		t-test 0.30	 0.77
	No	%	No	%	X2	P value
Sex: Male Female	 8 12	 40.0 60.0	 9 11	 45.0 55.0	 0.10	 0.75
Special habits: None smokers	 16 4	 80.0 20.0	 18 2	 90.0 10.0	FE 0.78	 0.66

X2 = Chi square test, FE = Fisher's Exact test

Table 2 shows no statistical differences between the two groups regarding the mean age. The number of female patients is more than male patients in each group representing 60% (12 patients out of 20 patients) in group A and 55% (11 patients out of 20) in group B.

Table 3: Preoperative clinical data between the studied groups:

		Group A (N = 20)		Group B (N = 20)		t-test	P value
VAS (leg):	mean ±SD Range	3.9±1.2 1 – 6		4.0±1.0 3 – 6		0.43	0.67
VAS (back):	mean ±SD Range	7.0±0.9 6 – 8		6.6 ±1.0 5 – 8		1.36	0.18
Motor power:	mean ±SD Range	5.0±0.0 5 – 5		5.0±0.0 5 – 5		0.0	1.0
		No	%	No	%	X2	
Sensation:	Intact	20	100	20	100	----	-----

X2 = Chi square test, F = Fisher's Exact test

Table 2 describes the clinical evaluation of the patients in the studied groups showing no statistical differences between the two groups regarding the mean VAS of back or leg pain ($p>0.05$). All the studied patients had no neurological deficits.

Table 4: Preoperative functional and radiological assessment between the studied groups

		The studied groups				Test	P value
		Group A (N = 20)		**Group B(N = 20)**			
Oswestry Disability Index:	mean ±SD Range	55.45±8.07 43 – 67		55.05±8.63 39 – 68		**t-test** 0.15	0.88
Percentage of slippage on dynamic PXR	mean ±SD Range	25.25%±10.19 10 – 40 %		23.75%±9.30 10 – 35%		**U** **0.51**	0.61
		No	%	No	%	**X^2**	
Affected level (MRI)	L3 – L4 L4 – L5 L5 – S1	2 12 6	10.0 60.0 30.0	2 10 8	10.0 50.0 40.0	0.49	0.79

X^2 = Chi square test, U = Mann Whitney U test

Table 4 shows that there were no statistical differences between the two groups regarding preoperative mean ODI and mean percentage of vertebral slippage on dynamic X-ray ($p>0.05$). The table also shows that L4-5 was the most commonly affected level in both groups accounting for 60% (12 patients out of 20) in group A and 50% (10 patients out of 20) in group B.

Table 5: Comparison of follow up data and base line data in group A

	Group A (N = 20)			Test	P value
	BASE LINE	**6 months**	**12 months**	**W**	
VAS (leg)				**3.89**	$<0.001^1$
mean ±SD	3.9±1.2	0.45±0.60	0.10±0.31	**3.96**	$<0.001^2$
Range	1 – 6	0 – 2	0 – 1	**2.33**	0.02^3
VAS (back)				**3.96**	$<0.001^1$
mean ±SD	7.0±0.9	1.65±0.99	0.45±0.51	**3.96**	$<0.001^2$
Range	6 – 8	0 – 5	0 – 1	**3.78**	$<0.001^3$
ODI				**3.82**	$<0.001^1$
mean ±SD	55.45±8.07	13.55±10.16	7.40±3,35	**3.93**	$<0.001^2$
Range	43 – 67	5 – 55	5 – 20	**3.87**	$<0.001^3$
Percentage of slippage				**3.95**	$<0.001^1$
mean ±SD	25.25±10.19	8.25±5.91	8.25±5.91	**3.95**	$<0.001^2$
Range	10 – 40	0 – 15	0 – 15	**0.0**	$1,0^3$
Grade of fusion					
mean ±SD		1.40±0.75	1.30±0.73	**1.41**	0.15^3
Range		1 – 4	1 – 40		

W = Wilcoxon Signed test

1 = comparing base line data and 6 months follow up data

2 = comparing base line data and 12 months follow up data

3= comparing 6 months follow data and 12 months follow up data

Table 5 shows comparison between the preoperative, 6 months and 12 months follow up of group A patients regarding:

- **VAS:**

The mean leg VAS has dramatically improved from 3.9±1.2 (preoperative) to 0.45±0.60 (6 month), then scored 0.10±0.31 at 12 months follow up. The mean VAS improvement is 88.5% after 6 month and 97.4% after 12 months follow up. [VAS improvement % = (preoperative score -post operative score) / preop. score x100].

The results of Wilcoxon signed test indicates that there is a statistically significant differences in leg VAS across the three time points alternatively (pre-operative, six and twelve-month follow-up after TLIF (P<0.05).

The mean back VAS has also improved from 7.0±0.9 (preoperative) to 1.65±0.99 after 6 months, and then scored 0.45±0.51 at 12 months follow up. The mean VAS improvement is 76.4% after 6 month and 97.4% after 12 months follow up. [VAS improvement % = (preoperative score -post operative score) / preop. score x100].

The results of Wilcoxon signed test indicate that there is a statistically significant Differences in back VAS across the three time points alternatively (pre-operative, six and twelve-month follow-up after TLIF (P<0.05).

- **ODI:**

The mean ODI score prior to treatment was 55.45±8.07, then dropped to 13.55±10.16 after six months then to 7.40±3.35. ODI reduction is statistically significant (P< 0.05). ODI improvements were 75.6% after 6 month and 86.7% after one year.

[ODI improvement % = (preoperative score -post operative score) / preop. score x100].

- **Degree of reduction:**

The mean preoperative percentage of slippage was 25.25±10.19%, and then decreased to 8.25±5.91% postoperatively. Difference in spondylolisthesis grade is statistically significant (P< 0.05), (Wilcoxson signed ranked test). Percentage of reduction was 59.4%.

Table 6: Comparison of follows up data and base line data among group B patients:

	Group B (N = 20)			Test	P value
	BASE LINE	**6 months**	**12 months**	**W**	
VAS (leg):				**3.97**	<0.001[1]
mean ±SD	4.0±1.0	0.45±0.51	0.30 ±0.47	**3.97**	<0.001[2]
Range	3 – 6	0 – 1	0 – 1	**1.73**	0.08[3]
VAS (back):				**3.96**	<0.001[1]
mean ±SD	6.6 ±1.0	**1.65**±0.75	**0.90**±0.64	**3.96**	<0.001[2]
Range	5 – 8	**0 – 3**	**0 – 2**	**2.89**	0.004[3]
ODI:				**3.92**	<0.001[1]
mean ±SD	55.05±8.63	13.25±3.23	**7.65**±2.08	**3.92**	<0.001[2]
Range	39 – 68	7 – 19	**5 – 13**	**3.93**	<0.001[3]
Percentage of slippage:				**3.94**	<0.001[1]
mean ±SD	23.75±9.30	9.25±4.66	9.25±4.67	**3.94**	<0.001[2]
Range	**10 – 35**	**0 – 15**	0 – 15	**0.0**	1,0[3]
Grade of fusion:					
mean ±SD		1.85±0.81	1.60±0.60	**2.23**	0.02[3]
Range		1 – 3	1 – 3		

W = Wilcoxon Signed test

1 = comparing base line data and 6 months follow up data

2 = comparing base line data and 12 months follow up data

3= comparing 6 months follow data and 12 months follow up data

Table 6 shows comparison between the preoperative, 6 month and 12 months follow up of group B patients regarding:

- **VAS:**

The mean leg VAS has dramatically improved from 4.0±1.0 (preoperative) to 0.45±0.51 (6 month), then scored 0.30 ±0.47 at 12 months follow up. The mean VAS improvement is 71% after 6 month and 92.5% after 12 months follow up.

[VAS improvement % = (preoperative score -post operative score) / preop. score x100].

The results of Wilcoxon signed test indicates that there is a statistically significant differences in leg VAS across the three time points alternatively (pre-operative, six- and twelve-month follow-up) (P<0.05).

The mean back VAS has also improved from 6.6 ±1.0 (preoperative) to 1.65±0.75 after 6 months, then scored 0.90±0.64 at 12 months follow up. The mean VAS improvement is 86.4% after 6 month and 75% after 12 months follow up.

[VAS improvement % = (preoperative score -post operative score) / preop. score x100].

The results of Wilcoxon signed ranks test indicates that there is a statistically significant differences in back VAS across the three time points alternatively (pre-operative, six and twelvemonth follow-up after TLIF (P<0.05).

- **ODI:**

The mean ODI score prior to treatment was 55.05±8.63, then dropped to 13.25±3.23 after six months then to 7.65±2.08. ODI reduction is statistically significant (P< 0.05). (Wilcoxson signed ranked test). ODI improvements were 75.9% after 6 month and 86.8% after one year.

[ODI improvement % = (preoperative score - post operative score) / preop. score x100].

- **Degree of reduction:**

The mean preoperative percentage of slippage was 23.75±9.30 %, then decreased to 9.25±4.66 % postoperatively. Difference in spondylolisthesis grade is statistically significant (P< 0.05). (Wilcoxson signed ranked test). Percentage of reduction was 61.1%.

Table 7: Six months follow up data between the studied groups

6 months follow up data	**The studied groups**		Test	P value
	Group A N = 20	**Group B N = 20**	**U**	
VAS (leg):				
mean ±SD	0.45±0.60	0.45±0.51	**0.17**	0.86
Range	0 – 2	0 – 1		
VAS (back):				
mean ±SD	1.65±0.99	**1.65**±0.75	**0.40**	0.69
Range	0 – 5	**0 – 3**		
ODI:				
mean ±SD	13.55±10.16	13.25±3.23	**1.48**	0.14
Range	5 – 55	7 – 19		
Grade of fusion:				
mean ±SD	1.40±0.75	1.85±0.81	**2.01**	0.045
Range	1 – 4	1 – 3		
Percentage of slippage:				
mean ±SD	8.25±5.91	9.25±4.66	**0.42**	0.67
Range	0 – 15	**0 – 15**		

Table 7 shows no statistical difference between the two groups after 6 months follow up regarding leg and back VAS of pain, ODI, and percentage of slippage (p>0.05). Grade of fusion in group A was statistically better than group B (p<0.05).

Table 8: Twelve-months follow up data between the studied groups

12 months follow up data	**The studied groups**		Test	P value
	Group A N = 20	**Group B N = 20**	**U**	
VAS (leg): mean ±SD Range	0.10±0.31 0 – 1	0.30 ±0.47 0 – 1	**1.24**	0.21
VAS (back): mean ±SD Range	0.45±0.51 0 – 1	**0.90**±0.64 **0 – 2**	**1.26**	0.21
ODI: mean ±SD Range	7.40±3,35 5 – 20	**7.65**±2.08 **5 – 13**	**0.42**	0.67
Grade of fusion: X ±SD Range	1.30±0.73 1 – 40	1.60±0.60 1 – 3	**2.10**	0.04
Percentage of slippage: mean ±SD Range	8.25±5.91 0 – 15	9.25±4.67 0 – 15	**0.42**	0.67

Table 8 shows no statistical difference between the two groups after 12 months follow up regarding leg and back VAS of pain, ODI, and percentage of slippage ($p>0.05$). Grade of fusion in group A was statistically better than group B ($p<0.05$).

DISCUSSION

In the present study, arthrodesis was performed by transpedicular screws instrumentation based on data suggesting it can improve fusion rates. Twenty patients with degenerative lumbar stenosis and spondylolisthesis underwent lumbar decompression, transpedicular fixation and transforaminal lumbar interbody fusion (Group A). Another group, with the same number of patients, underwent lumbar decompression, transpedicular fixation and posterolateral fusion (Group – B).

- **Epidemiologic findings:**

In our study, the mean age of presentation in group (A) was 54.55±4.26 SD (range 48 – 60) and in group (B) was 54.15±4.17 SD (range 45 – 60). There was no significant difference between the two groups regarding the mean age of presentation. The number of female patients was slightly larger than that of male patients. The female patients represented 60% and 55% of studied patients in group A and B respectively.

Most of the studies investigating the prevalence of degenerative spondylolisthesis and canal stenosis showed female predominance. **Jacobsen *et al.*[5]** reported the prevalence of degenerative lumbar spine stenosis was 2.7% for males and 8.4% for females, with a F:M ratio of 6.4:1. **Wang *et al.*[6]** demonstrated that the prevalence of degenerative lumbar spondylolisthesis is very gender-specific and age-specific. Few women and men have degenerative lumbar spondylolisthesis before 50 years old and after 50 years both women and men begin to develop degenerative lumbar spondylolisthesis with faster development rate in women than men.

The most common affected level in all the studied patients was L4-5 accounting for 55% (22 patients). This finding coincides with the results obtained by **Wáng *et al.*[7]** in their study. They noted that the most commonly involved level was L4–L5, followed by L5–S1 and L3–L4.

Preoperative evaluation:

All patients in the present study were subjected to functional evaluation by the Oswestry disability index with no significant difference between the two groups in its preoperative value (P = 0.88). The average value of ODI for group A was 55.45 ± 8.07 SD (range 43% – 67%) and for group B was 55.05±8.63SD (range 39% – 68%).

The average leg pain VAS for group A was 3.9±1.2 (range 1 – 6) and for group B was 4.0±1.0 (range 3 – 6). The average back pain VAS for group A was 7.0±0.9 (range 6 – 8) and for group B was 6.6 ±1.0 (range 5 – 8).

Radiological imaging of the studied patients revealed grade 1 or 2 spondylolisthesis with an average percentage of slippage 25.25±10.19 (range 10 – 40) for group A and 23.75±9.30 (range10 – 35) for group B.

A good aspect of this study that should be noted that there were no significant differences between the studied groups in all the preoperative assessment

criteria. P value was > 0.05 between two groups regarding ODI, VAS, neurological status, affected level and degree of spondylolisthesis.

- **Operative data**

The average operative time for group A was 141.0±23.15 min and for group B was 135.0±35.03 min with no significant difference between the two groups (P = 0.43).

The average amount of blood loss in group A (335.0±89.0 ml) was significantly lower than that for group B (502.5±138.1 ml) p <0.001. Similarly, **Challier *et al.*[8]** in their randomized controlled trial (RCT) reported a greater mean volume of blood loss in the TLIF group (364 mL) compared with the PLF group (271 mL), althoughthis result also failed to reach statistical significance (p=0.08).

Intraoperative unintended durotomy occurred in two cases in group A and in one case in group B. All were repaired with no near or remote consequences.

Postoperative management:

Postoperative mobilization is started either the evening of surgery or the next morning. Postoperative analgesics were used being helpful during the first few postoperative days to relieve back pain caused by surgical incision. Patients are usually discharged home on the third to fifth day after surgery. The mean number of days of hospital stay was3.05±1.10 days for group A and 3.15±0.75 days for group B.

Immediate postoperative leg pain assessment showed improvement of symptoms in all studied patient accounting for 78.2% improvement in mean VAS in group A and 62% improvement in group B.

Postoperative x-ray shows reduction of average spondylolisthesis grade from 25.25% ± 10.19 SD preoperatively to 8.25% ± 5.91 SD postoperatively in group A and from 23.75±9.30 SD preoperatively to 9.25%±4.66 SD postoperatively in group B with no significant difference between the two groups.

- **Clinical and functional outcomes:**

In group A patients, we noticed a significant improvement of leg pain immediate postoperative and after 6 months and 12 months follow up (p < 0.05). There was significant improvement of mean VAS of back pain when comparing the preoperative value with those in the six-month and twelve-month follow up visits. Regarding ODI, its preoperative values also decreased significantly in the six and twelve months follow up compared with the preoperative percentages.

Lowe *et al.*[9] conducted a prospective study on 40 patients with degenerative lumbar conditions treated by TLIF with an average 3-year follow-up. Thirteen of them had spondylolisthesis. Good to excellent clinical results were achieved in 79% of patients and solid radiographic fusion in 90% of patients.

Regarding group B patients, there was a significant improvement of leg pain immediate postoperative and after 6 months and 12 months follow up (p < 0.05). There was significant improvement of mean VAS of back pain when comparing the preoperative value with those in the six-month and twelve-month follow up visits. ODI values decreased significantly in the six and twelve months follow up compared with the preoperative percentages.

Comparing the clinical outcome between the two groups, we found that VAS of leg and back pain improved in the two groups but there were no significant differences between the two groups whether after six or twelve months of follow up. This coincides with **Høy *et al.*[10]** in their RCT as they could not demonstrate any superiority of the procedure with respect to function and back pain in a 2 years perspective follow up. Neither could we demonstrate any significant improvement in leg pain in the TLIF group compared to the PLF group[10].

The study done by Challier et al also showed no significant difference between the PLF group and TLIF group regarding these outcomes[8].

A retrospective study done by **Ghasemi**[11]consisted of 145 consecutive patients of degenerative spondylolisthesis who had undergone lumbar fusion between September 2010 and October 2013.65 patients underwent instrumented PLF group and 80 patients were included in TLIF procedure and 65 patients were included in the instrumented PLF group. There was no significant difference between the two groups with respect to VAS for leg pain in follow up results. But there were significant differences between groups concerning VAS for back pain in favor of the TLIF group.

Whereas **Etemadifar *et al.*[12]** conducted a study on 50 patient with degenerative spondylolisthesis and demonstrated significantly lower back pain and leg pain in the TLIF group at 24-month follow-up.

In our study, ODI decreased in the two groups without significant differences between the two groups in either six or twelve months follow up. Similarly, **Challier *et al.* [8]** in their RCT reported an ODI improvement of 19 in the PLF compared with 28 in the TLIF group; however, this difference failed to reach statistical significance (p=.080)(.

Carreon *et al.*[13] searched the National Neurosurgery Quality and Outcomes Database (N2QOD) and matched 101 patients with degenerative lumbar disorders who underwent PLF to patients who underwent TLIF. As expected after propensity matching, the TLIF and PLF cohorts were similar in demographic data and preoperative criteria.

Carreon *et al*.[13] demonstrated that both TLIF and PLF improved the scores for back and leg pain and

ODI at 3 and 12 months after surgery relative to baseline. Twelve months after surgery, patients who had undergone TLIF had a statistically significantly greater improvement in the mean ODI score than the PLF patients. The TLIF patients also had greater improvements in the mean scores for back pain and leg pain than those in the PLF group, but these differences did not reach statistical significance.

- **Radiological outcome: Fusion:**

No review of the radiologic assessment of spinal fusion would be complete without mention of the controversial relationship between clinical outcome and radiologic outcome. It is important to note that patients with demonstrated technical success on radiologic assessment may not demonstrate clinical success and vice versa [(14)].

In the present study, the TLIF group shows a high grade of fusion according to Bridwell grading criteria for spinal fusion and significantly better than the PLF group of patients either in six-month follow up ($p = 0.045$) or twelve-month follow up ($p = 0.04$).

These results are consistent with the RCT results of **Challier *et al.*[(8)]** which reported a fusion rate of 56.7% (17/30) in the PLF group and 96.7% (29/30) in the TLIF group ($p< 0.001$)[(8)].

Theoretically, interbody fusion results in high fusion rates. It provides a large vascularized bed for fusion. Interbody grafting and pedicular screw augmentation subject the graft to compressive loads. Additionally, Proper end plate preparations**,**as well as well-positioned interbody spacers, optimize the fusion environment. Furthermore, synthetic bone substitutes enrich the biological media for fusion[(15)].

Several prior studies have compared the two types of fusions. Although some studies reported that interbody fusion was superior to PLF in the improvement of back pain other studies demonstrated that both procedures provided nearly equivalent outcomes.

Høy *et al.*[(10)] found that fusion rate at 2 years was 94 % (44 of 47 patients with available radiographs) in the TLIF group compared to 88 % (42 of 48 patients with available radiographs) in the PLF group ($p = 0.31$).

In studies providing equivalent fusion outcome, 2 possible rationales for explaining why TLIF does not demonstrate advantages in fusion. First, fusion can be obtained by creating suitable situation, which all of common methods can provide, especially fusion rates are the same in circumferential fusion and PLF[(16)].

Second, in TLIF, after the disc is extracted, the remaining intervertebral space is filled for a better flexibility, conforming to the biomechanics of the lumbar spine. In PLF, fixation is combined withfusion of vertebral body/transverse process, without dealing with intervertebral space. Most of the degenerative lumbar disorders involve

a degenerative disc, so processing the disc may improve clinical efficacy. Therefore, we conjecture that a cage might play a vital role in improving the efficacy more than promoting fusion[(17)].

- **Complications:**

We found low complication rates in our study. Two cases in group A had dural tear and one case in group B. All were repaired intraoperatively without any further consequences. No cases were reported with postoperative neurological deficits. No cases of adjacent level disease were encountered in the follow up period.

One case of cage infection and subsidence accompanied by loosening of fixation screws was reported in group A. The patient complained of severe back pain and leg pain. The patient underwent surgical intervention for debridement and removal of the fixation system via posterior approach and retroperitoneal approach. The patient was followed up until infection and inflammatory markers improved then he underwent lumbar fixation.

These results are nearly matching or less than others reviewed in the literature. Pooswamy et al. demonstrated a 9.5% (2/21) infection rate in the PLF group and a 5.2% (1/19) infection rate in the TLIF group[(18)]. **Berven *et al.*[(19)]** reported a 3.1% (2/65) infection rate in the PLF group and a 3.7% (3/80) infection rate in the TLIF group. They didn't report any cases of infection either in PLF group (0/32) or TLIF group (0/24).

Various studies provide conflicting recommendations regarding dealing with infected interbody cages. A recent study that was conducted by **Chang *et al.*[(20)]** analyzed data from 4923 patients who had undergone TLIF with cage and posterior pedicle-screw instrumentation for spondylolysis or degenerative spondylolisthesis. Of the 4923 patients, 32 (0.65%) had developed infection of the interbody cage.

They concluded that the most important factor contributing to TLIF cage retention failure was epidural fibrosis of the previous transforaminal route and biofilm adhesion on interbody devices affecting infection clearance. Thus, they recommended a combined anterior and posterior approach for radical debridement with cage removal and fusion to achieve better clinical outcomes[(20)].

Limitations of the study:

Long term studies provide more realistic data as they show clinical and radiological success or failure as well as the complications of the surgical procedure. This is clear in spinal interventions which sometimes alter the biomechanics.

Our study reviewed the outcomes up to one year, so a longer follow up is advisable. Our sample size

was 40 cases which is comparable to some studies in the literature. However, in bigger studies, more complications could be seen and statistical analysis is likely to be more accurate.

CONCLUSION

The choice of lumbar fusion modality is dependent on patient and surgeon-specific considerations. From the present study and other studies, both TLIF and PLF provide improvement of disability and pain in patients with degenerative lumbar disorders. TLIF is superior to PLF with regard to achieving radiographic fusion. There is no significant clinical or functional outcome to support the use of TLIF over traditional PLF in the treatment of degenerative lumbar disorders, especially with the increased material costs associated with interbody fusion.

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