TLIF VERSUS PLIF IN MANAGEMENT OF LOW GRADE SPONDYLOLISTHESIS

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ABSTRACT

Background: *Spinal fusion is commonly performed together with rigid instrumentation to treat low-grade spondylolisthesis. Several fusion methods have been reported for low-grade spondylolisthesis via various approaches including posterolateral fusion (PLF), posterior lumbar interbody fusion (PLIF), transforaminal lumbar interbody fusion (TLIF), and anterior lumbar interbody fusion (ALIF) The choice of lumbar fusion technique must be individualized based on the clinical needs of each patient, and the surgical outcome for each procedure.*

Aim of the work: *This study was done to evaluate the results obtained in patients undergoing TLIF compared with PLIF with pedicle screw fixation for the treatment of low grade spondylolisthesis.*

Material and Methods: *This study was carried out on sixty patients fulfilling the selected criteria, admitted to the neurosurgery department of the Main Alexandria University hospital between January 2005 and December 2008, thirty consecutive patients underwent transforaminal lumbar interbody fusion (group I) and another thirty consecutive patients underwent posterior lumbar interbody fusion (group II). Patients have been followed up clinically and radiologically for a period ranged from 6-18 months.*

Results: *The mean VAS for back and leg pain significantly decreased from 6.99 ± 0.9 to 2.1±0.7 and 6.4±0.8 to 2.0±0.9 in group I and from 7.37±1.0 to 1.7±0.7 and 6.3±0.7 to 1.6±0.8 in group II, respectively, (*$P < 0.05$*). The average pre operative disk and foramen height in the TLIF group improved from 6.4±1.1 and 14.9±0.9 preoperatively to 11.4±0.8 and 18.5±0.6 postoperati vely, respectively. At last follow up there was minimal loss of correction down to 10.6±0.7 and 18.0±0.5 respective ly. Similarly in the PLIF group, preoperative disk and foramen height were improved from 6.7±0.7 and 14.6±0.3 to 11.5±0.5 and 18.3±0.7 immediately post operative. At last follow up minimal loss of correction was noted with average disc height of 10.8±0.4 and 17.7±0.7 re spectively. Both groups achieve statistically significant difference in restoration of disc and foramen height from the preoperative and postoperative, (*$P < 0.05$*). But, there was no statistically significant difference between the two groups. In group I there were 22 cases (73.3%) of excellent, 8 cases (26.7%) of good, and no cases of fair results, but in group II there were 20 cases (66.7%) of excellent, 9 cases (30%) of good, and 1 case (3.3%) of fair results.*

Conclusion*: Interbody fusion with either a PLIF technique or a TLIF technique provides good outcome in the treatment of low grade spondylolisthesis. The TLIF procedure is simpler and safer than PLIF with very good outcome. So, TLIF technique offers a useful alternative to the more traditional PLIF procedure.*

Keywords: *Spondylolisthesis, Interverterbral fusion, TLIF, PLIF.*

INTRODUCTION

Several fusion methods have been reported for low-grade spondylolisthesis via various approaches including posterolateral fusion (PLF),[1,2] posterior lumbar interbody fusion (PLIF),[3-5] transforaminal interbody fusion (TLIF),[6-9] anterior lumbar interbody fusion (ALIF),[10,11] and finally a combined posterior-anterior approach (circumferential fusion, 360 degree fusion).[12-16] The choice of lumbar fusion technique must be individualized based on the clinical needs of each patient, the surgical outcome for each procedure based on the surgical techniques, and the individual skills of the surgeons.

Interbody fusion has gained popularity for surgical treatment of low-grade spondylolisthesis; these techniques provide solid fusion of spinal segments with maintaining the load-bearing capacity and proper disc height.[11] The reconstruction of the anterior column after disc evacuation is important because 80% of the compressive, torsion, and shear forces are transmitted through the anterior column.[17-19]

The PLIF procedure was first described by Briggs and Milligan,[20] who used laminectomy bone chips in the disc space as interbody graft. Jaslow [21] modified the technique by positioning an excised portion of the spinous process within the intervertebral space. Cloward[22] described new technique using impacted blocks of iliac crest autograft that made the popularity of PLIF surgery increased. Technically, PLIF is more difficult than posterolateral fusion techniques (i.e., intertransverse fusion in which bone graft spans between the transverse processes), but it has the advantage of substantially increasing the fusion rates in more than 85% of patients. Despite the increased fusion rate, this technique was fraught with complications related to blood loss, dural/neural injury, graft extrusion, and arachnoiditis.[23]

Because of the technical challenges, the use of the PLIF procedure remained significantly limited until

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the 1990s, at which time the advent of preformed supplementary interbody implants and instruments which increased the technical ease and subsequent popularity of this technique.[23-26] Various types of implants, mostly the synthetic cages have now become a standard part of PLIF to support and stabilize the disc space until bone graft unites the bone of the opposing vertebral endplates.[17, 27] With newer implants and standard sets of instruments, fusion rates of the PLIF procedure have improved, with some authors reporting successful fusion in more than 90% of patients.[27] The popularity of this technique has continued to increase. More recently, interbody cages have composed of a wide range of materials, such as titanium mesh, carbon fiber, and polyether ether ketone (PEEK).[17] Not only have fusion rates improved with this evolution, but technical advances in these implants have also improved their safety and ease of application, further adding to the popularity of the PLIF procedure. Finally, augmentation of the PLIF procedure with the addition of pedicle screws increases the stability of the construct and has been reported to increase the fusion rate of this procedure compared with stand-alone grafts.[28, 29]

Posterior lumbar interbody fusion requires retraction of the thecal sac and nerve roots to gain sufficient access to the posterior disc space through the spinal canal. This increases the risks of incidental durotomy and injury to the nerve roots, and this incidence of neural injury increases when the PLIF procedure is used as a revision surgery because of the epidural scar tissue formation. The retraction of the nerve root during insertion of the cage has been associated with postoperative radiculopathy in up to 13% of cases.[30] PLIF also, requires violation of the structural integrity of both facet joints to achieve adequate graft placement, which may increase the immediate postoperative instability and lead to failure if pedicle screw instrumentation is not added.[31]

In 1982, Harms and Rolinger [32] reported the use of bone graft packed in a titanium mesh that was inserted via a transforaminal route into the disc space. Termed ‘‘transforaminal lumbar interbody fusion’’ (TLIF), this technique relied on distracting the motion segment through pedicle screws that were placed before cage insertion, and it could be accomplished without exposing more than the ipsilateral foramen. It minimizes retraction on the thecal sac, decreasing the risk of durotomy and limiting the possibility of neural injury, and epidural scarring.[32] TLIF enables placement of the graft within the anterior or middle of the disc space to restore lumbar lordosis. Finally, because the contralateral laminae and spinous processes can be preserved, additional surface area is available to help achieve a posterior fusion.[31, 32]

Much has been reported about the advantages and disadvantages of each approach. The present study was done to evaluate the results obtained in patients undergoing TLIF compared with PLIF with pedicle screw fixation for the treatment of low-grade spondylolisthesis.

METHODS

This study was carried out on 60 patients presented with single level of L5–S1 or L4–L5 low grade spondylolisthesis (grades I-II) that were admitted to the neurosurgery department of the Main Alexandria University hospital, in a period between January 2005 and December 2008. 30 consecutive patients underwent transforaminal lumbar interbody fusion (group I) and anther 30 consecutive patients underwent posterior lumbar interbody fusion (group II). The average follow-up periods were 6-18 months. The two groups had similar age and sex distribution, and level of pain. The inclusion criteria included were low grade spondylolisthesis (grades I–II) which only single level fusion. Exclusion criteria included pathologic conditions of the lumbar spine (trauma, tumor, or infection), or previous spine surgery.

The PLIF procedure was performed in the standard fashion reported in the introduction of this study, with two cages packed with bone graft inserted inside the disc space. Posterior segmental spinal pedicle screws instrumentation was used in all cases. The TLIF procedure was performed in the standard fashion reported, with one kidney shaped cage packed with bone graft. Posterior segmental spinal pedicle screws instrumentation was used in all cases. Brace support was recommended for 6–8 weeks after surgery.

The patients were followed up for a period ranged from 6-18 months; Clinical outcome was graded using the visual analog scale (VAS, score ranged from 0-10 with 0 represents no pain). The patients were evaluated radiologically in the follow-up period as regards the height of the disk space and the intervertebral foramen, the cage position, and the fusion rate. The criteria for fusion are the continuity of trabecular pattern, and the non-union was defined as a visible gap. These parameters were measured by pre- and postoperative standing lateral radiographs by using a measuring program and by using the CT-scan reconstruction.

Statistical analysis:

Data were analyzed using SPSS software package version 15.0 (SPSS, Chicago, IL, USA). Quantitative data was expressed using range, mean and standard deviation while qualitative data was expressed in frequency and percent. Qualitative data was analyzed using Chi-square test and also exact tests such Fisher exact and Monte Carlo were applied to compare the two groups. Quantitative data

was analyzed using Mann-Whitney test to compare between two groups while Wilcoxon Signed Rank test was used to compare different periods for the same group.

RESULTS

Sixty patients were operated in this study, thirty consecutive patients underwent transforaminal lumbar interbody fusion (TLIF) (group I) and another thirty consecutive patients underwent posterior lumbar interbody fusion (PLIF) (group II).

In group I, all the patients had low back pain and 28 patients of them had unilateral sciatica, 12 pt on the right side and 16 pt on the left side and only 2 patients had bilateral sciatica with left more than the right side. In group II, all the patients had low back pain and 26 patients of them had unilateral sciatica, 15 pt on the right side and 11 pt on the left side and only 4 patients had bilateral sciatica.

In group I we operated on L4-5 in 18 patients and L5-S1 in 12 patients, while in group II we operated on L4-5 in 16 patients and L5-S1 in 14 patients. The two groups had similar age and sex distribution, as shown in table I.

The clinical outcome for the 2 treatment groups was analyzed by VAS score, at the postoperative follow-up assessment both treatment groups showed significant improvement in all categories. Before surgery, both treatment groups had significantly higher disability scores. There were no statistically significant differences between the 2 groups in terms of pre- and postoperative VAS scores for back and leg pain ($P > 0.05$). However, clinical data in both groups demonstrated statistically significant improvement from the pre- to postoperative periods ($P < 0.05$). The mean VAS for back and leg pain significantly decreased from (6.99 ± 0.9) to (2.1 ± 0.7) and (6.4 ± 0.8) to (2.0 ± 0.9) in the group I and from (7.37 ± 1.0) to (1.7 ± 0.7) and (6.3 ± 0.7) to (1.6 ± 0.8) in the group II, respectively, as shown in table II.

As regards the disc height, we found that in group I, the average disc height was (6.4 ± 1.1) in the preoperative period and (11.4 ± 0.8) in the immediate postoperative period and became (10.6 ± 0.7) after the follow up period, while in group II we found that the average disc height was (6.7 ± 0.7) in the preoperative period and (11.5 ± 0.5) in the immediate postoperative period and became (10.8 ± 0.4) after the follow up period table III.

As regards the foramen height, we found that in group I, the average foramen height was (14.9 ± 0.9) in the preoperative period and (18.5 ± 0.6) in the immediate postoperative period and became (18.0 ± 0.5) after the follow up period, while in group II we found that the average foramen height was (14.6 ± 0.3) in the preoperative period and (18.3 ± 0.7) in the immediate postoperative period and became (17.7 ± 0.7) after the follow up period table III.

The disk height and intervertebral foramen height were better than preoperative ($P < 0.05$), and there were no difference between two groups ($P > 0.05$). The lost of intervertebral space and intervertebral foramen were similar between two groups ($P > 0.05$).

The average hospital stay in group I ranged from 2-7 days (3.03 ± 1.7) while in group II ranged from 3-10 days (3.9 ± 1.3). So there were a shorter convalescence time for patients in the group I compared to those in the group II, the difference was significant ($p<0.05$). The operative time in group I was ranged from100-205 minutes (mean 144.1 ± 30.8) appeared to be shorter than that in group 2 which ranged from130-230 (mean 176.2 ± 25.7). So, there was a significant difference between the 2 groups ($p<0.05$). The intraoperative blood loss among patients in the group I was ranged from 100-1000 ml (mean 407.4 ± 283.8), while in group II the intraoperative blood loss ranged from 120-1100 ml (mean 547.3 ± 235.1). This difference was not significant ($p<0.05$). As regard the spinal fusion, we found that 27 patients (90%) had good spinal fusion and only 3 patients (10%) had no obvious fusion in group I, while in group II we found that 29 patients (96.7%) had good spinal fusion and only 1 patient (3.3%) had no obvious fusion. This difference was not significant ($p<0.05$). Finally there was no case of cage extrusion in both groups table IV.

There were three complications of group I, included two cases of postoperative radiculitis and one case of screw loosening that were treated medically, while seven complications related to group II, included four cases of unintended durotomy with one case of CSF leak from the wound postoperative that stopped spontaneously with medication, another two cases complained of postoperative radiculitis and lastly one case of screw loosening. No serious complications recorded in both groups as deep wound infection or revision surgery.

The over all outcome we found that there were 22 (73.3%) cases of excellent results and 8 (26.7%) cases of good results in TLIF group, on the other group there were 20 (66.7%) cases of excellent results and 9 (30.0%) cases of good results and only 1 (3.3%) case of fair result in PLIF group table V.

Table I: Clinical data of the patients

	Group I		Group II		Test of sig.
	N=30	%	N=30	%	
Sex					
Male	13	43.3	14	46.7	$\chi^2 = 0.795$
Female	17	56.7	16	53.3	p = 0.067
Age					
Range	26.0 – 58.0		33.0 – 60.0		Z = 1.324
Mean ± SD	39.2 ± 8.5		42.3 ± 7.5		p = 0.163
Low back pain	30		30		
Sciatica					
RT	12	40.0	15	50.0	
LT	16	53.3	11	36.7	MCp = 0.484
BIL	2	6.7	4	13.3	
Level					
L4-5	18	60.0	16	53.3	$\chi^2 = 0.271$
L5-S1	12	40.0	14	46.7	p = 0.602

χ^2: Chi square test Z : Z for Mann Whitney test MCp: p for Monte Carlo test

Table II: Pre and postoperative clinical data

			Pre operative	Post operative	p_1
VAS back	Group I	Range	6.0 – 9.0	1.0 – 4.0	<0.001*
		Mean ± SD	6.99 ± 0.9	2.1 ± 0.7	
	Group II	Range	6.0 – 9.0	1.0 – 3.0	<0.001*
		Mean ± SD	7.37 ± 1.0	1.7 ± 0.7	
	p_2		0.175	0.123	
VAS leg	Group I	Range	6.0 – 9.0	1.0 – 4.0	<0.001*
		Mean ± SD	6.4 ± 0.8	2.0 ± 0.9	
	Group II	Range	6.0 – 9.0	1.0 – 3.0	<0.001*
		Mean ± SD	6.3 ± 0.7	1.6 ± 0.8	
	p_2		0.632	0.061	

P1: value for Wilcoxon signed ranks test between pre and post operative in each group
P2: value for Mann Whitney test between group I and group II at each period
* : Statistically significant at $p \leq 0.05$ (VAS= visual analog scale.)

Table III: Pre and postoperative radiological data

			Pre operative	Immediate post operative	Follow up
Inter vertebral disc height (mm)	Group I	Range	4.3 – 8.1	9.5 – 13.5	8.5 – 12.0
		Mean ± SD	6.4 ± 1.1	11.4 ± 0.8	10.6 ± 0.7
		p_1		<0.001*	<0.001*
		p_2			0.342
	Group II	Range	5.3 – 8.1	10.5 - 12.5	10.1 – 11.3
		Mean ± SD	6.7 ± 0.7	11.5 ± 0.5	10.8 ± 0.4
		p_1		<0.001*	<0.001*
		p_2			0.381
	p		0.351	0.619	0.431
Foramen height (mm)	Group I	Range	12.5 – 16.4	18.0 – 20.0	17.2 – 19.0
		Mean ± SD	14.9 ± 0.9	18.5 ± 0.6	18.0 ± 0.5
		p_1		<0.001*	<0.001*
		p_2			0.718
	Group II	Range	14.0 – 15.0	16.5 – 19.5	16.0 – 18.9
		Mean ± SD	14.6 ± 0.3	18.3 ± 0.7	17.7 ± 0.7
		p_1		<0.001*	<0.001*
		p_2			0.642
	p		0.164	0.141	0.092

p: p value for Mann Whitney test between group I and group II at each period
p_1:p value for Wilcoxon signed ranks test between pre operative and other periods in each group
p_2: p value for Wilcoxon signed ranks test between immediate postoperative and follow up in each group
* : Statistically significant at $p \leq 0.05$

Table IV: Operative data of both groups

	Group I (n = 30)	Group II (n = 30)	Test of sig.
Hospital stay (days)			
Range	2.00 – 7.00	3.00 – 10.00	$p_1 = 0.024^*$
Mean ± SD	3.03 ± 1.70	3.9 ± 1.30	
Operation time (min)			
Range	100.00 – 205.00	130.00 – 230.00	$p_1 < 0.001^*$
Mean ± SD	144.10 ± 30.80	176.0 ± 25.70	
Blood loss (ml)			
Range	100.00 – 1000.00	120.00 – 1100.00	$p_1 = 0.341$
Mean ± SD	407.40 ± 283.80	547.30 ± 235.10	
Fusion rate			
Range	27 (90.0%)	29 (96.7%)	$p_2 = 0.612$
Mean ± SD	3 (10.0%)	1 (3.3%)	

p_1: p value for Mann Whitney test
p_2: p value for Fisher Exact test
* : Statistically significant at $p \leq 0.05$

Table V: Outcome of both groups

	Group I		Group II		MCp
	No.	%	No.	%	
Excellent	22	73.3	20	66.7	
Good	8	26.7	9	30.0	0.784
Fair	0	0.0	1	3.3	

MCp: p value for Monte Carlo test

DISCUSSION

The goal of the surgical treatment of spondylolisthesis includes, the stabilization of the motion segment, the decompression of neural elements, the reconstitution of disc space height, and the restoration of sagittal plane translational and rotational alignment. This goal could be achieved through either anterior or posterior approach or combined.[33]

PLIF is the most commonly used but it requires a bilateral exposure with loss of the posterior tension band at the level of fusion, also to allow bony fusion it needs a significant retraction of the neural structures and cannot be performed safely in recurrent cases secondary to scar tissue formation.[18] The cauda equine also obstructs the posterior approach to the disc when PLIF is performed in higher lumbar levels, so we must perform discectomy and graft insertion in a bilateral fashion, leading to increase the operative time. In contrast, the angle of approach normally obtained during TLIF allows a unilateral approach to the disc space, thus reducing operative time and blood loss.[6]

TLIF is usually performed in unilateral approach with preservation of the interlaminar surface on the contralateral side, which can be used as a site for additional fusion. Like PLIF, TLIF is easily enforced when combined with posterolateral fusion and instrumentation.[6,7] Both procedures can provide circumferential spinal stabilization through a single posterior approach, but the more lateral access to the disk space in the TLIF technique requires less retraction of the thecal sac and neural elements than with the PLIF technique.[8]

In our study, we found no statistically significant differences between the 2 groups in terms of pre- and postoperative VAS scores for back and leg pain. However, clinical data in both groups demonstrated statistically significant improvement from the pre- to postoperative periods. The mean VAS scale for back and leg pain significantly decreased from (6.99 ± 0.9) to (2.1 ± 0.7) and (6.4 ± 0.8) to (2.0 ± 0.9) in the group I and from (7.37 ± 1.0) to (1.7 ± 0.7) and (6.3 ± 0.7) to (1.6 ± 0.8) in the group II, respectively. This result is matched with other studies as Kim et al[34] found that there was marked improvement in both back pain and leg pain in both groups of TLIF and PLIF without any significant differences between the two groups. Also, Videbaek et al[19] reported that the circumferentially fused patients with TLIF had a significantly improved outcome compared with those treated by means of PLIF.

As regards the disc height, we found that in group I, the average disc height was (6.4 ± 1.1) in the preoperative period and (11.4 ± 0.8) in the immediate postoperative period and became (10.6 ± 0.7) after the follow up period, while in group II we found that the average disc height was (6.7 ± 0.7) in the preoperative period and (11.5 ± 0.5) in the immediate postoperative period and became (10.8 ± 0.4) after the follow up period.

As regards the foramen height, we found that in group I, the average foramen height was (14.9 ± 0.9) in the preoperative period and (18.5 ± 0.6) in the immediate postoperative period and became (18.0 ± 0.5) after the follow up period, while in group II we found that the average foramen height was (14.6 ± 0.3) in the preoperative period and (18.3 ± 0.7) in the immediate postoperative period and became (17.7 ± 0.7) after the follow up period. The disk height and intervertebral foramen height were better than preoperational ($P < 0.05$), and there were no difference between two groups ($P > 0.05$). The loss of intervertebral space and intervertebral foramen were similar between two groups ($P > 0.05$). This findings were matched with other studies as Deng-lu Yan[35] and Cheng-long Soo found that the disk height and intervertebral foramen height were better than preoperational ($P < 0.05$), and there were no difference between two groups ($P > 0.05$). The loss of intervertebral space and intervertebral foramen were similar between two groups ($P > 0.05$).

We found the fusion rate was 90% in TLIF group in comparison to 96.7% in PLIF group with no statistically significant difference in both group. This matched with other studies as Kim et al, [34] reported a high fusion rate of 95.7% in the TLIF group and 100% in the PLIF group and there was no statistically significant difference in the fusion rate between the TLIF and PLIF groups.

The rate of complications in TLIF were less than that in PLIF and not serious. We found in TLIF only 2 cases (6.6%) of mild postoperative radiculitis and one case (3.3%) of screw loosening that were treated medically in contrast to PLIF we found 4 cases (13.3%) of dural tear with one case (3.3%) of CSF leak postoperatively also, 2 cases (6.6%) of postoperative radiculitis and one case (3.3) of screw loosening that were treated medically. These findings are matched with other studies as Humphreys et al[36] who found that patients undergoing the PLIF procedure had a higher incidence of complications, including radiculitis, which was attributed to the need for greater medial retraction of the thecal sac with the PLIF technique, also, Deng-lu Yan[35] and Cheng-long Soo in a comparative study of PILF and TLIF treatment in adult degenerative spondylolisthesis, found that there were four complications in the PLIF group included three cases of radiculitis (one man and two women) and one case of screw loosening (woman).

As regards the over all outcome we found that there were 22 cases (73.3%) of excellent results and 8 cases (26.7%) of good results in TLIF group, on the other group there were 20 cases (66.7%) of excellent results and 9 cases (30.0%) of good results and only 1 case (3.3%) of fair result in PLIF group. This in comparison with other studies we found that Deng-Lu Yan [35] in a similar comparative study found that there were 42 cases of excellent, 29 cases of good, 11 cases of general, and 3 cases of poor results in PLIF group. There were 46 cases of excellent, 31 case of good, 12 case of general, and 2 cases of poor results in TLIF group.

Conclusion: Interbody fusion with either a PLIF technique or a TLIF technique provides good outcome in the treatment of low grade spondylolisthesis. The TLIF procedure is simpler and safer than PLIF with very good outcome. So, TLIF technique offers a useful alternative to the more traditional PLIF procedure.

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