

CLINICAL STUDY

Comparison between posterior lumbar interbody fusion and transforaminal lumbar interbody fusion in the management of lumbar spondylolisthesis

Katuch V¹, Grega R¹, Knorovsky K¹, Banoci J¹, Katuchova J², Sasala M³, Ivankova H⁴, Kapralova P⁵

1st Department of Surgery, Faculty of Medicine at Safarik University and University Hospital, Kosice, Slovakia. jana.katuchova@upjs.sk

ABSTRACT

BACKGROUND: Lumbar spondylolisthesis is a relatively common cause of low back and lower extremity pain. The most common type, degenerative lumbar spondylolisthesis (DLS), is a disease that causes stenosis of the spinal canal. Two surgical methods of treatment are widely accepted, namely posterior lumbar interbody fusion (PLIF) and transforaminal lumbar interbody fusion (TLIF).

MATERIALS AND METHODS: Between 2015 and 2017, the findings of 333 consecutive DLS patients who underwent surgical decompression with instrumented fusion were analyzed in a prospective study at the Department of Neurosurgery University Hospital and Faculty of Medicine at Safarik University in Kosice. The PLIF and TLIF procedures were performed in 214 and 119 patients, respectively. The clinical results and quality of life were compared.

RESULTS: In comparison with PLIF, the TLIF procedures show better results as to the mean time of surgery (118.61 ± 24.74 vs 147.56 ± 38.62 min), blood loss (271.74 ± 104.45 vs 361.23 ± 142.78 ml) and number of blood transfusions (6 vs 38); $p=0.015$, $p=0.023$, and $p=0.001$, respectively. PLIF and TLIF groups were compared as to the number of cases with nerve root injuries (14 vs 2), dural tear (17 vs 3), wound infections (8 vs 3) and reoperations (15 vs 2); $p=0.04$, $p=0.04$, $p=0.55$ and $p=0.03$, respectively. The quality of life at follow-up examinations significantly improved as measured with VAS and ODI ($p=0.001$).

CONCLUSION: This research found that both surgical techniques, TLIF and PLIF, are suitable for DLS treatment. The two methods differed in postoperative complications which were less frequent in TLIF. There were no significant differences in the postoperative quality of life (Tab. 5, Ref. 19). Text in PDF www.elis.sk.

KEY WORDS: degenerative lumbar spondylolisthesis, posterior lumbar interbody fusion, transforaminal lumbar interbody fusion, comparison, quality of life.

Introduction

Degenerative lumbar spondylolisthesis (DLS) is a disease that causes stenosis of the spinal canal. Surgery is indicated mainly for functional impairment (1). Surgical treatment aims to improve neurological problems. It is essential to perform radical decompression associated with instrumented fusion to avoid secondary

destabilization (2). Decompression surgery alone (e.g., laminectomy) is usually not recommended, as instability is still present, and subsequent fusion will be required in most patients. Some authors recommend indirect decompression by fusion between vertebral bodies, but the most common technique is that of direct posterior decompression with instrumented fusion. Both transforaminal lumbar interbody fusion (TLIF) and posterior lumbar interbody fusion (PLIF) have been used in the treatment of DLS (3, 4). The goal of spinal fusion operation is to achieve solid arthrodesis of the spinal segments while restoring the disk's height, immobilizing the unstable segment, and restoring the load on the anterior structures (5, 6).

Materials and methods

From January 2015 to December 2017, a total of 333 consecutive patients with DLS underwent surgical decompression with instrumented fusion at the Department of Neurosurgery University Hospital and Faculty of Medicine at Safarik University in Kosice. Informed consent was obtained from all 333 patients. The PLIF

¹Department of Neurosurgery, Faculty of Medicine at Safarik University and University Hospital, Kosice, Slovakia, ²First Department of Surgery, Faculty of Medicine at Safarik University and University Hospital Kosice, Slovakia, ³Department of Surgery, Faculty of Medicine at Safarik University and Agel Hospital, Kosice-Saca, Slovakia, ⁴Department of Anesthesiology and Intensive Medicine, J. A. Reiman Faculty Hospital, Presov, Slovakia, and ⁵Department of Anesthesiology and Intensive Medicine, Eastern Slovak Institute of Cardiovascular Diseases and Faculty of Medicine at Safarik University, Kosice, Slovakia

Address for correspondence: J. Katuchova, 1st Department of Surgery, Faculty of Medicine at Safarik University and University Hospital, Trieda SNP 1, SK-040 01 Kosice, Slovakia.
Phone: +421.55.640.3896

and TLIF surgical procedures were performed in 214 and 119 patients, respectively.

The study's inclusion criteria were radiological findings confirming DLS and low-back and leg pain associated with neurogenic claudication. All patients enrolled in the study underwent unsuccessful conservative treatment for six months or more. Patients who had an intervertebral fusion at three or more levels were excluded from the cohort.

In our study, the fusion rate and complications associated with decompression and stabilization in spondylolisthesis patients have been investigated in groups of patients with PLIF or TLIF procedures.

Tab. 1. Demographic data of the DLS patients from TLIF and PLIF groups.

Variable	TLIF group (n=119)	PLIF group (n=214)	p
Gender (M/F)	52/67	95/119	0.99
Mean age (yr)	55.21±9.22	56.51±10.71	0.12
Hypertension	31	45	0.29
Diabetes	6	9	0.72
BMI	25.56±5.12	23.78±4.78	0.81
ASA	2.2±0.5	2.1±0.7	0.54
Surgical level			
L3/L4	11	25	0.33
L4/L5	59	97	
L5/S1	34	49	
L3/L4 – L4/L5	7	25	
L4/L5 – L5/S1	8	18	
Operative time (min)	118.61±24.74	147.56±38.62	0.015
Blood loss (ml)	271.74±104.45	361.23±142.78	0.023
Blood transfusion	6 (5.04%)	38 (17.75%)	0.001

Tab. 2. Postoperative complications in TLIF and PLIF groups.

	TLIF (n=119)	PLIF 214 (n=14)	p
Nerve root injury	2 (1.68%)	14 (6.54%)	0.04
Dural tear	3 (2.52%)	17 (7.94%)	0.04
Wound infection	3 (2.52%)	8 (3.73%)	0.55
Re-operation	2 (1.68%)	15 (7.01%)	0.03

Tab. 3. Comparison of preoperative and follow-up conditions in DLS patients from the TLIF group measured by means of VAS and ODI.

	TLIF							p
	Before surgery	After surgery – follow-up						
		Week	Months					
	1	3	6	12	24	36		
VAS	7.2±1.6	2.7±1.8	2.3±1.7	1.6±1.1	1.5±1.9	1.4±1.8	1.5±2.1	0.001
ODI	54±8	23±4	17±5	18±4	12±2	13±3	12±2	0.001

Tab. 4. Comparison of preoperative and follow-up conditions in DLS patients from the PLIF group measured by means of VAS and ODI.

	PLIF							p
	Before surgery	After surgery – follow-up						
		Week	Months					
	1	3	6	12	24	36		
VAS	7.1±1.5	2.7±1.9	2.1±1.8	1.8±1.7	1.6±2.1	1.5±1.7	1.6±2.3	0.001
ODI	55±11	22±5	18±6	17±5	12±3	13±4	12±3	0.001

The differences in operation time, blood loss, ASA, BMI, diabetes mellitus, and level of surgical intervention in both groups of patients (PLIF/TLIF) were evaluated. Moreover, the clinical outcome was observed, including the postoperative Visual Analog Scale of pain (VAS) and the Oswestry Disability Index (ODI) 1 week after the operation, and then in 3, 6, 12, 24 and 36 months.

The statistical analysis was performed by using StatPlus Software. The Fisher's exact test, Pearson chi-square, Mann-Whitney and Kruskal-Wallis tests were used in data analysis. $p < 0.05$ was considered statistically significant.

Results

A total of 333 patients were included in this study. The mean follow-up time was 4.32 years (range 3.08–5.93 y). The patients who underwent the PLIF procedure were assigned as a PLIF group (n=214), while patients who underwent TLIF procedure were assigned as a TLIF group (n=119). The detailed demographic data of patients are summarized in Table 1.

There were no significant differences between the TLIF and PLIF groups of patients as to gender, age, hypertension, diabetes mellitus, BMI, and ASA. The operative times in the TLIF and PLIF groups were 118.61±24.74 min and 147.56±38.62 min, respectively; $p=0.015$. We identified greater blood loss in the PLIF group (361.23±142.78 ml) as compared to that in the TLIF group (271.74±104.45 ml); $p=0.023$. As to the administration of blood transfusion units, we found it to be more frequent in the PLIF group than in the TLIF group: 38/214 (17.75%) versus 6/119 (5.04 %); $p=0.001$. The statistically significant differences between the two methods were found to be in operative time, blood loss, and transfusion rate.

During the evaluation of postoperative complications, we found nerve root injury in 14 patients from the PLIF group (6.54 %) and 2 patients from the TLIF group (1.68 %); $p=0.04$. The dural tear was confirmed in 17 patients from the PLIF group (7.94 %) and 3 patients from the TLIF group (2.52 %); $p=0.04$. Wound infections were observed in 8 patients from the PLIF group (3.73%),

of whom, only one patient required reoperation due to deep infection. In the TLIF group, the wound infection was identified in 3 patients (2.52 %) while no patient presented deep infection. In our study the nerve root injury and dural tear were more frequent in the PLIF group. The incidence of infectious complications in the wound in TLIF and PLIF groups was comparable, i.e., no statistically significant differences were identified; $p=0.55$ (Tab. 2). Because of wound infection and dural tear, 15 patients in the PLIF group (7.01%) required reoperation; on the other hand, in the TLIF group, 2 (1.68 %) patients had postponed reoperation; $p=0.03$.

DLS patients' quality of life before and after surgical procedures by means of TLIF

Tab. 5. Comparison of preoperative and follow-up conditions in DLS patients from TLIF and PLIF groups measured by means of VAS and ODI.

		TLIF	PLIF	p
Before	VAS	7.2±1.6	7.1±1.5	0.41
	ODI	54±8	55±11	0.44
1 week after	VAS	2.7±1.8	2.7±1.9	0.23
	ODIO	23±4	22±5	0.12
3 months after	VAS	2.3±1.7	2,1±1.8	0.15
	ODI	17±5	18±6	0.17
6 months after	VAS	1.6±1.1	1.8±1.7	0.75
	ODI	18±4	17±5	0.67
12 months after	VAS	1.5±1.9	1.6±2.1	0.51
	ODI	12±2	12±3	0.83
24 months after	VAS	1.4±1.8	1.5±1.7	0.12
	ODI	13±3	13±4	0.80
36 months after	VAS	1.5±2.1	1.6±2.3	0.58
	ODI	12±2	12±3	0.89

or PLIF was evaluated using VAS and ODI scores. In both group of patients, the VAS and ODI scores significantly decrease at the final follow-up as compared to preoperative scores (p=0.001). Moreover, in the present study the most significant improvement in quality of life was found to take place during the period between 1 week and 6 months after the operation. When monitoring the patients' quality of life 1, 2, and 3 years after the surgery, the patients' condition was stabilized and without statistically significant changes (Tabs 3, 4, 5).

Discussion

DLS is characterized by one vertebral body slipping over the other vertebral body below. Finally, the process results in central spinal canal stenosis and/or instability. DLS is a relatively common cause of low-back and/or leg pain that limits activity levels. The symptoms may also include lumbar radiculopathy and intermittent neurogenic claudication (7). In 1935, Junghanns was the first to describe DLS as pseudospondylolisthesis (8). The incidence of degenerative spondylolisthesis is about 4 % in the population, and is more common in people older than 50 years. Women suffer from DLS more frequently than men, namely in a 3:1 ratio. DLS usually affects one or two levels of the lumbar spine, while L4/L5 is the mostly affected intervertebral space (2, 7).

The treatment of spondylolisthesis starts with conservative therapy that should be no shorter than three months (6). Failed medical treatment is the indication for surgery. The operative treatment is necessary when back and/or leg pain is persistent or recurrent, life activities are restricted, neurological deficit is significant and bowel or bladder symptoms are present. These clinical symptoms have to correlate with radiological findings on X-ray and MRI. The surgical treatment aims to stabilize, reduce the displaced vertebra (return to position), decompress and remove nerve compression (9, 10).

Because the decompression alone can worsen the instability, many surgeons recommended fusion to stabilize the spine (11, 12). Among spinal fusion techniques, widely accepted are TLIF

and PLIF procedures, while the former lumbar interbody fusion was described as first by Cloward in 1940 (13). PLIF is accessing the intervertebral space via a posterior approach. In 1982, Harms and Rolinger (14) reported TLIF as a substitution to PLIF. TLIF reaches the intervertebral space more laterally than PLIF. Many surgeons performed a comparison of the effectiveness of both TLIF and PLIF procedures. The bilateral route used during PLIF, as opposed to the unilateral route used in TLIF procedures, could be associated with higher incidence of complications, longer operation duration, and greater blood loss (15–18).

In the present study, the comparison between TLIF and PLIF groups of DLS patients shows statistically significant shorter mean time of surgery 118.61±24.74 min in the TLIF group versus 147.56±38.62 min in PLIF patients; p=0.015. The blood loss values in TLIF and PLIF groups were 271.74±104.45 ml and 361.23±142.78 ml, respectively; p=0.023. The necessity of blood transfusion was in 6 (5.04 %) patients in the TLIF group as compared to 38 (17.75 %) in the PLIF group; p=0.001. In the study by Liu and colleagues (3) the mean values of intra-operative time and blood loss volume in the PLIF group were statistically significantly higher than in the TLIF group.

The most common postoperative complications after fusion surgery include iatrogenic nerve root dysfunction, dural tear, and wound infection (4). In our study, the nerve root injury in PLIF and TLIF groups took place in 14 (6.64 %) and 2 (1.68 %) patients, respectively; p=0.04. The instances of dural tear in PLIF and TLIF groups were confirmed in 17 (7.94 %) and 3 (2.52 %) patients, respectively; p=0.04. Wound infections in PLIF and TLIF groups were observed in 8 (3.75 %) and 3 (2.54 %) patients, respectively; p=0.55. The difference in reoperation between the TLIF and PLIF groups was statistically significant, namely there were 2 (1.68 %) cases of reoperation in the TLIF group and 15 (7.01 %) cases of reoperation in the PLIF group; p=0.03.

Recently, several clinical studies documented a comparison between TLIF and PLIF techniques (3, 4, 15–18). However, the PLIF procedures were associated with a higher postoperative complication rate, but TLIF and PLIF had very similar clinical outcomes. Liu et al. found comparable short-term functional results in 226 patients undergoing TLIF and PLIF procedures (3). Lenz et al. reported on their three-year observation of the clinical outcome after lumbar spinal fusion surgery for DLS (9). The authors confirmed significant benefits in patients after surgery; moreover, they showed a considerable restoration of anterior displacement and sagittal rotation. A comparative study of PLIF and TLIF treatment in adults suffering from DLS was performed by Agrawal et al (17). In this study, no statistically significant difference between TLIF and PLIF surgical approaches was pointed out; both procedures provide good outcomes and improve life quality. The evaluation of additional surgery in patients after PLIF or TLIF fusion was documented in a study by Gaffney and coworkers (15). In both groups of patients, similar clinical outcomes were seen. Patients treated with PLIF were less likely to undergo the next lumbar surgery. Talia and colleagues (16) made a comparison of different types and approaches to lumbar interbody fusion. The results show that PLIF has good fusion rates and low complica-

tion rates but is limited by the thecal sac and nerve root retraction. Their findings pointed out that some complications can be avoided by performing TLIF, and therefore this method should be preferable in revision surgery.

In 2018, Lan et al did a systematic review and meta-analysis of the differences between TLIF and PLIF (4). A total of 16 studies involving 1,502 patients reported that both TLIF and PLIF could reach equally beneficial clinical outcomes and fusion rates in DLS treatment. However, TLIF was superior to PLIF owing to lower values of operation time, blood loss, and incidence of root injury and dural tear. There was no significant difference between the two groups regarding wound infection and graft malposition (4).

Kunder et al (19) performed a meta-analysis including 9 studies, 990 patients with TLIF and PLIF procedures. They found that TLIF gives advantages over PLIF, namely of being associated with lower incidence of complications, smaller blood loss, and shorter operative time. The long-term results of both techniques were comparable with a lower postoperative ODI score for TLIF (19).

In our study, the evaluation of the quality of life at the final follow-up was found to yield a significant decrease in both VAS and ODI scores as compared to preoperative scores ($p=0.001$). Moreover, in the present study, we identified the most significant improvement in the quality of life in the period between one week and 6 months after the operation. When monitoring the patients' quality of life 1, 2, and 3 years after the surgery, the patients' condition was stabilized, without statistically significant changes.

Conclusion

The present study results showed that both surgical techniques, TLIF and PLIF, are suitable for DLS treatment. We demonstrated the difference in rates of nerve root injury, dural tear, blood loss, duration of operation, and blood transfusion in favor of TLIF procedures. On the other hand, there were no significant differences between PLIF and TLIF surgical procedures as to clinical findings and quality of life when using VAS and ODI scoring methods after 1, 2, and 3 years

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