

A comparative study of perioperative complications between transforaminal versus posterior lumbar interbody fusion in degenerative lumbar spondylolisthesis

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Abstract

Background Both posterior lumbar interbody fusion (PLIF) and transforaminal lumbar interbody fusion (TLIF) are accepted surgical techniques for the treatment of degenerative lumbar spondylolisthesis (DLS). However, it is still unclear one technique offers distinct advantages over the other.

Objective A retrospective study was performed to compare perioperative complications and functional outcomes of patients undergoing TLIF versus PLIF for DLS.

Methods A total of 226 consecutive patients who underwent surgery for treatment of DLS at three institutions were evaluated from January 2012 to December 2014. In this series, 125 patients underwent PLIF and 101 received TLIF. The operative time, blood loss, allogeneic blood transfusion rate and perioperative complications (including

re-operative rate, nerve root injury, dural tear, wound infection) were compared between the two groups. Pain (VAS) and functional outcomes of patients (Kirkaldy-Willis criteria) were quantified before surgery and 1 week after surgery.

Results Patients involved in the two groups had similar baseline demographic, clinical and radiographic characteristics. The PLIF group was associated with a higher incidence of post-operative iatrogenic nerve root dysfunction [12 cases (9.6 %) versus 2 cases (1.9 %), $P = 0.018$] and dural tears [15 cases (12 %) versus 4 cases (3.9 %), $P = 0.030$]. The re-operation rate was significantly higher in patients undergoing PLIF [13 cases (10.4 %) versus 2 cases (1.9 %), $P = 0.011$]. In addition, intra-operative blood loss, operative times, and allogeneic blood transfusion rates were higher in the PLIF group when compared to the TLIF group ($P < 0.05$). The wound infection rate of the PLIF group was similar to that of the TLIF group (7.2 versus 5.0 %, $P = 0.486$). VAS scores were decreased from 7.08 ± 1.13 to 2.84 ± 0.89 in the PLIF group, and from 7.18 ± 1.09 to 2.84 ± 0.91 in the TLIF group, respectively ($P = 0.32$). 85.6 % of patients in the TLIF group had good or excellent functional outcomes within the first post-operative week compared to 83.2 % in the PLIF group ($P = 0.64$).

Conclusion Both PLIF and TLIF were equally beneficial in improving short-term functional outcomes for patients with DLS. However, PLIFs were associated with statistically significant higher incidences of nerve root injury, dural tears, allogeneic blood transfusion, increased intra-operative times, blood loss and re-operations. Therefore, caution should be exercised when considering PLIFs.

Keywords Lumbar spondylolisthesis · Surgical treatment · Lumbar interbody fusion · Complications

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Introduction

Degenerative lumbar spondylolisthesis (DLS), also called lumbar arthritis spondylolisthesis, is a degenerative spinal disorder, which often results in low back and leg pain related to spinal stenosis. Indications for surgical treatment include persistent or recurrent back and/or leg pain, neurogenic claudication and progressive neurological deficit [1]. Surgical procedures include reduction of the misaligned vertebra and reconstitution of the physiological lumbar lordosis by interbody fusion. Because posterior lumbar interbody fusion (PLIF) has the ability to restore spinal alignment, provide indirect decompression of the neural foramina, and affords solid fixation of spinal segments while maintaining load bearing capacity and proper disc height, it is commonly used in the degenerative lumbar disorders [2]. Previous studies have revealed that PLIFs can be associated with nerve injury, dural tear and epidural scarring [3, 4]. Since Harms et al. modified the technique to transforaminal lumbar interbody fusion (TLIF) [5], TLIFs have been used as an alternative technique for surgical treatment of lumbar degenerative diseases [6, 7]. Despite this, however, there exists few direct comparisons of the perioperative complications and clinical outcomes between PLIF and TLIF in adult degenerative spondylolisthesis. In a multi-center study, we retrospectively present a direct comparison of perioperative complications and short-term outcomes of PLIFs and TLIFs.

Materials and methods

Patients

A total of 226 consecutive patients with DLS underwent PLIF or TLIF in three institutions from January 2012 to December 2014. The study protocol was ethically approved by the Human Research Ethics Committee of the three institutions. Informed consent was obtained from all participants. 125 patients received PLIFs and 101 patients received TLIFs. All three institutions performed both procedures and no significant difference was found among them for patients undergoing PLIF or TLIF ($P = 0.98$). Selection of the procedure was based on patient preference. The risks, advantages and disadvantages of each procedure were discussed with each patient before surgery. Pre-operative variables are denoted in Table 1. Inclusion criteria were radiological evidence of degenerative spondylolisthesis with low back pain and/or leg pain, or neurogenic claudication, which had failed routine conservative treatment for more than 6 months. Patients who underwent three or more levels of intervertebral fusion were excluded.

Table 1 Demographic characteristics of the PLIF group and TLIF group

	PLIF group (<i>n</i> = 125)	TLIF group (<i>n</i> = 101)	<i>P</i> value
Gender (<i>n</i>)			0.136
Female	85	59	
Male	40	42	
Mean age (years)	55.05 ± 10.16	54.10 ± 12.91	0.660
Spondylolisthesis Grade			0.724
Grade I	71	55	
Grade II	54	46	
Locations (<i>n</i>)			0.098
L3/4	2	5	
L4/5	84	53	
L5/S1	34	36	
L3/4–L4/5	1	4	
L4/5–L5/S1	4	3	
Smoker (<i>n</i>)	13	8	0.523
Hypertension (<i>n</i> %)	24	10	0.052
Diabetes (<i>n</i>)	7	5	0.829
BMI (kg/m ²)	21.45 ± 4.04	23.02 ± 5.18	0.988

Surgical procedures

All patients underwent one or two level interbody fusion. The PLIF procedure was performed as previously described [8]. TLIFs were performed in the standard fashion reported by Harms et al. [5]. Interbody fusions were carried out with a PEEK cage filled with local bone graft or allogenic bone in all patients. Posterior segmental spinal pedicle screw instrumentation was used in all cases. The operation time, blood loss, allogeneic blood transfusion rate and perioperative complications (including re-operative rate, nerve root injury, dural tear, wound infection) were recorded in the two groups. All patients used a lumbosacral brace when ambulating for 1 week post-operatively. Pain (VAS) and functional outcomes of the patients were quantified before surgery and 1 week after the surgery. Functional outcome was assessed by using the Kirkaldy-Willis criteria [9].

Statistical analysis

Statistical analysis was performed using SPSS 13.0 (SPSS Inc., Chicago, IL, USA), and all data were expressed as mean ± standard deviation (SD). The data were analyzed by Student's *t* test and Chi square test. A value of $P < 0.05$ was considered statistically significant.

Results

There were no significant differences between the PLIF and TLIF groups in terms of pre-operative clinical variables including age, gender, spondylolisthesis grade, and vertebral levels involved (Table 1).

Operation time and blood loss

The mean intra-operative time and blood loss volume were statistically higher in the PLIF group than those of TLIF group (241.61 ± 67.31 versus 187.67 ± 45.54 min, $P = 0.037$; and 482.91 ± 403.12 versus 308.06 ± 385.16 ml, $P = 0.035$, respectively). In PLIF group, the allogeneic blood transfusion rate was 19.2 % (24/125), which was higher than that of TLIF group (4.9 %, 5/101) ($P = 0.001$).

Perioperative complications

Patients who underwent PLIF had a higher incidence of post-operative iatrogenic nerve root dysfunction [12 cases (9.6 %) versus 2 cases (1.9 %), $P = 0.018$] and dural tears [15 cases (12 %) versus 4 cases (3.9 %), $P = 0.030$] than those of TLIF group. Of the patients with nerve root dysfunction, 10 patients in the PLIF group and 2 patients from the TLIF group had resolution of their symptoms after re-operation (Table 2). 10.4 % (13 cases) of PLIF patients and 1.9 % (2 cases) of the TLIF patients required a re-operation because of nerve root injury and wound infection ($P = 0.011$). 7.2 % of PLIF patients had a wound infection (superficial infection in 6 cases and deep infection in 3 cases), compared to 5.0 % in the TLIF group (superficial infection in 4 patients and deep infection in 1 patient). And one patient in PLIF with deep wound infection underwent re-operation. This was not statistically significant ($P = 0.486$).

VAS scores and functional outcomes

Post-operatively, VAS scores were decreased from 7.08 ± 1.13 to 2.84 ± 0.89 in the PLIF group and from 7.18 ± 1.09 to 2.84 ± 0.91 in TLIF group, respectively ($P = 0.32$). According to the Kirkaldy-Willis criteria, the functional outcomes in TLIF patients were excellent in 65 cases (52.0 %), good in 42 (33.6 %) and fair in 18 (14.4 %). In PLIF patients, the functional outcomes were excellent in 48 cases (47.5 %), good in 35 cases (34.7 %) and fair in 17 cases (16.8 %) during the first week after surgery. No difference was noted between the two groups ($P = 0.64$). Illustrative examples of patients who underwent PLIFs or TLIFs are shown in Figs. 1 and 2.

Table 2 Outcomes of the two different surgical treatments for the degenerative lumbar spondylolisthesis

	PLIF group (<i>n</i> = 125)	TLIF group (<i>n</i> = 101)	<i>P</i> value
Bone graft materials (<i>n</i>)			0.200
Cage with local bone	60	46	
Local bone	61	45	
Cage with allograft	5	10	
VAS score	7.08 ± 1.13	7.18 ± 1.09	0.320
Re-operation (<i>n</i>)	13	2	0.011
Nerve root injury (<i>n</i>)	12	2	0.018
Dural tear (<i>n</i>)	15	4	0.030
Wound infection (<i>n</i>)			0.486
Superficial infection	6	4	0.760
Deep infection	3	1	0.424

Discussion

Degenerative lumbar spondylolisthesis was first described by Junghans as pseudospondylolisthesis in 1935 [10]. Pathophysiologically, it is characterized by one vertebral body slipping over the other, potentially resulting in central spinal canal stenosis and/or instability. The incidence of DLS in the general population is approximately 4.1 % [11, 12]. Although most studies recommend conservative treatment [13], increasing evidence demonstrates that surgery may be usually necessary if patients experience no improvement with conservative measures [14]. Sengupta et al. [15] suggested three distinct indications for surgical treatment of DLS, including: (1) persistent or recurrent back and/or leg pain or neurogenic claudication with reduction of quality of life despite a reasonable trial of nonoperative treatment (a minimum of 3 months); (2) progressive neurologic deficit; (3) bladder or bowel symptoms. The primary purpose of surgery is to correct sagittal and coronal imbalances as well as decompress the neural elements, relieving both the patient's back and leg symptoms. Because decompression without concomitant stabilization may cause worsening of the inherent instability associated with spondylolisthesis, leading to further misalignment and potential worsening of neurologic symptoms, many surgeons recommend instrumented fusion to stabilize the spine [16]. Since Cloward et al. [17] first described the PLIF technique in 1940, interbody fusion techniques have gained popular for patients with degenerative lumbar disorders. Currently, as a modification of PLIF, TLIF has gained considerable traction as an alternative procedure [18]. However, there remains no conclusive evidence demonstrating differences in perioperative complications or clinical outcomes between PLIF and TLIF for treating DLS.

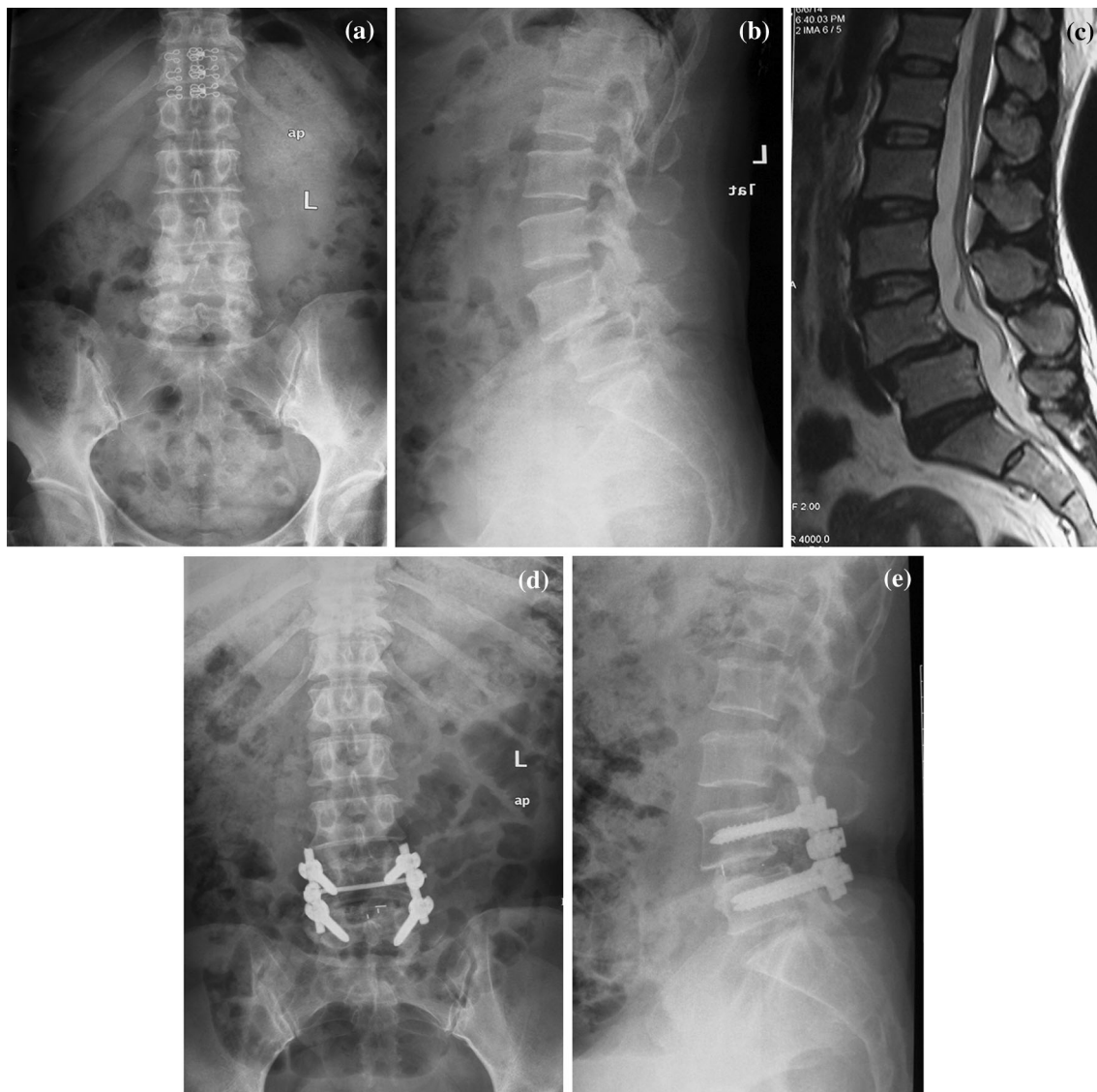


Fig. 1 PLIF procedure for the patient with degenerative lumbar spondylolisthesis. **a, b** Pre-operative posteroanterior and lateral views of a 43-year-old female patient with L4/5 spondylolisthesis. **c** Pre-

operative MRI. **d, e** Posteroanterior and lateral films at the first week post-operatively

Based on the current study, the average operation time, blood loss and allogeneic blood transfusion rate were statistically higher in the PLIF group compared to the TLIF group ($P > 0.05$). This is most likely due to the fact that a PLIF requires bilateral discectomy and interbody bone graft and cage placement, which increase intra-operative times, blood loss, and patients requiring blood transfusions. In this study, VAS scores were significantly improved in both PLIF and TLIF groups post-operatively. However, no statistical difference was found between the two groups ($P = 0.32$). 85.6 % of patients in TLIF group had good or excellent function outcomes during the first week post-operatively compared to 83.2 % of PLIF patients

($P = 0.64$). These results were similar to the study of Yan et al. [19].

Although PLIF has demonstrated effective clinical outcomes in patients, several studies have shown that it can be associated with increased neural complications such as nerve injury, dural tear and epidural scarring [3, 4, 20]. Such injuries result from excess medial retraction of the dura when placing the cage [21]. In contrast, TLIFs use a posterior approach to the spine via the far lateral portion of the vertebral foramen, which would reduce the risks associated with PLIF. In the present study, we confirm these hypotheses, as the incidence of post-operative iatrogenic nerve root dysfunction was 9.6 % in the PLIF group and

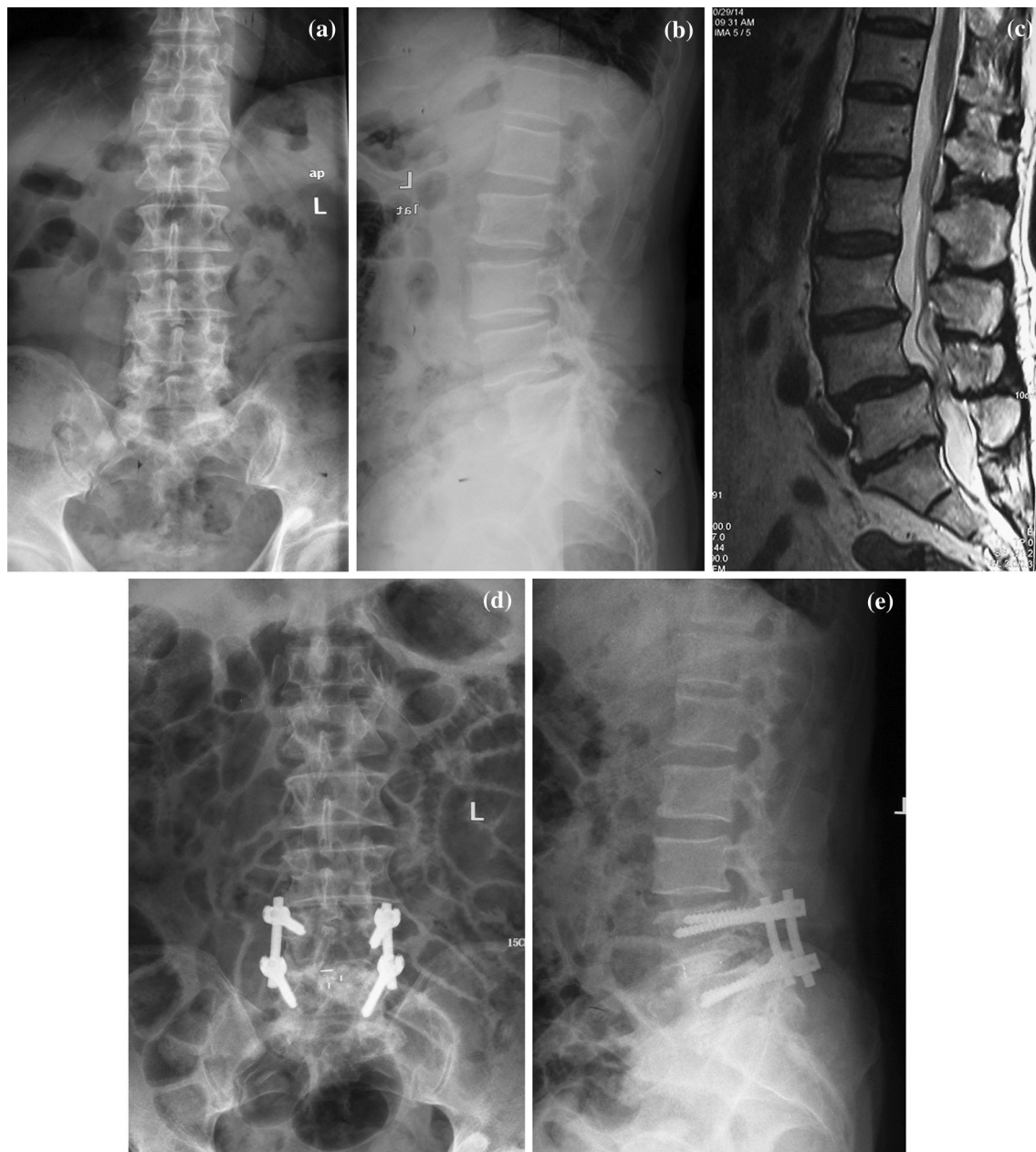


Fig. 2 TLIF procedure for the patient with degenerative lumbar spondylolisthesis. **a, b** Pre-operative posteroanterior and lateral views of a 76-year-old male patient with L4/5 spondylolisthesis. **c** Pre-operative MRI. **d, e** Posteroanterior and lateral films at the first week after surgery

1.9 % in the TLIF group ($P = 0.018$). These results are consistent with the findings of Yan et al. [19] (3.3 % in PLIF versus 2.1 % in TLIF) and Sakeb et al. [22] (5.8 % in PLIF versus no case in TLIF). The incidence of dural tear of this study was 12 % in the PLIF group and 3.9 % in TLIF group, which were commensurate with those reported in Sakeb et al.'s study [22] (7.7 % in PLIF versus none in TLIF). Compared to the TLIF group, the wound infection of the PLIF group was higher (7.2 versus 5.0 %). In addition, the re-operative rate of PLIF group was 10.4 % and it was significantly higher than that of PLIF group

(1.9 %) in our study. Patients underwent re-operation were resulted from nerve root injury (12 cases in PLIF versus 2 cases in TLIF) and deep wound infection (1 patient in PLIF). Thus, according to the present study, the incidence of intra-operative complications of PLIF was higher than that TLIF.

Although this study demonstrates satisfactory results about PLIF and TLIF in the treatment of DLS, some limitations were presented in it, including retrospective analysis of the data and short-term follow-up for patients. In addition, the surgical procedure was chosen by the patients

preference while discussed with the surgeons. A randomized controlled trial and long-term follow-up are needed to further define long-term outcomes.

Conclusion

Both PLIF and TLIF were equally beneficial in improving short-term functional outcomes for patients with DLS. However, PLIFs were associated with statistically significant higher incidences of nerve root injury, dural tears, allogeneic blood transfusion, increased intra-operative times, blood loss and re-operations. For carefully selected patients, TLIFs may be a safer approach in treating DLS compared to PLIFs.

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Compliance with ethical standards

Conflict of interest No benefits in any form have been or will be received from any commercial party related directly and indirectly to the subject of this manuscript.

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