Oblique lateral interbody fusion combined with Wiltse approach pedicle screw fixation for the treatment of single-level Degenerative Lumbar Spondylolisthesis: A retrospective study

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Research Article

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Abstract

Background: The study aimed to explore the efficacy of oblique lateral interbody fusion (OLIF) combined with Wiltse approach pedicle screw fixation in the treatment of single-level degenerative lumbar spondylolisthesis (DLS).

Methods: This is a retrospective study. The study enrolled 54 patients with single-level DLS who were treated at the Affiliated Jiangnan Hospital of Zhejiang Chinese Medical University from May 2018 to June 2020. (OLIF group) 24 cases operated using OLIF combined with Wiltse approach pedicle screw fixation, and (PLIF group) 30 cases operated by PLIF. The primary outcome measures were visual analog scale (VAS) pain scores, Oswestry dysfunction index (ODI), and the lower lumbar spine anterior convexity angle. The secondary outcome measures were operation time, intraoperative blood loss, postoperative drainage, hospitalized days, intervertebral space height, and postoperative complications.

Results: All patients were followed up for 12-20 months, with a mean of 16.2 months. There were significant differences in VAS (2.63±0.58 vs 3.57±0.63, P<0.001) and ODI (9.67±0.92 vs 10.63±1.40, P<0.05) between the OLIF group and PLIF group on postoperative days (PODs) 1–3. However, the differences in VAS and ODI between the two groups were not significant at 6 months postoperatively. And there was a significant decrease in VAS (2.63±0.58 vs 1.08±0.28, P<0.05) and ODI (3.57±0.63 vs 1.10±0.31, P<0.05) in both groups in the PODs 1–3 and 6-month postoperative comparisons. OLIF group showed better intervertebral space height and the lower lumbar spine anterior convexity angle scores on PODs 1–3 and at 6 months postoperatively.

Conclusion: OLIF combined with the Wiltse approach pedicle screw fixation can achieve good short-term clinical results in the treatment of single-level DLS. This surgical approach is less invasive, promotes early functional recovery, shortens hospitalization time, and improves the quality of life.

Introduction

Partial or complete slippage of the upper and lower vertebrae and loss of disc height due to structural abnormalities of the adjacent vertebral junctions caused by lumbar degeneration is clinically known as degenerative lumbar spondylolisthesis (DLS)\(^1\). Based on the direction of displacement, it is classified as anterior, posterior, and lateral displacement, while the most common type is the L4/L5 anterior slip with a Meyerding classification of grade \(^1\) to \(^3\). The clinical prevalence is in the range of 4%-11%, with a prevalence in people over 50 years of age. The main clinical manifestations are low back and leg pain, lower extremity skin loss, lower extremity muscle weakness, and intermittent claudication\(^4, 5\).

Lumbar fusion is the mainstream surgical procedure for the treated DLS to restore the intervertebral space height, relieve nerve root compression, and stabilize the vertebral body of the motion segment. Posterior lumbar interbody fusion (PLIF) is the classic procedure for the DLS, with a success rate of over 90% in the management of lumbar spondylolisthesis and lumbar disc disease, but the PLIF procedure has a high incidence of nerve injury and is more traumatic. With the development of medical technology
and minimally invasive procedures, anterior lumbar interbody fusion (ALIF), extreme lateral interbody fusion (XLIF), and direct lateral interbody fusion (DLIF) have gradually provided new treatment options for degenerative lumbar spine diseases, but they have their limitations\cite{6,7}. Silvestre et al\cite{8}, first used oblique lateral interbody fusion (OLIF) instead of the lateral lumbar interbody fusion (LLIF), which has the advantages of ALIF and LLIF and also compensates for the disadvantages of the other procedures with a higher safety profile through the natural gap between the large abdominal vessels and the psoas major muscle. However, DLS, if performed purely with OLIF, will have the risk of incomplete correction of vertebral slippage and sinking and prolapse of the intervertebral fusion due to osteoporosis and poor bone condition. At this time, posterior small-incision nail rod internal fixation is needed to maintain the stability of the injured spine and compensate for the deficiencies of the OLIF-only procedure, but there are few reports on this. Hence, the current study aimed to explore the efficacy of OLIF combined with Wiltse approach pedicle screw fixation in the treatment of single-level DLS.

**Methods**

**Study design**

This was a retrospective study. Of the 60 potentially eligible patients treated, 4 were excluded because they did not meet the inclusion criteria and 2 declined to participate (Fig. 1). The study enrolled 54 patients with single-level DLS who were treated at the Affiliated Jiangnan Hospital of Zhejiang Chinese Medical University from May 2018 to June 2020. There were 24 male and 30 female cases, aged 50-75 years, with a mean of 62.3 years. The slipped segments: L3/L4 in 8 cases and L4/L5 in 46 cases. (OLIF group) 24 cases were treated with OLIF combined with Wiltse approach pedicle screw fixation and (PLIF group) 30 cases were treated with PLIF. There was no statistically significant comparison between the two groups in terms of gender, age, slipped segment, VAS score, ODI score, intervertebral space height, and lower lumbar anterior convexity angle (all $P>0.05$). Baseline characteristics and baseline clinical assessment were comparable (Table 1).

**Inclusion and exclusion criteria**

Inclusion criteria:

1. aged between 50 and 75 years
2. diagnosis of single-level degenerative slippage with a Meyerding grade of 1
3. the presence of symptoms such as intractable low back pain
4. ineffective conservative treatment for more than 3 months and significant interference with daily life
5. complete data with postoperative follow-up of more than 6 months

Exclusion criteria:

1. Patients with other major medical or surgical diseases
2. diagnosis of non-single-level DLS with a Meyerding grade of II or higher
3. Patients with severe osteoporosis
4. Previous history of back or abdominal surgery
5. spinal tumors or significant spinal stenosis
6. incomplete data with a postoperative follow-up of fewer than 6 months

**Surgical techniques**

For the OLIF group, patients were generally anesthetized and placed in the right lateral recumbent position. The left lumbar abdominal field was routinely disinfected and toweled. An inverted skin incision was made 3 cm above the left iliac crest, about 5 cm long, and the skin, subcutaneous, fascia, external oblique abdominal muscle, internal oblique abdominal muscle, and transverse abdominal fascia were incised layer by layer, and the posterior peritoneum was pushed forward to expose the left psoas major muscle. After fluoroscopy, the vertebral space of the injured vertebra was determined, the vertebral space and cartilage endplates were cleaned, the vertebral space was enlarged sequentially by trial molds, the suitable fusion device was placed into the vertebral space of the injured vertebra, and the depth of the fusion device was adjusted after fluoroscopy to reach satisfaction. Thorough hemostasis was achieved, the incision was flushed with saline, the instrument gauze was counted without error, one negative pressure drainage tube was left in place, the transverse, internal, and external oblique abdominal muscles were repaired, the incision was sutured layer by layer, and the incision was wrapped with a sterile dressing. The patients were changed to the prone position, the lumbosacral region was routinely disinfected and toweled, a longitudinal incision was made along the line of the spinous process of the target vertebral body, and the skin, subcutaneous tissue, and deep fascia were incised layer by layer. A multi-issue approach was made, the outer edge of the posterior articular eminence of the vertebral plate was exposed, the bilateral articular eminence of the injured vertebrae was exposed, and the arch locating pin was driven into the outer lower edge, the position was adjusted after fluoroscopy to reach satisfaction, the hole was reamed, tapped, and the arch screws were placed, and the arch nails were seen to be in good position after fluoroscopy, the bilateral US connecting rods were installed, slight pressure was applied, and the nuts were tightened, and the internal fixation and fusion device were seen to be in good position after fluoroscopy. The incision was rinsed with saline, sutured layer by layer, and the incision was dressed with a sterile dressing. (Fig. 2)

For the PLIF group, patients were generally anesthetized, and placed in the prone position, and the lumbosacral region was routinely disinfected and toweled. An incision was made between the spinous processes of the untargeted vertebrae, and the skin, subcutaneous tissue, and lumbar dorsal fascia were incised, and the paravertebral muscles were peeled away, and the muscles were retracted on both sides to reveal the vertebral plates and articular processes of the corresponding segments. The intersection of the upper articular eminence and the transverse eminence is used as the location, and under the monitoring of the C-arm X-ray machine, the target vertebral body is opened, reamed, tapped, and the pedicle screws are placed on both sides of the vertebral body, and the vertebral plate is removed and decompressed with
a bone chisel and a vertebral plate bite forceps. The ligament flavum and the superior articular eminence of coalescence were removed, the lateral saphenous fossa was enlarged, the dural sac and nerve roots were retracted with a nerve puller, the injured intervertebral disc was removed, the endplate was treated, saline was flushed, an intervertebral fusion was implanted, the rod and nut were installed with compression, the arch system and the fusion were well-positioned under fluoroscopy, hemostasis was completely stopped, a large amount of saline was flushed, a negative pressure drain was placed, the incision was closed layer by layer, and the incision was dressed with a sterile dressing. (Fig. 3)

**Postoperative management**

Postoperative antibiotics were routinely administered for 2 days, and the drainage tube was removed when the flow was less than 10 ml. In the case of cerebrospinal fluid leakage, drainage was left in place for not less than 10 d. Postoperative analgesia was routinely administered. Functional training of the lower limbs was started on the 2nd postoperative day, and the patient could walk in bed under the protection of elastic reinforced lumbar girth on the 3rd postoperative day and carry out functional rehabilitation exercises. Oral anti-osteoporosis drugs were taken for postoperative follow-up treatment of osteoporosis. Regular postoperative review of X-ray and other imaging examinations.

**Primary outcomes**

The VAS was used to assess the low back pain status, and the ODI was used to evaluate the functional status at PODs 1-3 and 6 months postoperatively. The lower lumbar spine anterior convexity angles were compared between the two groups (the angle between the upper endplate of the injured vertebra and the upper endplate of the injured vertebra is positive for anterior convexity).

**Secondary outcomes**

To compare the operative time, intraoperative bleeding, postoperative drainage, the length of hospital stay, and postoperative complications in the two groups. To compare the lumbar spinal space height (mean value of the height of the anterior and posterior margins of the injured spinal space) between the two groups. Macnab surgical rating criteria for low back pain to evaluate clinical outcomes.

**Follow-ups**

Monthly frontal and lateral x-rays were taken for six months after surgery, followed by radiographs every three months for another six months. VAS, ODI, intervertebral space height, and the lower lumbar spine anterior convexity angles were used to assess lumbar motion function. The modified Macnab scale was used to evaluate the clinical efficacy at the final follow-up. (Excellent: complete disappearance of symptoms and resumption of work-life; Good: mild symptoms and mild limitation of activities, no effect on work-life; OK: reduced symptoms and limitation of activities, affecting normal work and life; Poor: no difference before and after treatment, or even worse.)

**Ethical consideration**
All participants signed a written informed consent to participate in the study. The study protocol was consistent with the guidelines of the Declaration of Helsinki. The study was approved by the Medical Ethics Committee of the Affiliated Jiangnan Hospital of Zhejiang Chinese Medical University (Hangzhou Xiaoshan Hospital of Traditional Chinese Medicine) (20180815).

**Statistical analysis**

Data were analyzed using SPSS 22.0 statistical software. Normally distributed, chi-squared quantitative data were expressed by mean ± standard deviation or number (%). Paired samples t-test was applied for intra-group comparisons and independent samples t-test for inter-group comparisons. Count data were compared using the chi-square test. P-value less than or equal to 0.05 was considered significant, and less than 0.001 was highly significant.

**Results**

A total of 54 patients were enrolled in the study. All patients were followed up for 12-20 months, with a mean of 16.2 months. Results showed that the duration of surgery in the OLIF group was significantly less than in the PLIF group (91.46±6.83 vs 110.67±10.40min, P<0.001). Intraoperative bleeding was significantly less in the OLIF group compared with the PLIF group (92.92±9.55 vs 183.33±24.40ml, P<0.001). In addition, postoperative drainage was significantly less in the OLIF group compared to the PLIF group (31.88±6.73 vs 65.33±10.17ml, P<0.001). Hospitalized days in the OLIF group were significantly less than in the PLIF group (6.63±0.77 vs 9.93±0.91d, P<0.001) (Table 2).

In the OLIF group, there was one neurological complication and one endplate injury, and no cerebrospinal fluid leakage, fusion device displacement, or sinking occurred. Three neurological complications, one cerebrospinal fluid leak, two endplate injuries, and one fusion displacement or subsidence occurred in group B. No intervertebral space infection occurred in either group, and no pedicle screw fracture or loosening was observed. However, there was no significant difference in the total complication rate between the two groups (Table 3).

Comparisons of VAS and ODI scores showed significant improvement during follow-ups in both groups (All p< 0.05). There were significant differences in VAS (2.63±0.58 vs 3.57±0.63, P<0.001) and ODI (9.67±0.92 vs 10.63±1.40, P<0.05) between the OLIF group and PLIF group on PODs1-3. However, the differences between the two groups were not significant at 6 months postoperatively.

The VAS and ODI scores were significantly lower when compared within the two groups at postoperative and postoperative 6 months, and the differences were statistically significant (P<0.05). The differences were statistically significant (P<0.05) when comparing the postoperative and 6-month postoperative intervertebral space height and lower lumbar anterior convexity angle scores between the two groups. Within the two groups, there was no significant decrease in the postoperative and 6-month postoperative interbody height and lower lumbar anterior convexity angle scores, but the differences were statistically
significant (P<0.05). The overall excellent rate in both groups, the difference was not statistically significant (P>0.05) (Table 3). Typical cases are shown in Figure 1,2.

**Discussion**

With the increasing aging in China, the incidence of lumbar degenerative diseases has increased, and DLS is one of the highly prevalent types of lumbar degenerative diseases\[9,10\]. The pathogenesis of DLS is poorly defined, the etiology is complex, and it is often combined with lumbar scoliosis, lumbar spinal stenosis, and osteoporosis. Clinically, it can produce intractable lower back and hip pain, intermittent trekking, and radicular symptoms in the lower extremities. Although the symptoms can be somewhat controlled after some conservative modality interventions such as physical therapy, they are prone to recurrence. Some studies have shown\[11,12\] that about 10% of patients with DLS have indications for surgery. When long-term conservative treatment is unsuccessful, surgery is often required to completely relieve the dysfunction.

In traditional surgical treatment, most vertebral fusion is used such as open surgery ALIF, PLIF, and minimally invasive surgery TLIF, XLIF, and DLIF\[13–17\]. The most classic PLIF procedure is capable of decompressing the spinal canal directly, correcting the anterior lumbar convexity angle, resetting the slipped vertebral body, and restoring a certain height of the vertebral space. The lumbar stability is enhanced by the posterior nail bar system, which improves the stability of the fusion. However, this procedure destroys the stability and integrity of the posterior lumbar column, causing irreversible damage to the small joints and the posterior lumbar complex, which in turn strains the dura mater and nerve roots, which inevitably leads to complications such as adjacent vertebral disease, nerve injury, increased operative time and intraoperative bleeding. The OLIF procedure, officially named by Silvestre et al. The procedure establishes working through the gap between the psoas major muscle and the abdominal aorta channel, which greatly reduces the occurrence of complications and has been used as a new means of treatment for lumbar spondylolisthesis\[18,19\]. In patients with DLS, there are more cases of osteoporosis and poor bone condition, and the biomechanical strength of OLIF Standalone is often inadequate, which requires posterior small-incision nail rod internal fixation to compensate for this deficiency\[20\]. There is no definitive answer to the question of whether to perform OLIF Stand alone or open posterior fusion for DLS. The need for anterior fusion and posterior fixation for superior union remains controversial. The author used OLIF combined with Wiltse access pedicle screw fixation to treat single-level DLS with good recent clinical results. This procedure is less invasive, has fewer complications, promotes early functional recovery, shortens hospitalization time, and improves the quality of life.

**Advantages Of Olif Combined With Wiltse Approach Pedicle Screw Fixation For Single-level Dls**
The principles of treatment for single-level DLS need to revolve around various aspects of decompression, bracing, repositioning, stabilization, balance, and complications. Simple OLIF cannot meet this and conventional PLIF has certain shortcomings. Yang SL et al.\[21\] used OLIF combined with Wiltse approach pedicle screw fixation for DLS, yielding effective postoperative correction of the coronal Cobb angle (19.6° ± 4.8° vs 6.9° ± 3.8°, P < 0.05), sagittal spine axis (4.3 ± 4.3 vs 1.5 ± 1.0 cm, P < 0.05), anterior lumbar convexity angle (29.4° ± 8.6° vs 40.8° ± 5.8°, P < 0.05), significant improvement in lumbar and leg pain and functional scores, high fusion rate, and good stability.

In the present study, the author used OLIF combined with Wiltse access pedicle screw fixation to treat patients with single-level DLS. The results showed that the operative time was (91.46 ± 6.83) min, intraoperative bleeding was (92.92 ± 9.55) ml, postoperative drainage was (31.88 ± 6.73) ml, and hospital stay was (6.63 ± 0.77) d, which was significantly better than the PLIF group, and the difference was statistically significant. And the postoperative VAS and ODI scores, intervertebral space height, and lower lumbar anterior convexity angle scores were significantly improved, and the differences were statistically significant when compared with the PLIF group. Overall, there were also fewer postoperative complications and high effectiveness, and satisfactory recent clinical efficacy was obtained. Its main advantages are as follows:

(1) The OLIF procedure works in the gap between the psoas major muscle and the abdominal aorta, and finally reaches the target disc directly, with the operating interval in the anterior lumbar spinal canal, which can effectively reduce the vascular nerve injury in the abdominal cavity and around the spinal canal, and significantly reduce the operation time, bleeding and complications.

(2) The OLIF procedure and the Wiltse approach preserve the ligamentous complex and posterior column structure to a greater extent, effectively avoiding excessive stripping and injury to the paravertebral muscles, which not only maintains the structural stability and stress environment of the lumbar spine, but also reduces the degree of postoperative low back pain. No direct spinal decompression is required, with little trauma and quick recovery.

(3) The implanted intervertebral fusion can have a larger area than the PLIF procedure, and the intervertebral fusion comes with an anterior or lateral convexity angle, which can restore the intervertebral space height and indirect spinal canal decompression while reconstructing the coronal sagittal balance. It can improve the stability of the anterior and middle columns of the lumbar spine and assume the main axial pressure.

**Indications For Olif Combined With Wiltse Approach Pedicle Screw Fixation For Single-level Dls**

OLIF combined with Wiltse approach pedicle screw fixation for single-level DLS has significant advantages over OLIF and PLIF alone, but the indications for the procedure still need to be controlled. (1)
no further posterior decompression is required; (2) mild lumbar degenerative slippage with Meyerding grade I; (3) no disc prolapse, no severe ligamentum flavum hyperplasia or calcification, and no severe spinal stenosis in the target segment. (4) persistent low back pain and other symptoms exist, conservative treatment > 3 months or more is ineffective and significantly affects life; (5) good spinal stability, no serious lateral protrusion or kyphosis, no serious osteoporosis, and the patient can accept this operation; (6) no history of lumbar interbody fusion surgery in the target segment, no non-lumbar degenerative pathology such as septic disc infection; (7) necessary and suitable for Wiltse approach patients with pedicle screw fixation.

**Surgical Considerations For Olif Combined With Wiltse Approach Pedicle Screw Fixation For Single-level Dls**

Rational surgical planning and operation are crucial, and to Abe et al.\(^22\), found in a multicenter retrospective study that most of the complications of OLIF were operationally related, and the complication rate was 48.3%, so we need to keep the following surgical considerations in mind:

(1) Postural exchange: Since the OLIF procedure requires right lateral recumbency and the Wiltse approach requires a prone position for pedicle screw fixation, it is necessary to pay attention to the replacement of lateral block and axillary pillow during the articulation and position rotation, and to prevent wound contamination and aseptic operation during this process.

(2) Bleeding control: preoperative lumbar MRI examination is performed to assess the anatomical position of the abdominal vena cava and the natural gap between the vessels, and to exclude vascular variant alignment. Intravenous tranexamic acid can be administered half an hour before surgery, thus reducing intraoperative bleeding. Familiarity with the anatomical position avoids injury to the main arteries such as the common iliac and iliolumbar and complete hemostasis, and autologous blood transfusion can be used.

(3) Surgical access and traction: accurate body surface positioning of the OLIF surgical incision is required before surgery, the access cannot be too vertical or tilted, and excessive traction cannot be used to stimulate the psoas major muscle to avoid postoperative thigh paresthesias and reduced strength of the psoas major muscle.

(4) Avoid ureteral injury: intraoperative blunt separation of tissues needs to be cautious, if the intraoperative urinary fluid outflow is seen, or postoperative appearances such as abdominal pain, abdominal distension, hematuria, vomiting, etc. need to be promptly addressed and remedied.

(5) Avoid nerve injury: intraoperative use of somatosensory evoked potential detection can help reduce the chance of intraoperative nerve injury and identify patients who are prone to induce neurological injury.
(6) Fusion device sedimentation vigilance: intraoperative scraping of cartilage endplates should avoid bony endplate injury. For those with more lax bone quality, a wider intervertebral fusion should be selected and the fusion should be implanted as parallel to the vertebral space as possible.

(7) Posterior pedicle screw treatment: avoid excessive deviation to the lateral side of the transverse process during pedicle screw implantation or multiple adjustments of the nail placement channel resulting in poor stability. When the bone is lax, the nail channel can be reinforced with polymethylmethacrylate to increase screw stability.

Conclusion

The study reports favorable results by OLIF combined with Wiltse approach pedicle screw fixation in the treatment of single-level DLS as it provides significant pain relief, restores the height of the vertebral space and the lower lumbar spine anterior convexity angle, improves lumbar mobility, and maintains biomechanical strength. OLIF combined with the Wiltse approach pedicle screw fixation had less operative time, intraoperative bleeding, postoperative drainage, and hospitalized days than PLIF. Moreover, complications of PLIF showed no significant differences compared to OLIF combined with Wiltse approach pedicle screw fixation.

Declarations

Consent for publication

Written informed consent was obtained from the patient for publication of this case report and any accompanying images. A copy of the written consent is available for review by the Editor of this journal.

Availability of data and materials

Not applicable.

Competing interests

All the authors declare that they have no conflicts of interest.

Funding

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Authors’ contributions
Weibin Du and Yi Dong did the data collection and writing. Weibin Du and Zhenwei Wang were major contributors to writing the manuscript. Weibin Du, Renfu Quan, and Jiwei Qi contributed to the conception and design of the study. All authors read and approved the final manuscript.

References


Tables

Table 1 Baseline demographic and clinical characteristics of two groups
<table>
<thead>
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<th></th>
<th>OLIF group</th>
<th>PLIF group</th>
<th>p</th>
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</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>61.38±6.79</td>
<td>60.83±6.67</td>
<td>0.770</td>
</tr>
<tr>
<td>Gender, n (%)</td>
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<tr>
<td>Male</td>
<td>10(42%)</td>
<td>14(47%)</td>
<td>0.819</td>
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<tr>
<td>Female</td>
<td>14(58%)</td>
<td>16(53%)</td>
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<tr>
<td>VAS</td>
<td>6.42±0.83</td>
<td>6.73±0.69</td>
<td>0.132</td>
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<td>ODI (%)</td>
<td>46.67±5.69</td>
<td>47.47±6.361</td>
<td>0.632</td>
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<tr>
<td>Spondylolisthesis(n)</td>
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<td></td>
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<tr>
<td>L3/L4</td>
<td>3</td>
<td>5</td>
<td>0.712</td>
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<tr>
<td>L4/L5</td>
<td>21</td>
<td>25</td>
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<tr>
<td>ISH (n)</td>
<td>5.58±1.02</td>
<td>5.77±1.22</td>
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<tr>
<td>LACA (*)</td>
<td>10.92±1.86</td>
<td>11.17±2.02</td>
<td>0.642</td>
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</table>

Data are presented as mean ± standard deviation, unless otherwise stated

VAS: visual analog scale; ODI: Oswestry dysfunction index; ISH: intervertebral space height; ACA: the lower lumbar spine anterior convexity angle

Table 2 Comparisons of perioperative related indicators between two groups

<table>
<thead>
<tr>
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<th>OLIF group</th>
<th>PLIF group</th>
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<tr>
<td>OT (min)</td>
<td>91.46±6.83</td>
<td>110.67±10.40</td>
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<tr>
<td>IBL (ml)</td>
<td>92.92±9.55</td>
<td>183.33±24.40</td>
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<tr>
<td>PD (ml)</td>
<td>31.88±6.73</td>
<td>65.33±10.17</td>
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<tr>
<td>HDs (d)</td>
<td>6.63±0.77</td>
<td>9.93±0.91</td>
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</tbody>
</table>

Data are presented as the mean ± standard deviation

OT: Operation time; IBL: intraoperative blood loss; PD: postoperative drainage; HDs: hospitalized days

Table 3 Comparisons of postoperative days 1-3 and 6 months postoperatively related indicators between two groups
<table>
<thead>
<tr>
<th></th>
<th>OLIF group</th>
<th>PLIF group</th>
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<td><strong>VAS</strong></td>
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<tr>
<td>PODs 1-3</td>
<td>2.63±0.58</td>
<td>3.57±0.63</td>
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<tr>
<td>POMs 6</td>
<td>1.08±0.28</td>
<td>1.10±0.31</td>
<td>0.838</td>
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<tr>
<td><strong>ODI (%)</strong></td>
<td></td>
<td></td>
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<tr>
<td>PODs 1-3</td>
<td>9.67±0.92</td>
<td>10.63±1.40</td>
<td>0.004</td>
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<tr>
<td>POMs 6</td>
<td>5.63±1.41</td>
<td>6.07±1.08</td>
<td>0.212</td>
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<tr>
<td><strong>ISH (mm)</strong></td>
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<tr>
<td>PODs 1-3</td>
<td>13.08±1.53</td>
<td>10.07±1.51</td>
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<tr>
<td>POMs 6</td>
<td>12.75±1.33</td>
<td>9.77±1.20</td>
<td>0.000</td>
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<td><strong>LACA (°)</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>PODs 1-3</td>
<td>17.92±1.44</td>
<td>15.83±1.64</td>
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<tr>
<td>POMs 6</td>
<td>17.71±1.37</td>
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<td>complications</td>
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<td>NC</td>
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<tr>
<td>ISI</td>
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<td>CFL</td>
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<td>ED</td>
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<td>2</td>
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<td>DSFD</td>
<td>0</td>
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<tr>
<td>Total incidence</td>
<td>8.3%</td>
<td>23.3%</td>
<td>0.189</td>
</tr>
<tr>
<td><strong>MR, n (%)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excellent</td>
<td>20(83.3%)</td>
<td>22(73.3%)</td>
<td></td>
</tr>
<tr>
<td>Good</td>
<td>3(12.5%)</td>
<td>5(16.7%)</td>
<td></td>
</tr>
<tr>
<td>OK</td>
<td>1(4.1%)</td>
<td>3(10.0%)</td>
<td></td>
</tr>
<tr>
<td>Poor</td>
<td>0(0)</td>
<td>0(0)</td>
<td></td>
</tr>
<tr>
<td>Total excellent and good rate</td>
<td>24(95.8%)</td>
<td>27(90.0%)</td>
<td>0.873</td>
</tr>
</tbody>
</table>

Data are presented as mean ± standard deviation, unless otherwise stated.

VAS: visual analog scale; ODI: Oswestry dysfunction index; PODs: postoperative days; POMs: postoperative months; ISH: intervertebral space height; LACA: the lower lumbar spine anterior convexity
Figures

Figure 1

Flowchart of the study protocol
A 71-year-old female with degenerative L4/L5 lumbar grade I slippage was treated with OLIF combined with Wiltse approach pedicle screw fixation. (A, B) The preoperative frontal and lateral radiographs showed that the L4/L5 lumbar spine was slipped in the first degree, the lumbar spine was unstable, the intervertebral space height was 5.5 mm, and the lower lumbar spine anterior convexity angle was 9.8°. (C, D) Postoperative 6 months frontal and lateral radiographs showed that the internal fixation was stable
and in good position. The intervertebral space height was 10.2 mm, and the lower lumbar spine anterior convexity angle was 16.3°.

Figure 3

A 52-year-old male with degenerative L4/L5 lumbar grade I slippage was treated with PLIF. (A, B) Preoperative frontal and lateral radiographs showed that the L4/L5 lumbar spine was slipped in the first
degree, the lumbar spine was unstable, the intervertebral space height was 5.5 mm, and the lower lumbar spine anterior convexity angle was 9.8°. (C, D) Postoperative 6 months frontal and lateral radiographs showed: stable internal fixation and good position. The intervertebral space height was 10.2 mm and the lower lumbar spine anterior convexity angle was 16.3°.