

## Original Article

# Mini-open transforaminal lumbar interbody fusion through a modified Wiltse paraspinous approach for recurrent lumbar disc herniation

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**Abstract:** Recurrent lumbar disc herniation (RLDH) has been estimated to occur in 5% to 15% of patients after discectomies. Traditional transforaminal lumbar interbody fusion (TLIF) is characterized by great trauma. In recent years, surgical treatment of lumbar degenerative diseases has shown a minimally-invasive trend, with the TLIF technique developing to mini-open incisions. Perioperative data (duration of procedure, intraoperative blood loss, postoperative drainage, time to ambulation, length of hospital stay) and primary efficacy outcomes (visual analog scale for back and leg pain-VAS and Oswestry Disability Index-ODI) were compared between the mini-open TLIF group and TLIF group, along with bony fusion and complications. A total of 45 patients were followed up for 24 to 60 months. VAS scores and ODIs were significantly reduced in the 2 groups after surgery ( $P<0.001$ ). Operation time, intraoperative blood loss, postoperative drainage, time to ambulation and length of hospital stay significantly decreased in the TLIF group, compared with the PLIF group ( $P<0.001$ ). Mini-open TLIF through a modified Wiltse paraspinous approach can achieve satisfactory clinical outcomes in the treatment of RLDH. It has several advantages, including less invasiveness and lower incidence of complications, such as intraoperative dural tears, compared with traditional TLIF.

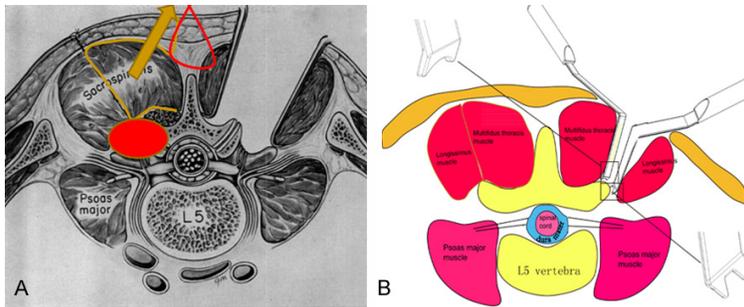
**Keywords:** Recurrent lumbar disc herniation, mini-open posterior surgery, transforaminal lumbar interbody fusion, modified wiltse paraspinous approach

## Introduction

Recurrent lumbar disc herniation (RLDH) is defined as the occurrence of herniated disc material at the same level in patients that have undergone discectomies, experiencing at least a pain-free 6-month interval. It has been noted to occur in 5 to 15% of cases surgically treated for primary lumbar disc herniation [1]. Lumbar disc herniation (LDH) can relapse after resection of nucleus pulposus. Patients receiving failed conservative treatment should undergo re-correction. Relevant studies have reported that re-operation rates after the first discectomy can be up to 15% [2-5].

It remains controversial whether fusion is needed in the second operation [6]. Due to late revision after the second discectomy, fusion operations tend to be chosen [7-9]. Traditional transforaminal lumbar interbody fusion (TLIF) is characterized by great trauma. The operation is often difficult due to epidural scar tissue adhesion caused by the previous operation, increasing incidence rates of dural tears and nerve injuries during the operation [10-12]. Minimally-invasive transforaminal lumbar interbody fusion (Mis-TLIF) has unique advantages. Scar tissues do not need to be peeled off extensively, muscle and soft tissue injuries are reduced, and the dural nerve root is pulled less [13]. However, intervertebral revision via channel-assisted Mis-TLIF is hard due to the steep learning curve, technical complexity, expensive instrumentation, limited visualization of the spine, and absence of clear benefits over open procedures in terms of complication rates and outcomes [14, 15]. To simplify the operation, a simple and practical exposure tool has been designed, aiming to treat recurrent lumbar disc herniation (RLDH) with mini-open TLIF via a secondary-modified Wiltse approach (Figure 1).

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**Figure 1.** A. Schematic map for modified Wiltse's approach. Yellow line indicates the modified approach, red elliptic region indicates the operating range of spinal operation, and arrow indicates the direction of muscle movement after the muscles were pulled during operation. Red line indicates that the bilateral deep fascia can be sutured directly to the supraspinous ligament after completion of operation. B. Combined with the exposure tools we designed, the surgical procedures will be more convenient under secondary-modified Wiltse approach.

**Table 1.** General data of patients

	Mini-open TLIF (n=21)	TLIF (n=24)	P
Gender (male/female)	11/10	16/8	0.329
Age (years old)	49.2±8.9	52.0±8.9	0.298
Body mass index (BMI) (Kg/m <sup>2</sup> )	27.0±1.9	27.4±1.2	0.397
Segment			0.995
L3/4	1	1	
L4/5	14	16	
L5/S1	6	7	
Course of disease (months)			0.537
<3	9	14	
3-12	6	7	
12-24	3	2	
> 24	3	1	
Follow-up time (months)	34.4±9.0	40.0±10.7	0.066

For patients with recurrent disc herniation that have undergone discectomies, mini-open TLIF via a secondary-modified Wiltse approach is superior to traditional TLIF in terms of fewer equipment costs, fewer technical difficulties, and reduced surgical duration and complication rates. This study introduces the simple and convenient TLIF technique for treatment of RLDH, aiming to explore whether this operation method can decrease surgical trauma.

### Patients and methods

#### Patients

A total of 45 patients with RLDH were enrolled, from January 2009 to December 2014. These

patients were randomly divided into two groups, including 24 patients treated with traditional PLIF (PLIF group) and 21 patients treated with TLIF via secondary-modified Wiltse approach (TLIF group). General data (gender, age, body mass index, segment, course of disease, follow-up time) are summarized in **Table 1**. All experimental protocols in this research were approved by The First Hospital of Nanjing Medical University Ethics Committee and informed consent was obtained from all patients.

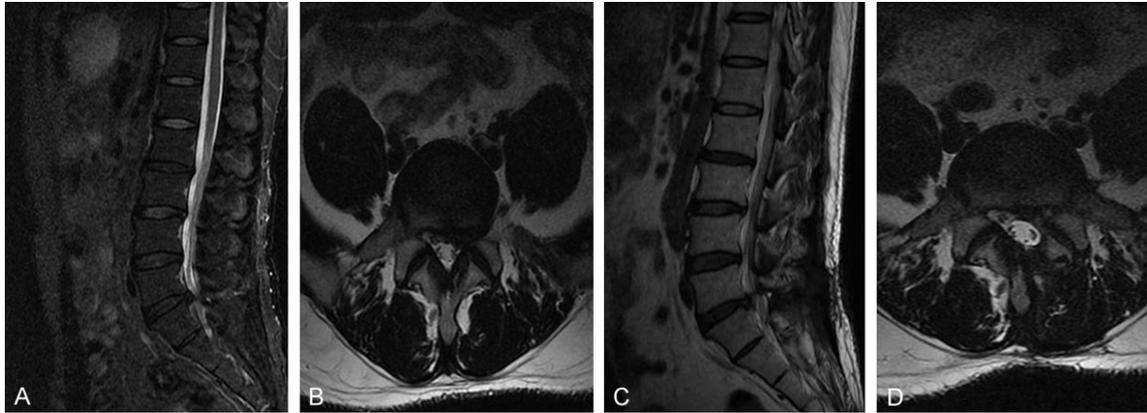
Criteria for surgery included: 1) Patients with the symptom remission phase > 6 months after the first discectomy (single segment); 2) Patients with radicular pain as the main symptom of recurrence receiving failed conservative treatment (at least 3 months); 3) Images via magnetic resonance imaging (MRI) showed that the recurrent herniation occurred on the same or opposite side of original operative segment (**Figure 2**) and the compressive object confirmed via intraoperative exploration was nucleus pulposus tissues rather than scars [16]; and 4) Patients that were followed up for more than 24 months after

operation. Exclusion criteria were: 1) Patients with lumbar fractures, active infections, or tumors; and 2) Patients with serious osteoporosis or spinal deformities.

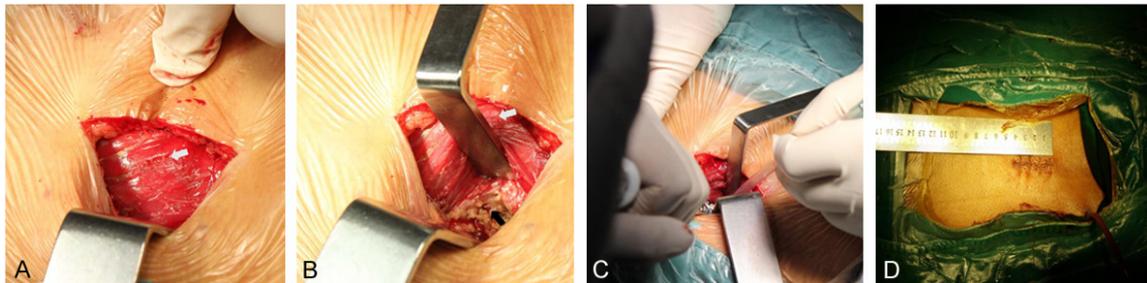
#### Description of surgery

In the mini-open TLIF group, a midline wound incision was made and the deep fascia was cut up longitudinally from the original incision along the supraspinous ligament. The intermuscular space was pulled to expose the surgical field using the lateral retractor and medial retractor (**Figure 3A, 3B**). According to the entry direction measured before the operation and the anatomical relationship between screw-setting vertebra and supraspinous ligament [17], screws

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**Figure 2.** A, B. Before the first surgery, lumbar MR showed the left-rear protrusion of L5/S1 intervertebral disc and obvious compression against the left nerve root. C, D. Before the second surgery, MR images indicated the original operative segment of the left disc vertebral prominent again.



**Figure 3.** A, B. Mini-open TLIF via secondary-modified Wiltse approach used the exposure tools to peel off till the intermuscular space between multifidus muscle (White arrow) and longissimus muscle and exposure facet joints (Black arrow). C. Benefit of this approach was the clear intraoperative exposure and the screw setting was feasible under near-direct vision. D. The length of the sutured incision was about 4 cm.

were implanted into the upper and lower vertebrae of affected segments (**Figure 3C**). A small number of paravertebral muscles were peeled off inwards along the upper vertebral plate on the recurrence side and the spinous retractor was used to pull the multifidus muscle inwards to clearly expose the remaining vertebral plate and articular process. Cicatricial adhesion produced by ventral dural nerve roots and rear tissues of intervertebral space was carefully separated. Additionally, the inferior lumbar lateral recess and nerve root canal were expanded to completely relax the compressed nerve root. The contralateral intervertebral foramen was opened and the residual nucleus pulposus was removed. Bone substances removed from the vertebral attachment were crushed and filled into the front intervertebral space and one reniform cage with autologous bone was implanted into the side with obvious symptoms. After detecting the nerve root and drainage, bilateral

deep fascias and middle supraspinal ligament were sutured and the wound was closed layer by layer (**Figure 3D**).

In the traditional TLIF group, a midline wound incision was made, the paraspinal muscles were dissected from the spinous process, and facetectomy and interbody fusion were performed. Screws were then inserted and rods were installed.

### *Postoperative management*

Prophylactic antibiotics were applied for 48-72 hours to prevent infections. The drainage tube (drainage fluid <50 mL) was removed timely. Patients were guided for straight-leg-raising training and wore the lumbar brace for 3 months after the operation. Postoperative anteroposterior and lateral plain radiographs and computed tomography (CT) scans were taken for all patients on follow-ups after 3 months, 12

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**Table 2.** VAS and ODI (2-year follow-up)

	Mini-open TLIF	TLIF	P	
VAS (waist pain)	Before operation	5.3±2.7 (6.0)	6.0±2.3 (7.0)	0.353
	1 year after operation	2.4±1.0 (2.0)	3.0±1.1 (3.0)	0.064
	2 years after operation	2.2±1.2 (3.0)	2.8±1.1 (3.0)	0.087
VAS (leg pain)	Before operation	6.8±2.0 (7.0)	7.1±1.8 (7.0)	0.599
	1 year after operation	2.1±1.2 (2.0)	1.9±0.9 (2.0)	0.527
	2 years after operation	2.0±1.0 (2.0)	2.1±0.8 (2.0)	0.711
ODI (%)	Before operation	55.9±10.4 (53.0)	57.5±9.1 (57.0)	0.585
	1 year after operation	22.1±7.2 (19.0)	25.3±8.1 (21.5)	0.171
	2 years after operation	21.9±7.5 (20.0)	26.0±6.4 (24.5)	0.054

**Table 3.** Perioperative data, complications, and fusion

	Mini-open TLIF	TLIF	P
Operation duration (min)	119.8±25.2 (110.0)	172.6±45.8 (174.0)	<0.001
Intraoperative blood loss (mL)	224.7±61.1 (250.0)	422.1±103.5 (415.0)	<0.001
Postoperative drainage (mL)	176.1±41.2 (180.0)	380.4±87.4 (350.0)	<0.001
Out-of-bed activity time (d)	3.2±0.7 (3.0)	5.3±1.3 (5.0)	<0.001
Period of hospitalization (d)	7.3±1.7 (7.0)	10.7±2.2 (10.0)	<0.001
Complication [n (%)]			
Dural tear	1 (5)	5 (21)	0.376
Leakage of cerebrospinal fluid	0	2 (8)	0.502
Fat liquefaction of incisions	0	1 (4)	0.585
Symptomatic ASD	1 (5)	2 (8)	0.630
Fusion [n (%)]			0.225
Grade I (full fusion)	16 (76)	22 (92)	
Grade II (solid fusion)	5 (24)	2 (8)	

months, and 24 months. CT two-dimensional reconstructed images were used to evaluate interbody fusion, according to a previous study [18].

### Evaluation criteria

Imaging examinations were used to evaluate the effects of surgery, including lumbar plain film and CT and magnetic resonance imaging (MRI). Horizontal intervertebral displacement in dynamic position > 3 mm or angle change > 10° indicated segmental instability.

Meyerding grading was adopted for the spondylolysis degree. Modic typing was used in the assessment of end-plate inflammation via MRI. Perioperative evaluation indexes included operation duration, intraoperative blood loss and postoperative drainage, out-of-bed activity time, and period of hospitalization. Moreover, visual analogue scale (VAS) and Oswestry Disability Index (ODI) scores were used for evalua-

tion of waist-leg pain and dysfunction.

### Statistical analysis

SPSS 20.0 software was used for statistical analysis. Chi-squared or Fisher's exact tests were used for enumeration data and *t*-test was used for normal data (age, body mass index (BMI), recurrence interval and follow-up time). Mann-Whitney U-test was used for operation time, intraoperative blood loss, postoperative drainage, out-of-bed activity time, and period of hospitalization. Measurement data are presented as mean ± SD and median. *P*<0.05 indicates a statistically significant difference.

## Results

### Basic characteristics of enrolled patients

All patients tolerated the procedure well. Follow-ups were performed for every patient. General data (gender, age, body mass index, segment, course of disease, follow-up time) (Table 1), preoperative VAS scores, and ODI (Table 2) scores showed no statistically significant differences between the two groups (*P* > 0.05), suggesting that they were comparable.

### Comparison of perioperative data

Table 3 demonstrates that operation duration, intraoperative blood loss, postoperative drainage, out-of-bed activity time, and period of hospitalization in the mini-open TLIF group were all less than those in TLIF group. Differences were statistically significant (*P*<0.001).



**Figure 4.** A, B. After the second surgery, anteroposterior and lateral radiographs show: internal fixation in good location. C, D. 2-year CTs after second surgery show robust bone fusion of L5/S1 intervertebral discs.

#### *Radiological results of group TLIF and mini-open TLIF*

Preoperative MRIs showed disc herniation in the foramen causing foraminal or lateral recess stenosis and nerve root compression (**Figure 2C, 2D**). Ideal placement of interbody fusion cages was verified using postoperative anteroposterior and lateral views radiographies in all patients (**Figure 4A-C**). A total of 45 patients had complete or solid fusions in the final follow-up (Siepe CT fusion criteria). There were 16 cases of grade I and 5 cases of grade II in the mini-open TLIF group, while there were 22 cases of grade I and 2 cases of grade II in the TLIF group. There were no statistically significant differences in fusion between the two groups ( $P > 0.05$ , **Table 3**). No breakage or loosening of internal fixation occurred during follow-ups (**Figure 4D**).

#### *Results of follow-ups in TLIF and mini-open TLIF*

As described in **Table 2**, 45 patients were followed up for 24-60 months after the operation. Differences in VAS scores and ODIs were not statistically significant between the two groups at different time points (12 and 24 months) ( $P > 0.05$ ).

#### *Comparison of complications between TLIF and mini-open TLIF*

Complications are shown in **Table 3**. Dural tears occurred in 5 cases (21%) in the TLIF group, of which 2 cases had leakage of cerebrospinal fluid after the operation. Dural tears

occurred in 1 case in the mini-open TLIF group, without leakage of cerebrospinal fluid after the operation. Symptomatic adjacent segment degeneration (ASD) occurred in 1 case in the mini-open TLIF group at 39 months after operation. Two cases in the TLIF group suffered from symptomatic ASD at 29 and 48 months after the operation. There was 1 case of obesity (BMI=30.1) complicated with fat liquefaction of incisions in the TLIF group, which was healed after hyperosmolar drainage and dressing change.

#### **Discussion**

Difficulties in posterior lumbar disc revision surgery include the unpredictability and anatomical disorder of the previous surgery, increased incidence of dural tears, and spinal nerve root and cauda equina injuries due to separation of scar tissue adhesion [9, 19-21]. Minimally-invasive TLIF has higher operation requirements. Surgeons used to open surgery require specific training and adaptation processes [15, 22]. TLIF via classic modified Wiltse approach may cause increased incidence of skin necrosis, local hematoma, synovial cysts, and other complications due to extensive subcutaneous isolation [23].

Combined with the exposure tools designed (**Figure 1**), surgical procedures will be more convenient under this approach. Compared with the efficacy of conventional TLIF in the treatment of RLDH, it was found that the blood loss and total amount of postoperative drainage of mini-open TLIF via modified approach

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were less than TLIF. Patients usually act on the ground in the thoracic braces earlier, facilitating care and shortening hospital stays. The operation process has been simplified due to approach design and exposure tools, decreasing the operation time to a certain extent. Another benefit of this approach is the clear intraoperative exposure. The screw setting is feasible under near-direct vision (**Figure 3C**). Postoperative improvement in pain and dysfunction in patients was in accord with that in the TLIF group, fully proving that nerve root bony compression can be relieved via TLIF without extensive excision of vertebral spinous process and posterior ligament, achieving good curative effects and reducing trauma and blood loss.

However, in the early stages of this technique, incidence rates of cerebrospinal fluid leakage and pedicle screw misplacement were high [24]. There are still some shortcomings in the application of such devices in the operation: 1) This installation procedure is cumbersome and the working channel space is limited; and 2) Due to a small surgical field and difficult cooperation with the assistant, the difficulty of some surgical procedures has increased. The present study only compared modified TLIF with the traditional TLIF procedure. This study did not address channel-assisted minimally-invasive TLIF, which requires further study.

### Conclusion

Mini-open TLIF via a secondary-modified Wiltse approach in the treatment of RLDH has good curative effects, reducing surgical trauma with a lower incidence rate of related complications, compared with traditional TLIF.

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### Disclosure of conflict of interest

None.

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