Clinical Study of Unilateral Extraforaminal Lumbar Interbody Fusion (ELIF) Revision For Lumbar Disc Herniation After Primary Discectomy

Qilin Lu

Hubei 672 Orthopaedics Hospital of Integrated Chinese and western medicine(HB672OHICWM))

Jin Tang

HB672OHICWM

Long Chen

HB672OHICWM

Xiao-zhen Wang

HB672OHICWM

Yi-liang Zhu

Hubei 672 Orthopaedics hospital integrated of Chinese and Western Medicine

Ao-fei YANG (✉ yangaofei@hbhtcm.com)

Hubei Provincial Hospital of Traditional Chinese Medicine

Research

Keywords: Extraforaminal Lumbar Interbody Fusion, Unilateral pedicle screw fixation, Revision surgery

Posted Date: January 19th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-147573/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Abstract

Background: Lumbar disc herniation (LDH) is a common spinal disorder. The discectomy with non-fusion operation is widely used. When the revision is needed, the options for revision way is still controversial. This study aims to introduce unilateral extraforaminal lumbar interbody fusion (ELIF) revision surgery, and to investigate the clinical efficacy and complication of Unilateral Extraforaminal Lumbar Interbody Fusion (ELIF) in revising primary discectomy for lumbar disc herniation.

Methods: 16 patients with incomplete removal and recurrence herniation of lumbar disc after minimally invasive treatment without fixation were treated by ELIF with unilateral pedicle screw(UPS) from April 2016 to October 2020. All those patients including 11 male and 5 female aged 29-65 years were analyzed retrospectively. The clinical effects were evaluated by operation time, intraoperative blood loss, postoperative blood volume of drainage and complications. The Visual Analogue Scale(VAS), Oswestry Disability Index (ODI) were documented before, after surgery and at last follow-up.

Results: The operation time was 95.73 ± 10.5 min, the bleeding volume was 201.5 ± 27.6 ml. Postoperative blood volume of drainage was 50.7 ± 6.3 ml. 2 patients suffered dura tear. All patients were followed up for 12-26 months with 15.7 on average. VAS and ODI scores significantly improved at the preoperative, postoperative and the 12th month's follow up ($P < 0.05$).

Conclusion: The application of ELIF with unilateral fixation is a satisfied way to revise primary discectomy for lumbar disc herniation. However, the dura tear induced by scar tissue adhesion needs to be noticed.

Background

Lumbar disc herniation (LDH) is a common spinal disorder which mainly caused by degeneration and overloading pathological factors, and the incidence of LDH is increasing^[1]. Herniated intervertebral disc tissue stimulates nerve roots or (and) dural sac resulting in lower lumbar and leg pain and neurological symptoms^[2]. Surgical treatment will be recommended when the systematic conservative treatment failed. The non-fusion operation for LDH is widely used during the treatment for its advantages of minimally invasive, satisfied efficacy and quick recovery. Traditional partial laminectomy with discectomy(TPLD), microscope discectomy (MD),microendoscopic discectomy(MED) and percutaneous endoscopic lumbar discectomy(PELD) were classical non-fusion methods for treating LDH in last several decades^[3]. However, there are still some issues after non-fusion surgery involving incomplete removing the nucleus pulposus, recurrence of intervertebral disc herniation or failed back surgery syndrome (FBSS), et al. The options for revision way is still controversial.^[4, 5]. This study aims to introduce unilateral extraforaminal lumbar interbody fusion (ELIF) revision surgery for lumbar disc herniation after discectomy without fusion at first time. To our current knowledge, this kind of application has not been reported.

Methods

Inclusion and Exclusion Criteria

Inclusion criteria: Patients with lumbar disc herniation have underwent surgery of TPLD, MD, MED, PELD. Pathological factor in single segment caused unilateral symptom after non-fusion surgery. Followed up after ELIF surgery more than one year.

Exclusion criteria: Recurrent disc herniation induced bilateral symptoms. Single segment recurrence with instability of adjacent vertebral body. Single or mixed factors of spinal stenosis. Patient with high iliac crest if pathological segment was on L5/S1. Patient with scoliosis or multi-segmental instability. Patient with infection or tumor.

Patient Information

16 patients were enrolled from April 2016 to October 2020 according to the inclusion and exclusion criteria. There were 11 male and 5 female aged 29-65 years with 45.3 years on average. There were 4 cases of recurrence after TPLD, 2 cases after MED, 3 cases after MED, 6 cases after PELD, and 1 case underwent MED and PELD revision. Preoperative ODI and VAS were 6.3 ± 2.9 and 70.9 ± 15.3 respectively. ELIF technology and clinical application have been approved by Research Ethics Committee of Hospital (NO:672HREC20160101). All patients had informed consent and signed the consent forms before operation. ELIF were operated by a same senior surgeon Pro Zhu Yiliang.

Surgical Procedure

Patient was put in a prone position under general anesthesia. The upper and lower pedicle shadows of lumbar segment on pathological side were identified and marked on skin by AP view fluoroscopy. A longitudinal incision between the upper and lower pedicle shadows was made after conventional surgery area skin disinfection. Superficial fascia and lumbar dorsal fascia were opened, and the Wiltse approach (the gap between the longissimus and multifidus muscle) was used in muscle layer to reach the outer edge of superior and inferior facet joints. Two self-design retractors opened soft tissues to identified pedicle screw entering point on the upper vertebral body. This one pedicle screw was firstly placed after correct preparation. There self-design retractors were properly placed under the assistance of already implanted screw to create a square surgical space. Proper resection of the ventral part of superior articular process of lower vertebral body to enlarged Kambin triangle space for intraspinal and intervertebral space management in the next step. Operation was performed to remove of residual or re-herniated nucleus pulposus and hypertrophic scar tissue induced by original surgery. Subsequently, discectomy, endplate preparation, bone graft and cage implantation were carried out step by step. Lower pedicle screw was placed like the first one, and one pre-bent titanium rod was put and locked on screws after longitudinal proper compression. Position of cage, internal fixation and lumbar lordosis were evaluated by intraoperative fluoroscopy. The drainage tube was placed, and wound was sutured layer by layer (Figure 1. ELIF procedure) .

Rating Parameters

Duration of surgery, intraoperative blood loss, postoperative drainage were recorded. ODI and Vas were recorded one day before operation, 2 weeks and 12 months after operation. The complications both in perioperative and follow-up period were documented.

Statistical Analysis

The SPSS 21.0 software was used for statistical analysis. The measurement data were recorded as mean $\pm$ standard deviation ($\bar{x} \pm s$). The *t* test was used to compare the scores of ODI and VAS before and after ELIF surgery. *P*-value <0.05 was regarded as significant statistical difference.

Results

The ELIF operation was successfully performed for all patients. The operation time was 95.73 ± 10.5 min, the bleeding volume was 201.5 ± 27.6 ml. Postoperative blood volume of drainage was 50.7 ± 6.3 ml. Two patients suffered dura tear and no cauda equina nerve or nerve root injury has happened. The incision suture was removed 12-14 days after operation, and one dura tear patient was removed suture at 17th day after operation because of cerebrospinal fluid leakage. Patients were followed up for 12-26 months with 15.7 months on average. The scores of ODI and VAS at one day before operation, 14 days (average discharge days) and 12 months after operation were significantly improved (Table 1). No fusion or fixation failure and cage subsidence was observed during whole follow-up period. Although it was not essential after intervertebral fusion, two young patients have required to remove their internal fixations at 1.5 and 2 years after operation according to their own wishes. (Figure 2. one classic case)

Table 1 ODI and VAS before and after ELIF operation ($\bar{x} \pm s$)

	1 day pre-operation	2 weeks post-operation	12 months post-operation
VAS	6.3 ± 2.9	$3.4 \pm 0.9^{**}$	$2.6 \pm 0.8^{*}$
ODI	70.9 ± 15.3	$40.4 \pm 9.3^{***}$	$14.6 \pm 4.9^{***}$

Note: * is for $P \leq 0.05$, ** is for $P \leq 0.01$, *** is for $P \leq 0.001$.

Discussion

Lumbar disc herniation is a disorder of high incidence at present. The protrusion or prolapse of nucleus pulposus compress nerve root or cauda equina leading to low back and leg pain, spinal non-structural scoliosis and even cauda equina syndrome, et al^[6]. Surgical treatment always be recommended when the systematic conservative treatment does not work. Discectomies like TPLD, MD, MED and PELD are classic and universal applications^{[7][8]}. These methods have obvious advantages of minor tissues injury, less blood loss, fewer scars and faster recovery due to early postoperative pain relief. However, incomplete removing the nucleus pulposus, LDH recurrence or FBSS about these methods are inevitable^[9]^[10]. The LDH recurrence rate about discectomy is about 15%, and this rate increases with the observation

time going longer^[11]. OD/MD, MED, PELD have overall complication rates of 16.8% / 16.1%, 21.2% and 5.8%, respectively^[12]. The middle and long-term complications after discectomy involving the height of intervertebral space lost, hypertrophy facet joints and instability of spine also can cause the re-surgical symptoms. Therefore, revision surgery for lumbar disc herniation after primary discectomy deserves further concern.

The formation of scar tissue is a common condition after the primary surgery^[13]. To deal with these postsurgical scar tissues is a crucial step during the revision surgery. It is summarized that these scar tissues are classified as extraspinal and intraspinal canal types. Posterior approach is adopted for TPLD, MD and MED to treat LDH. Once the revision surgery is need for patients who have underwent these primary surgeries, PELD is an option according to the previous report^[14]. PELD from lateral posterior approach could totally avoid extraspinal canal scar tissues and partially avoid intraspinal canal scar tissues. However, this PELD revision may meet failure sometimes. In this study, a 37 years old male presented with low back and leg pain after endoscopic MED for L5/S1 disc herniation in July 2015. There was a relapse of nucleus pulposus caused serious symptom in August 2017. PELD was performed for revision in October. It was found that the herniated nucleus pulposus incomplete removal caused by the intraoperative extradural scar tissue adhesion—Figure 3. Additionally, multiple non-fusion surgeries for spinal column also has potential instability risk.

Lumbar interbody fusion is still the gold standard to relieve neurovascular compression and reconstruct lumbar sequence^[15]. At present, many fusion technologies are used clinically including posterior lumbar interbody fusion (PLIF), transforaminal lumbar interbody fusion (TLIF), anterior lumbar interbody fusion (ALIF), oblique lateral interbody fusion (OLIF) and so on, which are effective methods for the treatment of lumbar^[16]. In 1992, Kabins^[17] first proposed unilateral TLIF pedicle screw for intervertebral fusion. This unilateral fixation can not only reduce the damage of spinal structure, but also save the medical cost. In 2002, Phillips^[18] first introduced the extraforaminal lumbar interbody fusion (ELIF). This surgical method revealed satisfactory curative effect, immediate postoperative stability and high fusion rate in the treatment of lumbar degenerative diseases. In view of its obvious advantages, scholars have achieved satisfactory results in exploring the mechanical research and clinical reports of unilateral ELIF^[19].

It is found that , as compared with PLIF, TLIF, ALIF, OLIF, the ELIF is an appropriate revision method for the recurrence or residual of lumbar disc herniation after initial non- fusion surgery. Wiltse approach enters the gap between the longissimus and multifidus muscle to reach the outer edge of superior and inferior facet joints, which causes minor injury and avoids scar tissue like PELD. Scholars has reported that Wiltse approach can significantly reduce postoperative pain and reduce the incidence of postoperative paraspinal muscle atrophy and fat liquefaction^[20]. In this study, VAS score of preoperative low back pain and ODI score significantly decreased from (6.3±2.9 and 70.9±15.3) to (3.4±0.9 and 40.4±9.3) respectively at the first assessment after operation. In addition to relieving the nerve compression in spinal canal, the protection of soft tissue during operation provided a certain effect. With preserving the facet joints through extraforaminal approach, only partial resection the ventral bone of superior articular

process to enlarged Kambin triangle space for the next step's intraspinal and intervertebral management. Meanwhile, pedicle screws and cage under ELIF surgical filed can be inserted with a larger abduction angle. Additionally, Retaining the mechanical support including the posterior ligament complex and the middle column can improve the immediate stability and significantly reduce the influence for adjacent segments. Therefore, the unilateral fixation of ELIF can achieve satisfied efficacy in lumbar degenerative diseases including LDH revision surgery , and ELIF obtains significantly higher stability than TLIF in unilateral fixation^[21]. The well initial stability was not only an important factor for interbody fusion, but also a guarantee that the patient's symptoms can be continuously improved in one year. VAS 2.6 ± 0.8 , ODI 14.6 ± 4.9 . Apart from the symptom improvement, the amount of bleeding, during the ELIF revision, was 201.5 ± 27.6 ml and the drainage volume was 50.7 ± 6.3 ml. Therefore, unilateral fixation of ELIF is an effective and feasible revision way.

Wiltse approach under quadrant channel is a minimally invasive and classic application for lumbar interbody fusion, but quadrant surgical instruments is of high cost. In this study, three self-designed retractors (Fig. 4 A B, one with arc upper tip marked as α and two with arc lower head marked as β and γ) constructed a channel along Wiltse approach for the ELIF operation. First, two retractors α and β were maintained soft tissue channel to place one upper vertebral pedicle screw. The arc upper tip retractor α was placed on the outer edge of screw insertion point. The pedicle screw tail was used as a fulcrum to place the retractor β for blocking the dorsal soft tissue of lamina. The retractor γ was placed in inner inferior margin of lamina, which was against retractor β . (Fig. 4 C) Then, a stable and wide surgical field was presented. The tension of skin reduced by relaxing the retractor in time to avoid skin ischemia. The lower pedicle screw was implanted after cage implantation. The visual field occlusion by screw tails would happen during operation if two pedicle screw tails were inserted at the beginning . Therefore, three self-designed retractors combined with optimized pedicle screw placement order have constructed an ELIF revision channel with low cost and effective way.

Some issues and risks in ELIF for revision of non-fusion surgery need to be noticed as follow. To deal with the extradural scar tissue induced by original surgery is a crucial step. In this study, the scar tissue adhered to the ventral and lateral dura mater or never root were precisely separated by micro scissors. During this sharp dissection procedure, dura mater and never root needed to be carefully medially retracted, and this slight pulling force created a space which let micro scissors to touch annulus fibrosus layer as lower as possible for separation. The fragility extent of the dura mater is increased after first surgery. The risk of dura injury during revision operation should not be ignored. In this study, one patient had a relapse after 2 years of MED treatment for disc herniation, and underwent failure of PELD revision again. The dura tear occurred during the ELIF revision. The artificial dura mater was cut and attached to the tear part. Postoperatively, patient was advised to keep supine position on bed, and his bed was caudally raised with 20 cm at height, and preventive application of antibiotics which was able to pass through blood-brain barrier was carried out. The amount and color of drainage fluid were observed in time and intravenous liquid supplement was performed. When the volume of drainage began to reduce, intermittent clamp and release drainage tube was applicated combined with the observation of wound's

aseptic dressing. The drainage tube was removed once the skin dressing was on dry condition under persistent clamp condition of drainage tube (at the 4th day after surgery). The incision suture removal time was delayed according to the skin healing condition (17 days after surgery). ELIF retained the bone of posterior column structure. Therefore, the intervertebral autogenous bone implantation shortage was inevitable. Allogeneic bone was used in this study. However, lumbar disc herniation occurs mostly at L4/5 and L5/S1 level, proper caudal enlarge soft tissue can create a tunnel beneath skin. It will be a feasible operation to harvest posterior superior iliac spine autogenous bone under this tunnel. The risk of nerve outlet root injury needed to be cautioned during intervertebral fusion cage implantation. In the selection of cage, too wide head shape should be avoided. The nerve outlet root needed to be identified and protected during the bone and cage implanted through the outside of intervertebral foramen.

Conclusion

This retrospective study concludes that: for patients with recurrent or residual lumbar disc herniation after discectomy without fusion treatment, unilateral ELIF revision through Wiltse approach has theoretical feasibility and is of actual advantages of minimally invasive, controllable risk, satisfied efficacy and quick recovery, which is worthy of further large sample study. Patients with FBSS and lumbar segment instability after discectomy without fusion can also be included in further study too. However, it is particularly worth mentioning that risk of management for hypertrophic scar tissue induced by original surgery should not be ignored, and dura tear and cerebrospinal fluid leakage should be under predictable and reasonable management.

Abbreviations

VAS :Visual analogue scale; ODI: Oswestry disability index; ELIF: Extraforaminal lumbar interbody fusion; UPS: Unilateral pedicle screw; LDH: Lumbar disc herniation; TPLD: Traditional partial laminectomy with discectomy; MED: Microendoscopic discectomy; MD: Microscope discectomy; PELD: Percutaneous endoscopic lumbar discectomy; PLIF: Posterior lumbar interbody fusion; TLIF: Transforaminal lumbar interbody fusion; ALIF: Anterior lumbar interbody fusion; OLIF: Oblique lateral interbody fusion; FBSS: Failed back surgery syndrome

Declarations

Authors' contributions

QLL and JT performed surgery design and manuscript writing. QLL and JT contributed equally to this work. LC and XZW collected the basic and image data and carried out the statistical analysis. YLZ performed ELIF operation. AFY instructed design and checked data. All authors read and approved the final manuscript.

Authors' information

YLZ is the professor, chief surgeon and doctoral supervisor of the

Department of Orthopedics, Hubei 672 Orthopaedics Hospital of Integrated Chinese–Western Medicine, China. AFY is the professor and doctoral supervisor of the Department of Orthopedics, Hubei Provincial Hospital of Traditional Chinese Medicine and Hubei Provincial Academy of Traditional Chinese Medicine, China.

Funding

None

Availability of data and materials

The datasets about individual patients' privacy in this study are not publicly available.

Ethics approval and consent to participate

This study was approved by the Healthy Research Ethics Committee of Hospital (NO:672HRECH20160101)

Consent for publication

Yes

Competing interests

The authors declare that they have no competing interests.

Author details

1Department of Orthopedics, Hubei 672 Orthopaedics Hospital of Integrated Chinese–Western Medicine, Wuhan 430079 Hubei, China. 2 Department of Orthopedics, Hubei Provincial Hospital of Traditional Chinese Medicine, Wuhan, 430061 Hubei, China. 3 Department of Institute of Orthopedics, Hubei Provincial Academy of Traditional Chinese Medicine, Wuhan, 430061 Hubei, China.

References

1. Konieczny MR, Reinhardt J, Prost M, et al. Signal Intensity of Lumbar Disc Herniations: Correlation With Age of Herniation for Extrusion, Protrusion, and Sequestration[J]. Int J Spine Surg. 2020;14(1):102–7.
2. Desmoulin GT, Pradhan V, Milner TE. Mechanical Aspects of Intervertebral Disc Injury and Implications on Biomechanics[J]. Spine (Phila Pa 1976). 2020;45(8):E457–64.
3. Song HP, Sheng HF, Xu WX. A case-control study on the treatment of protrusion of lumbar intervertebral disc through PELD and MED[J]. Exp Ther Med. 2017;14(4):3708–12.

4. Ye YP, Hu JW, Zhang YG, et al. Impact of lumbar interbody fusion surgery on postoperative outcomes in patients with recurrent lumbar disc herniation: Analysis of the US national inpatient sample[J]. *J Clin Neurosci*. 2019;70:20–6.
5. Park JS, Choi SE, Cho TK, et al. Recurrence Rate after Herniotomy only versus Discectomy in Lumbar Disc Herniation[J]. *Korean J Spine*. 2013;10(4):227–31.
6. Postacchini F, Postacchini R. Operative management of lumbar disc herniation: the evolution of knowledge and surgical techniques in the last century[J]. *Acta Neurochir Suppl*. 2011;108:17–21.
7. Li H, Jiang C, Mu X, et al. Comparison of MED and PELD in the Treatment of Adolescent Lumbar Disc Herniation: A 5-Year Retrospective Follow-Up[J]. *World Neurosurg*. 2018;112:e255–60.
8. Qin R, Liu B, Hao J, et al. Percutaneous Endoscopic Lumbar Discectomy Versus Posterior Open Lumbar Microdiscectomy for the Treatment of Symptomatic Lumbar Disc Herniation: A Systemic Review and Meta-Analysis[J]. *World Neurosurg*. 2018;120:352–62.
9. Weigel R, Capelle HH, Al-Afif S, et al. The dimensions of "failed back surgery syndrome": what is behind a label?[J]. *Acta Neurochir (Wien)*. 2021;163(1):245–50.
10. Chen X, Chamoli U, Lapkin S, et al. Complication rates of different discectomy techniques for the treatment of lumbar disc herniation: a network meta-analysis[J]. *Eur Spine J*. 2019;28(11):2588–601.
11. Huang W, Han Z, Liu J, et al. Risk Factors for Recurrent Lumbar Disc Herniation: A Systematic Review and Meta-Analysis[J]. *Med (Baltim)*. 2016;95(2):e2378.
12. Chen X, Chamoli U, Vargas Castillo J, et al. Complication rates of different discectomy techniques for symptomatic lumbar disc herniation: a systematic review and meta-analysis[J]. *Eur Spine J*. 2020;29(7):1752–70.
13. Kurzbuch AR, Recoules-Arche D. Minimal invasive lumbar spine revision surgery at distance from the dura and postsurgical scar tissue: Extraforaminal Lumbar Interbody Fusion (ELIF)[J]. *J Clin Neurosci*. 2018;47:332–6.
14. Wang A, Yu Z. Comparison of Percutaneous Endoscopic Lumbar Discectomy with Minimally Invasive Transforaminal Lumbar Interbody Fusion as a Revision Surgery for Recurrent Lumbar Disc Herniation after Percutaneous Endoscopic Lumbar Discectomy[J]. *Ther Clin Risk Manag*. 2020;16:1185–93.
15. Lee YC, Zotti MG, Osti OL. Operative Management of Lumbar Degenerative Disc Disease[J]. *Asian Spine J*. 2016;10(4):801–19.
16. Schnake KJ, Rappert D, Storz B, et al. [Lumbar fusion-Indications and techniques][J]. *Orthopade*. 2019;48(1):50–8.
17. Kabins MB, Weinstein JN, Spratt KF, et al. Isolated L4-L5 fusions using the variable screw placement system: unilateral versus bilateral[J]. *J Spinal Disord*. 1992;5(1):39–49.
18. Phillips FM, Cunningham B. Intertransverse lumbar interbody fusion[J]. *Spine (Phila Pa 1976)*. 2002;27(2):E37–41.

19. Recoules-Arche D, Druschel C, Fayada P, et al. Unilateral Extraforaminal Lumbar Interbody Fusion (ELIF): Surgical Technique and Clinical Outcome in 107 Patients[J]. Clin Spine Surg. 2016;29(3):E162-70.
20. Anderson DG. Critical evaluation of article: Minimally invasive TLIF leads to increased muscle sparing of the multifidus muscle but not the longissimus muscle compared with conventional PLIF-a prospective randomized clinical trial[J]. Spine J. 2016;16(7):820–1.
21. Yang M, Sun G, Guo S, et al. The Biomechanical Study of Extraforaminal Lumbar Interbody Fusion: A Three-Dimensional Finite-Element Analysis[J], 2017, 2017: 9365068.

Figures

Figure 1

Wiltse approach between the longissimus and multifidus muscle (green arrow)→The ventral part resection of superior facet joint of lower vertebral body→red part→ to enlarged Kambin triangle space for intervertebral management.

Figure 2

Unilateral ELIF revision after MED for a male 38 years old patient. A. MRI in April 2016 showed L5 / S1 recurrence of disc right herniation after MED treatment in May 2015. B. CT in April 2016 showed partial bone loss at L5 lamina by last MED surgery. C. X-ray evaluation of internal fixation after unilateral ELIF revision. E. The horizontal and coronal CT view after surgery showed unilateral ELIF with preservation of facet joint. F. The internal fixation was removed after fusion in April 2018.

Figure 3

Green arrow in A showed the recurrent prolapse of nucleus pulposus. Red arrow in A showed the partial lamina resection by the previous MED operation. Yellow arrow in B showed residual nucleus pulposus after PELD revision.

Figure 4

A: three self-designed retractors; B: $225 \times 25 \times 70\text{mm}$ arc upper tip α , $225 \times 20 \times 50\text{mm}$ arc lower head β , $225 \times 25 \times 50\text{mm}$ arc lower head γ ; C: The yellow arrow indicated that the upper pedicle screw was implanted first, and the blue was the entrance of intervertebral space.