The clinical efficacy of unilateral biportal endoscopy revision for the recurrence of lumbar disc herniation after percutaneous endoscopic lumbar discectomy

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Article

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Abstract

Background

The purpose of this study was to describe the efficacy of the UBE (unilateral biportal endoscopy, UBE) technique in treating lumbar disc herniation after the failure of PELD (percutaneous endoscopic lumbar discectomy, PELD).

Methods

From December 2019 to December 2021, the clinical data of 21 patients with lumbar intervertebral disc herniation who recurred after PELD and revision with the UBE technique were retrospectively analyzed in our institution. To observe the clinical efficacy and imaging results of UBE in the treatment of recurrent lumbar disc herniation. Preoperative and postoperative VAS scores (visual analog scale, VAS), intraoperative blood loss (assessed by preoperative and postoperative hemoglobin, Hgb); Postoperative re-examination of MRI to observe the space-occupying situation of the prolapsed nucleus pulposus spinal canal (assessed by preoperative and postoperative spinal canal area (cm$^2$)); postoperative infection (assessment by preoperative and postoperative WBC and CRP levels), and finally statistical analysis. The time of revision surgery, the length of the surgical incision, the amount of sterile saline used during the operation, and the mean hospitalization time were also observed.

Results

The average hospital stay was 5.25 ± 3.35 days. The average surgical incision length was 2.45 ± 0.55 cm, the mean operation time was 50.25 ± 3.15 minutes, and the mean intraoperative sterile saline usage was 7125.50 ± 68.55 ml. The VAS score and Hgb of the patients before and after operation were significantly decreased, and the condition of the prolapsed nucleus pulposus and the space-occupying spinal canal was significantly improved in the postoperative MRI observation, all $P < 0.05$, the difference was statistically significant; the $P$ values of WBC and CRP changes before and after operation All were 0.05, and the difference was not statistically significant; No patient had an infection, nerve, blood vessel injury, cerebrospinal fluid leakage after surgery.

Conclusion

UBE can effectively treat the recurrence of lumbar intervertebral disc herniation after transforaminal surgery, but there are some shortcomings such as a large amount of sterile saline and anemia during operation.

Background
At present, the concept of minimally invasive technology has been deeply rooted in the concepts of the people, and traditional surgery has been developed in an all-around way to be minimally invasive. The spinal endoscopic technique is an emerging minimally invasive technique for the spine. In 1998, Yeung[1] first proposed the intervertebral foraminal endoscopy (YESS) technique through the Kambin triangle safety zone. In 2002, Hoogland[2] proposed the technique of percutaneous transforaminal mirror (TESSYS).

Lumbar disc herniation often causes pain in the waist and legs, which seriously affects patients' quality of life. For patients with simple LDH disease who are ineffective in conservative treatment, the PELD technique is often used, and most patients can achieve satisfactory effectiveness[3]. However, endoscopic nucleus pulposus removal has limitations such as a long learning curve, small operation space, and a small field of view [2]. At present, many surgeons use the Tess target technology to remove the prominent nucleus pulposus in clinical practice. After the nucleus pulposus is removed, due to factors such as weak tissue behind the spinal canal and scar tissue formation, LDH often recurs [4]. The current treatment methods for LDH recurrence are as follows: (1) Re-percutaneous single-channel transforaminal endoscopic nucleus pulposus resection: due to the adhesion and scar formation on the lateral foramen after the initial operation, it will affect the re-operation and the operation is difficult; (2) Open lumbar discectomy combined with lumbar fusion: lumbar fusion needs to remove the corresponding segment of the fusion and enter the spinal canal, which makes the lumbar spine lose mobility and increases the risk of postoperative intervertebral space infection, chronic low back pain, and neurovascular damage[5].

In recent years, a novel endoscopic technique using a UBE technique has been widely used in the treatment of LDH [6, 7]. Compared with traditional lumbar fusion, the UBE technique preserves the back muscles, has a smaller incision, less intraoperative blood loss, and less postoperative back pain, improving patient satisfaction and shortening the length of hospital stay. Compared with a single-channel foraminal mirror, it has an independent observation channel and operation channel. The observation channel generally uses a 0° or 30° arthroscope. The spinal canal can be explored and completely decompressed in all directions. At present, endoscopic fusion surgery can be well completed by the UBE technique [4].

The literature has reported that the UBE technique has achieved good results in treating LDH [8]. However, in patients with recurrence of LDH after PELD technique treatment, the efficacy of UBE technique revision surgery has not been reported in the literature. Therefore, the focus of this study was to investigate the efficacy of UBE revision in patients with LDH recurrence after the PELD technique, to provide a certain basis for its clinical promotion.

**Methods**

The study was conducted according to the revised declaration of Helsinki. This study was conducted with the approval of the Human Subjects Review Board of our institution (Ethics Number: 2021 Ningmin Ethics Shen Zi No. 0325 – 39). A retrospective analysis was performed from December 1, 2020, to December 31,
2021, in our institution and outside the institution using the PELD technique for the treatment of simple LDH. These patients who had a postoperative recurrence and Stay in our institution were all revisioned with the UBE technique; Inclusion criteria: (1) postoperative recurrence of lumbar intervertebral disc herniation, severe symptoms, and conservative treatment for more than 3 months, and the conservative effect is poor; (2) lumbar spine degeneration is not serious; (3) there is no lumbar instability and lumbar spondylolisthesis. Exclusion criteria: (1) severe lumbar degeneration and lumbar endplate; (2) lumbar instability; (3) spondylolisthesis of degree 2 and above. According to the above inclusion and exclusion criteria, a total of 24 patients were eligible, of which 1 patient was lost to follow-up after surgery, and 2 patients were not included in the study due to incomplete postoperative information. Finally, 21 patients were included in this study, and all patients signed an informed consent Book. There were 9 males and 12 females; the age ranged from 37 to 75 years old, with an average of \((54.6 \pm 14.30)\) years old. All patients had varying degrees of low back pain and unilateral lower extremity radiating pain, with or without numbness in the nerve distribution area and decreased lower extremity muscle strength. The lesions were located in L3/L4 segment in 5 cases, L4/L5 segment in 13 cases, and L5/S1 segment in 3 cases (shown in Table 1). The operations were all performed by the same senior doctor.

Table 1. Patient characteristic

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age in years</td>
<td>54.60±14.30</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Man</td>
<td>9</td>
</tr>
<tr>
<td>Female</td>
<td>12</td>
</tr>
<tr>
<td>Our institution</td>
<td>14</td>
</tr>
<tr>
<td>Outside institution</td>
<td>7</td>
</tr>
<tr>
<td>Level treated</td>
<td></td>
</tr>
<tr>
<td>L3-4</td>
<td>5</td>
</tr>
<tr>
<td>L4-5</td>
<td>13</td>
</tr>
<tr>
<td>L5-S1</td>
<td>5</td>
</tr>
<tr>
<td>Mean incision length (cm)</td>
<td>2.45±0.55</td>
</tr>
<tr>
<td>Mean in hospital days</td>
<td>5.25±3.35</td>
</tr>
<tr>
<td>Mean Operation times (mins)</td>
<td>50.25±3.15</td>
</tr>
<tr>
<td>Mean intraoperative sterile saline usage (ml)</td>
<td>7125.50±68.55</td>
</tr>
</tbody>
</table>

**Surgical Method**

Intravenous general anesthesia is used, the prone position is used during the operation, and the X-ray machine is used to locate the target space of the operation. On the anterior and posterior radiographs, a horizontal line is marked in the center of the target intervertebral space, and a mark is drawn along the inner edge of the pedicle. Take the intersection point of the two lines as the midpoint, and 1.5 cm up and down each as the body surface positioning points of the observation channel and the operating channel. Make a 1-1.5cm incision at each of the above-mentioned positioning points, make longitudinal incisions layer by layer, and thoroughly cut the lumbar back fascia, to make the water flow unobstructed during the operation, and maintain a smooth water flow is the key to obtaining a clear surgical field during the operation. The working channel and observation channel were gradually established. During the
intraoperative operation, the radiofrequency cautery of the soft tissue under the operating channel was performed to expose the Ligamentum flavum of the target intervertebral space, and the Ligamentum flavum was found. C-arm X-ray machine reconfirmed the location of the working channel as the target intervertebral space. Centering on the ligament flavum of the target vertebra, the Ligamentum flavum was exposed by cautery, the insertion point of the ligamentum flavum was exposed, and the Ligamentum flavum was removed. According to the preoperative MRI image data, the vertebral canal and the back of the vertebral body were explored with nucleus pulposus forceps to remove the detached nucleus pulposus.

Follow-up And Efficacy Evaluation Indicators

Data collection was followed up 1 day and 1 month after the operation. Observation indicators included: preoperative and postoperative VAS score; intraoperative blood loss assessed by the loss of Hgb before and after surgery; postoperative MRI to observe the space occupation of the prolapsed nucleus pulposus and spinal canal using Preoperative and postoperative spinal canal area (cm²) assessment; postoperative infection assessed by preoperative and postoperative WBC and CRP. Finally, statistical analysis was performed. The time of revision surgery, the length of the surgical incision, the amount of sterile saline used during the operation, the length of the incision, and the mean hospitalization time were also observed.

Statistical analysis

Statistical analysis was performed using SPSS 22.0 statistical software. X ± s represents measurement data. The preoperative and postoperative VAS scores, intraoperative blood loss, and postoperative MRI observation of prolapsed nucleus pulposus and space-occupying spinal canal were compared in patients with revision intervertebral disc herniation. Paired t-test was used to analyze data that obeyed a normal distribution. P < 0.05 considered the difference to be statistically significant.

Results

There were no postoperative complications such as infection, nerve injury, vascular injury, or cerebrospinal fluid leakage in 21 patients. The hospital stay was 5.25 ± 3.35 days, the length of the incision was 2.45 ± 0.55cm, the operation time was 50.25 ± 3.15 minutes, and the amount of sterile saline used during the operation was 7125.50 ± 68.55ml, shown in Table 1. One patient developed transient nerve root edema and lower extremity radicular pain, which improved after treatment with steroids for detumescence and mecobalamin nutrition. The preoperative and postoperative VAS scores, intraoperative blood loss, and postoperative MRI observation of prolapsed nucleus pulposus and space-occupying spinal canal are shown in Table 2, all P < 0.05, and the difference was statistically significant.
Table 2
Comparison of observation indexes before operation and postoperative 1 day and 1 month. \(^a\) Paired t-test. \(^b\) MRI showing the area of the spinal canal.

<table>
<thead>
<tr>
<th></th>
<th>VAS</th>
<th>Hgb (g/l)</th>
<th>MRI(^b) (cm²)</th>
<th>WBC((10^9/L))</th>
<th>CRP(mg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preoperative</td>
<td>7.52 ± 1.03</td>
<td>118.90 ± 9.97</td>
<td>1.35 ± 0.14</td>
<td>6.71 ± 0.22</td>
<td>5.71 ± 1.15</td>
</tr>
<tr>
<td>Postoperative 1 day(^1)</td>
<td>1.48 ± 0.75</td>
<td>96.70 ± 9.05</td>
<td>1.97 ± 0.13</td>
<td>6.78 ± 0.27</td>
<td>6.14 ± 1.31</td>
</tr>
<tr>
<td>Postoperative 1 month(^2)</td>
<td>1.04 ± 0.74</td>
<td>105.80 ± 6.44</td>
<td>1.99 ± 0.12</td>
<td>6.60 ± 0.27</td>
<td>5.40 ± 1.16</td>
</tr>
<tr>
<td>(t)^1</td>
<td>23.03</td>
<td>16.76</td>
<td>-17.55</td>
<td>-1.77</td>
<td>1.826</td>
</tr>
<tr>
<td>(t)^2</td>
<td>27.53</td>
<td>8.84</td>
<td>-18.12</td>
<td>2.068</td>
<td>1.375</td>
</tr>
<tr>
<td>P values(^1)</td>
<td>0.000(^a)</td>
<td>0.000</td>
<td>0.000</td>
<td>0.092</td>
<td>0.083</td>
</tr>
<tr>
<td>P values(^2)</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.052</td>
<td>0.184</td>
</tr>
</tbody>
</table>

**Typical Case**

A 48-year-old male patient was diagnosed with L4-5 intervertebral disc herniation at our institution on February 27, 2020, due to low back pain and left lower limb pain for 10 years. Due to the ineffectiveness of repeated conservative treatment, L4-5 PELD surgery was performed in our institution on March 1, 2020, and the symptoms of waist and leg pain were relieved after surgery. Unfortunately, on June 14, 2020, the pain in the waist and left lower limb recurred. (Fig. 1). The patient has been admitted to our institution again due to unbearable pain. Lumbar MRI examination showed recurrence of L4/5 intervertebral disc herniation. The preoperative examination was perfected, the contraindications for surgery were excluded, and UBE surgery was used. The prominent nucleus pulposus has been removed, and the nerve is not compressed. (Fig. 2)

**Discussion**

**Surgical options for patients with recurrent lumbar disc herniation after PELD**

At present, most of the reoperations for recurrence after LDH surgery are clinically performed with tunnel-assisted nucleus pulposus removal combined with lumbar fusion, which often requires stripping the muscle and soft tissue behind the spine, cutting the lamina, and facet joints, and entering the spinal canal, which increases the number of postoperative complications. Spinal instability, chronic back pain, and neurological and vascular risks [9]. The thoracoscopy-assisted percutaneous minimally invasive
nucleosome is a minimally invasive spine surgery (MISS) technique that has several advantages over posterior open surgery: preservation of skeletal muscle structure, shorter hospital stay, and smaller incisions [9]. However, due to the formation of scar tissue on the side of the intervertebral foramen after lateral foraminal surgery, it is difficult to perform lateral minimally invasive surgery again. The external percutaneous single-channel transforaminal technique is not conducive to exploration in all directions of the spinal canal because the working channel and the visual field channel are coaxial, the visual field is fixed, and the movable range of the working channel in the interlaminar approach is small. When performing L5-S1 intervertebral disc herniation surgery, the lateral transforaminal approach is often blocked by the high iliac spine, pedicle, and articular process, which makes it difficult to accurately target the cannula [10]. Lowering down on the management of patients with recurrent lumbar disc herniation presents challenges in terms of complete enucleation of the re-herniated nucleus pulposus and satisfaction with spinal canal exploration. In addition, due to the destruction of the lateral intervertebral foramen and the inner structure of the spinal canal after the lateral approach, the ligament flavum was partially removed, and a large number of scars proliferated. The original residual ligamentum flavum adhered to the dura mater and became the main structure of the scar tissue. Invasive surgery is difficult, and damage to the dura mater leads to a relatively high probability of cerebral fluid leakage and nerve root damage. Posterior proctoscopy requires special equipment for the DELTA large channel and has a long learning curve. Many primary orthopedic surgeons cannot master this technology.

UBE technique can avoid the scar tissue formed after the lateral approach. It adopts two independent channels that do not interfere with each other, one is the observation channel and the other is the operation channel, which can effectively remove the protruding nucleus pulposus in all directions in the spinal canal [11–13]. UBE enables high-resolution visualization in very small muscle dissections, allowing almost unlimited access to all laminectomy instruments [14]. High-definition endoscopic vision makes intraoperative exposure and dissection easier, operates in a water environment, has minimal bleeding under flowing sterile saline pressure, and has a clear field of vision. The surgical operation can be endoscopically assisted like traditional posterior surgical techniques. Surgical nucleosome technique. Due to the use of two independent channels, more detailed observations can be obtained compared to microscopic surgery, and good surgical results can be achieved. UBE is a new method that combines the advantages of endoscopy and microsurgery. Foramoscope use with single-channel systems is limited because the combined channels (viewing and instrumentation) limit the independent movement of the instruments. In contrast, the UBE system uses independent operating channels for the instruments, so movement and observation are not restricted. UBE technique is an endoscopic-assisted surgical nucleosome. It has a short learning curve, a good microscopic field of view, thorough surgical decompression, and less intraoperative blood loss. The intraoperative dual-channel can be replaced by an arthroscopic working system. Many primary hospital doctors This technique can be mastered and carried out [9].

In this study, 21 patients with recurrence after lateral PELD treatment of LDH were fully removed from the prolapsed lumbar intervertebral disc by UBE, and the nerve root was completely decompressed. Postoperative MRI showed that the nerve root was adequately decompressed. The symptoms of waist
and leg symptoms disappeared after the operation in all patients, and the VAS scores were significantly lower than those before the operation.

**Techniques For Using Radiofrequency In Surgery**

The radio frequency currently used clinically during the operation of UBE technology includes high-frequency radio frequency and plasma radio frequency. The range of high-frequency radio frequency is point-like, while the plasma radio frequency has a large area. Therefore, it is necessary to clarify whether the video equipment used is high-frequency radio frequency or plasma radio frequency during the operation. Plasma radiofrequency is highly efficient for cauterizing muscle and soft tissue outside the spinal canal, but blindly applying plasma radiofrequency for cauterization and hemostasis after removing the ligamentum flavum and entering the spinal canal may damage the dura, leading to dura rupture, cerebrospinal fluid leakage, and cauda equina nerve damage. Therefore, the plasma radio frequency is used outside the spinal canal, and the high-frequency radio frequency can be operated after entering the spinal canal, which is safer and the probability of damaging the dura and nerve roots is greatly reduced.

UBE is exposed from the posterior approach, so be careful after removing the ligamentum flavum and entering the spinal canal. The lateral foraminal surgery has already been done, so there is scar tissue adhesion between the nerve root and part of the lateral dura. During the operation, we used the nerve stripper to operate carefully and gently. We used the intraoperative water pressure to increase the water pressure and reduce the bleeding. Under the microscope, we used the laminae rongeur to remove part of the bone at the medial border of the inferior articular process, expand the operating space, and expose the nerve root on the shoulder. There is a large operating space on the shoulder of the nerve root, and radiofrequency hemostasis is performed. After exposing and separating the nerve from the shoulder of the nerve root, the soft tissue is cauterized by radiofrequency, and the protruding nucleus pulposus is searched and completely removed.

**Limitations Of This Study**

This study is a single-center retrospective study, with few included cases, short follow-up time, and no control group, so there is a certain bias in the results. It is hoped that a multicenter study will be conducted in future studies with more cases and longer follow-ups.

**Conclusions**

Although this study has many shortcomings, we can still conclude that the use of the posterior percutaneous minimally invasive technique of UBE can effectively repair patients with recurrent lumbar disc herniation after PELD. However, this technique also has shortcomings such as the large amount of sterile saline used during the operation and postoperative anemia.
Abbreviations
UBE: Unilateral Biportal Endoscopy; PELD: Percutaneous Endoscopic Lumbar Discectomy; VAS: visual analog scale; WBC: white blood count; CRP: C-Reactive Protein; MRI: magnetic resonance; LDH: Lumbar disc herniation.

Declarations

Acknowledgments
We thank all patients who participated in this study.
We also thank the operating room staff and the anesthesiologist.

Authors’ contributions
Cuihua Yuan collected the data, performed the statistical analysis, and wrote the first draft of the work.
Qijin Wang proposes article research ideas and revise articles.

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Availability of data and materials
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request

Ethics approval and consent to participate
ethics approval was obtained by the Affiliated Mindong Hospital Affiliated to Fujian Medical University (2021 Ningmin Ethics Shen Zi No. 0325-39). Participants provided written consent upon admission to enable researchers to agree to the study start date. Participants who did not provide written consent were excluded from the study.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests

Author Details
References


Figures

Figure 1

an Intraoperative operation of UBE. b Intraoperative radiofrequency cautery to expose the surgical field of view. c Separation of the adhering scar tissue exposes the prominent nucleus pulposus (black arrow). d Recurrence of prominent nucleus pulposus (black arrow). e Compressed nerves are decompressed. f UBE surgical incision.
Figure 2

a Preoperative L4-5 disc herniation (sagittal section). b Preoperative L4/5 disc herniation cross-section. c Recurrence of L4-5 disc herniation after PELD (sagittal section). d Recurrence of L4-5 disc herniation after PELD (cross-section). e MRI of the lumbar spine after UBE revision (sagittal section). f MRI of the lumbar spine after UBE revision (cross-section).