CLINICAL ARTICLE

Comparison of Clinical Outcomes and Muscle Invasiveness between Unilateral Biportal Endoscopic Discectomy and Percutaneous Endoscopic Interlaminar Discectomy for Lumbar Disc Herniation at L5/S1 Level

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Objective: Both unilateral biportal endoscopic discectomy (UBED) and percutaneous endoscopic interlaminar discectomy (PEID) could achieve favorable outcomes for lumbar disc herniation (LDH). There are limited studies comparing the two different methods of endoscopic discectomy. The objective was to comprehensively compare the clinical outcome and muscle invasiveness of UBED and PEID for the treatment of LDH at L5/S1 level with at least 1-year follow-up.

Methods: The retrospective cohort study enrolled 106 LDH patients of L5/S1 level from January 2018 to December 2020. There were 51 patients who underwent UBED (22 males and 29 females, 43.8 ± 14.2 years old) and 55 patients underwent PEID (28 males and 27 females, 42.3 ± 13.8 years old). Clinical outcomes and surgical invasiveness were compared between the two groups for at least 1 year follow-up. Clinical outcomes included visual analogue scale (VAS) scores, Oswestry Disability Index (ODI), complications, recurrence of LDH, intraoperative anesthesia time, operative time, number of intraoperative fluoroscopies, and postoperative length of stay. Surgical invasiveness was evaluated with serum CPK level and change rate of lean multifidus cross-sectional area (LMCSA). Independent-sample *t* test and paired sample *t* test were used to compare continuous data. Chi-square test and Fisher's precision probability tests were used to analyze the categorical data.

Results: Both groups achieved favorable clinical outcomes at the last follow-up, including VAS and ODI (all *P*s <0.05). The intraoperative anesthesia time for UBED was longer, but with no difference of operative time. As for intraoperative fluoroscopy times (2.5 *vs* 2.4), postoperative length of stay (2.1 *vs* 2.0 days), postoperative complications (5.9% *vs* 3.6%), there were also no significant difference. The serum CPK level and change rate of LMCSA for UBED was higher than PEID at postoperative 1st day. At the last follow-up, there was no significant difference in the change rate of LMCSA between the two groups ($P = 0.096$).

Conclusions: Both UBED and PEID could achieve favorable clinical outcomes for the treatment of L5/S1 LDH. Despite UBED is more invasive, the radiological manifestation of paraspinal muscle invasiveness was equal at last follow-up with at least 1 year. UBED is a safe and innovative alternative choice for treatment of LDH at L5/S1 level.

Key words: Discectomy; L5/S1; Lumbar Disc Herniation; Percutaneous Endoscopic Interlaminar Discectomy; Unilateral Biportal Endoscopy

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Introduction

Lumbar disc herniation (LDH) is one of the most common spinal diseases and cause the clinical symptom of low back pain and sciatica.[1] In recent years, with the development of minimally invasive surgical technique, endoscopic discectomy has become the popular surgical method for LDH failed with conservative treatment. Various endoscopic discectomy techniques have emerged and been widely performed with the aim to lessen tissue invasion, shorten the length of hospital stay, promote faster recovery and allow patients an earlier return to normal daily activities.[2–5]

The natural anatomic characteristic of the wider interlaminar space of L5/S1 provide favorable working space for both uniportal and biportal endoscopic discectomy *via* the posterior interlaminar approach. Percutaneous endoscopic interlaminar discectomy (PEID) is performed through a single portal with the posterior interlaminar approach. As the typical presentative of uniportal endoscopy, PEID combines the advantages of microscope and interlaminar approach, which has advantages in L5/S1 lumbar disc herniation and highly migrated disc herniation due to the great intervertebral space of the L5/S1 segment.[6,7] Unilateral biportal endoscopic (UBE) surgery, as a newly introduced minimally invasive method, has received great attention and become popular in recent years.[8–10] Different from PEID through uniportal, unilateral biportal endoscopic discectomy (UBED) provides the scope portal for endoscopic view and continuous irrigation, and the working portal for instrument manipulation.

Both UBED and PEID adopt posterior approach and share similar minimally invasive theory and operative procedures. The differences are mainly based on integration or separation of the viewing and working portal. Previous studies have demonstrated that both UBED and PEID could achieved favorable clinical outcomes for the treatment of LDH. However, there has been no much studies comparing the two endoscopic discectomy methods. Therefore, the purpose of the study was to comprehensively compare: (i) the clinical outcomes; and (ii) muscle invasiveness of UBED and PEID for the treatment of LDH at L5/S1 level with at least 1 year follow-up.

Materials and Methods

The study was approved by the ethics committee of Qilu Hospital of Shandong University (KYLL-202203-025). The informed consent was obtained from all patients before enrollment. We retrospectively reviewed the records of LDH patients at single L5/S1 level underwent endoscopic discectomy in our hospital from January 2018 to December 2020. One hundred six patients with complete clinical and radiological data were included and 51 patients underwent UBED and 55 patients underwent PEID respectively. The inclusion criteria were as follows: (i) LDH at L5/S1 level treated with endoscopic discectomy; and (ii) with complete clinical and radiological data and at least 1-year follow-up. Exclusion criteria were as follows: (i) multi-level LDH; (ii) previous lumbar surgery; (iii) lumbar spinal stenosis, spondylolisthesis, instability; and (iv) idiopathic or congenital and other structural spinal deformity. LDH diagnosis criteria based on the clinical neurological symptoms, physical examination and radiological manifestations, including CT and MRI. The type of disc herniation was evaluated with Michigan State University (MSU) classification,[11] which has been approve as a simple and reliable method to objectively measure herniated lumbar disc.

Surgical Technique

Unilateral Biportal Endoscopic Discectomy

UBED was performed under general anesthesia with the patient in prone position. The first anteroposterior fluoroscopy was performed to locate the landmark of entry points. Cranial and caudal entry points were located at the inner margin of pedicle and 1.5 cm above and below the lower margin of upper lamina of targeted level. For the left side, the cranial incision was used for endoscopic portal and the caudal one was for the working portal. Six millimeter-length cranial and 10 mm-length caudal incisions were created and the fascia perpendicular to the skin is cut to ensure the smooth water flow. For the working portal, soft tissues surrounding the interlaminar are swept through the blunt muscle-splitting to make the working space. After the scope and working instruments are inserted respectively, the fluoroscopy was performed to establish the correct targeted level. In the working portal, soft tissues between the lamina and ligamentum flavum are removed using radiofrequency probes. The lower lamina of upper lamina and ligamentum flavum of the targeted level were exposed. The drill and Kerrison punches were used to remove a part of the lamina and ligamentum flavum until the nerve root was exposed. Conventional surgical instruments can be used freely in various access angle like open surgery. Hemostasis for soft tissue and intraoperative epidural bleeding can be achieved with the use of radiofrequency probes. As for the bone bleeding, bone wax could be used for the bone bleeding. Discectomy could be performed after retraction of nerve root and herniated disc was removed until full mobilization of the nerve root was achieved.

Percutaneous Endoscopic Interlaminar Discectomy

PEID was performed under general anesthesia with the patient in prone position. The anteroposterior fluoroscopy was performed to locate the landmark of entry point, which was at the lateral edge of the interlaminar space. After a 8-mm-length skin incision was created, the serial dilators were introduced and docked in the interlaminar space, which was different from making the working space for UBED. A working channel was introduced and the final position was checked through the fluoroscopy. Then the endoscope system was introduced and the ligamentum flavum was exposed by radiofrequency probes. Special instruments for uniportal endoscopy were used because of limited working tube, which was completely different from UBED. Part of the

ligamentum flavum was removed to expose the nerve root and the tube was used to protect the nerve root to expose the disc. Then the protruded or sequestrated disc were removed to achieve the nerve root decompression. The difference of the surgical procedures between UBED (A) and PEID (B) are shown in Figure 1.

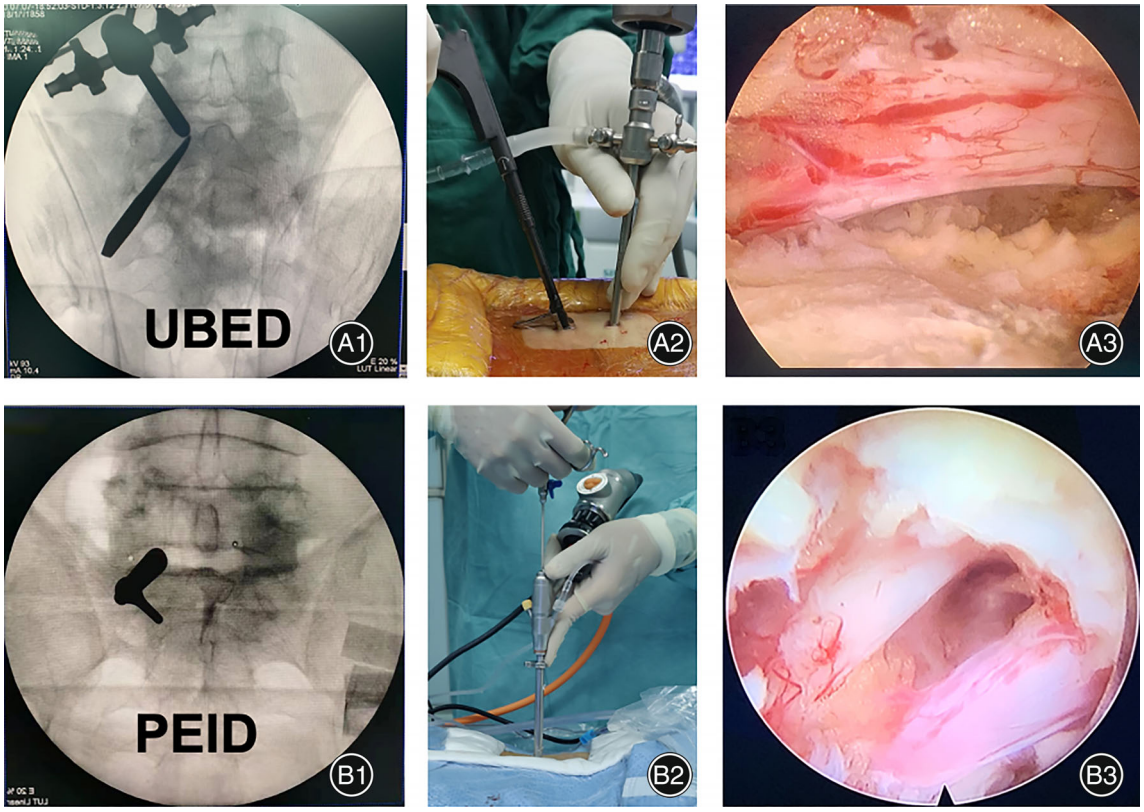

Fig. 1 The surgical procedure of UBED (A) and PEID (B). A1 and B1 were the intraoperative anteroposterior fluoroscopy for UBED and PEID. A2 and B2 present the different intraoperative manipulation for UBED and PEID. A3 and B3 showed the nerve root without compression after UBED and PEID. PEID, percutaneous endoscopic interlaminar discectomy; UBED, unilateral biportal endoscopic discectomy.

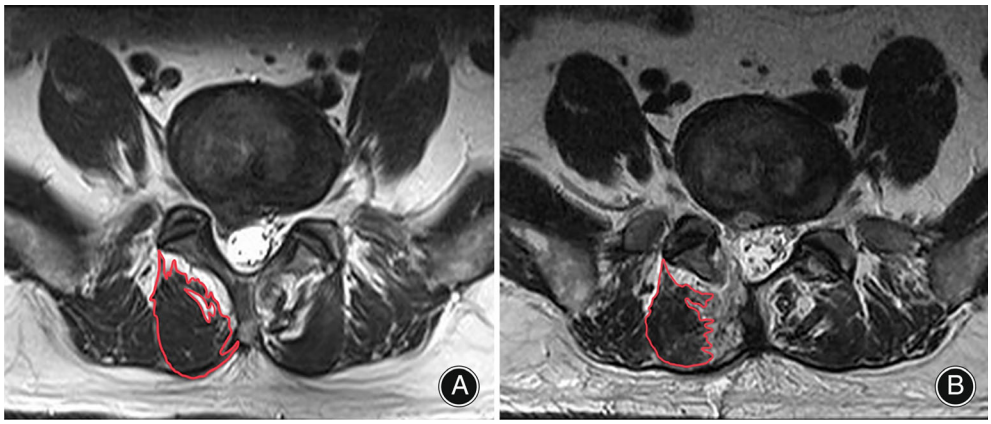

Fig. 2 The preoperative (A) and postoperative (B) measurement of LMCSA on MRI. The middle cross-sectional image of the operative disc was selected on T2-weighted MRI. The contour of mutifidus at the operative disc was outlined by irregular curve on the MRI image, and the area was calculated by the ImageJ software. The change rate of LMCSA is calculated as = (preoperative LMCSA − postoperative LMCSA) / preoperative LMCSA × 100%. LMCSA, lean multifidus cross sectional area; MRI, magnetic resonance imaging.

Clinical Outcome Assessment

The visual analogue scale (VAS) score for back pain and leg pain and Oswestry Disability Index (ODI) were collected preoperatively, postoperative 1st day, 3-months and the last follow-up. The difference before and after operation and between the two groups were compared and analyzed respectively. Complications related to the surgeries, recurrence of LDH and other related data, including intraoperative anesthesia time, operative time (time from skin incision to suture), number of intraoperative fluoroscopies, and postoperative length of stay, were collected and compared.

Assessment of Muscle Injury

Serum CPK levels were tested before surgery and at postoperative 1st day. CPK ratio was calculated as = CPK on postoperative 1st day/CPK before surgery. The surgery related muscle injury was assessed by lean multifidus cross sectional area (LMCSA) through lumbar spine MRI before surgery, at postoperative 1st day, 3-months and the last follow-up respectively. The middle cross-sectional image of the operative disc was selected on T2-weighted MRI. The contour of mutifidus at the operative disc was outlined by the irregular curve on the MRI image, and the area was calculated by the ImageJ software ImageJ 1.46 (National Institutes of Health, Bethesda, MD, USA). The radiological parameters were measured three times and the average value was calculated (Figure 2). The change rate of LMCSA is calculated as = (preoperative LMCSA − postoperative LMCSA) / preoperative LMCSA × 100%, which was used to evaluate the muscle injury between the two groups.

Statistical Analysis

Means and standard deviations were calculated for age, clinical outcome scores and radiological parameters. Differences between the two groups, preoperative and postoperative measurement data were determined by the independent-sample *t* test and paired sample *t* test. Chi-square test and Fisher's precision probability tests were

TABLE 1 Demographic and clinical characteristics for all the patients

	UBED group	PEID group	*t* value (χ^2)	*P* Value
Number of cases (n)	51	55	-	-
Sex (male/female)	22/29	28/27	0.641	0.423
Age (year)	43.8 ± 14.2	42.3 ± 13.8	0.536	0.593
BMI	25.4 ± 3.7	25.8 ± 3.6	−0.471	0.683
MSU Classification (n)			0.824	0.995
2-A	1	1		-
2-AB	18	19		-
2-B	21	23		-
3-A	3	4		-
3-AB	3	2		-
3-B	5	6		-
Preoperative symptom duration (months)	13.9 ± 25.1	10.2 ± 21.4	0.807	0.422
Postoperative length of stay (days)	2.1 ± 0.8	2.0 ± 0.8	0.371	0.711
Anesthesia time (minutes)	98.3 ± 10.6	90.5 ± 8.2	4.117	0.000
Operative time (minutes)	83.6 ± 10.8	80.2 ± 8.4	1.749	0.083
Intraoperative fluoroscopy times (n)	2.5 ± 0.6	2.4 ± 0.5	1.309	0.194

Note: Data are given as (n) or mean ± SD; $P < 0.05$ was considered statistically significant.; Abbreviations: BMI, body mass index; PEID, percutaneous endoscopic interlaminar discectomy; UBED, unilateral biporal endoscopic discectomy.

TABLE 2 Clinical outcome and radiological assessment for the two groups

	UBED group	PEID group	*t* value (χ^2)	*P* Value
VAS for back pain				
Preoperative	6.9 ± 1.1	6.8 ± 1.2	0.606	0.546
Postoperative 1st day	2.7 ± 1.0	2.4 ± 0.7	1.406	0.163
3 months follow-up	1.8 ± 0.5	1.8 ± 0.7	−0.462	0.645
Last follow-up	0.8 ± 0.5	0.7 ± 0.6	1.037	0.302
VAS for leg pain				
Preoperative	7.6 ± 1.1	7.8 ± 1.0	−0.980	0.329
Postoperative 1st day	2.8 ± 1.1	2.5 ± 1.0	1.167	0.246
3 months follow-up	1.9 ± 0.6	1.7 ± 0.7	0.968	0.335
Last follow-up	0.5 ± 0.6	0.4 ± 0.5	0.738	0.462
ODI				
Preoperative	67.2 ± 8.8	68.4 ± 5.6	−0.840	0.403
Postoperative 1st day	26.7 ± 4.3	27.4 ± 3.7	−0.948	0.346
3 months follow-up	16.6 ± 3.4	17.5 ± 3.1	−1.317	0.191
Last follow-up	8.0 ± 2.4	8.6 ± 2.5	−1.363	0.176
Complications, n (%)	3 (5.9%)	2 (3.6%)	0.007	0.931
Dural tear	1	1		
Nerve root injury	1	1		
Intervertebral infection	1	0		
LDH recurrence, n (%)	1 (2.0%)	2 (3.6%)	0.000	1.000
Serum CPK level (U/L)				
Preoperative	75.7 ± 36.1	73.2 ± 25.1	0.405	0.686
Postoperative 1st day	105.4 ± 46.7	90.1 ± 24.6	2.056	0.042
CPK ratio	1.4 ± 0.2	1.3 ± 0.3	3.129	0.002
The change rate of LMCSA (%)				
Postoperative 1st day	27.6 ± 11.7	12.1 ± 9.1	7.401	0.000
3 months follow-up	12.6 ± 7.6	6.4 ± 5.1	4.722	0.000
Last follow-up	3.9 ± 4.8	2.6 ± 2.4	1.679	0.096

Note: Data are given as (n) or mean ± SD; $p < 0.05$ was considered statistically significant.; Abbreviations: LDH, lumbar disc herniation; LMCSA, lean multifidus cross-sectional area; ODI, Oswestry Disability Index; PEID, percutaneous endoscopic interlaminar discectomy; UBED, unilateral biporal endoscopic discectomy; VAS, visual analogue scale.

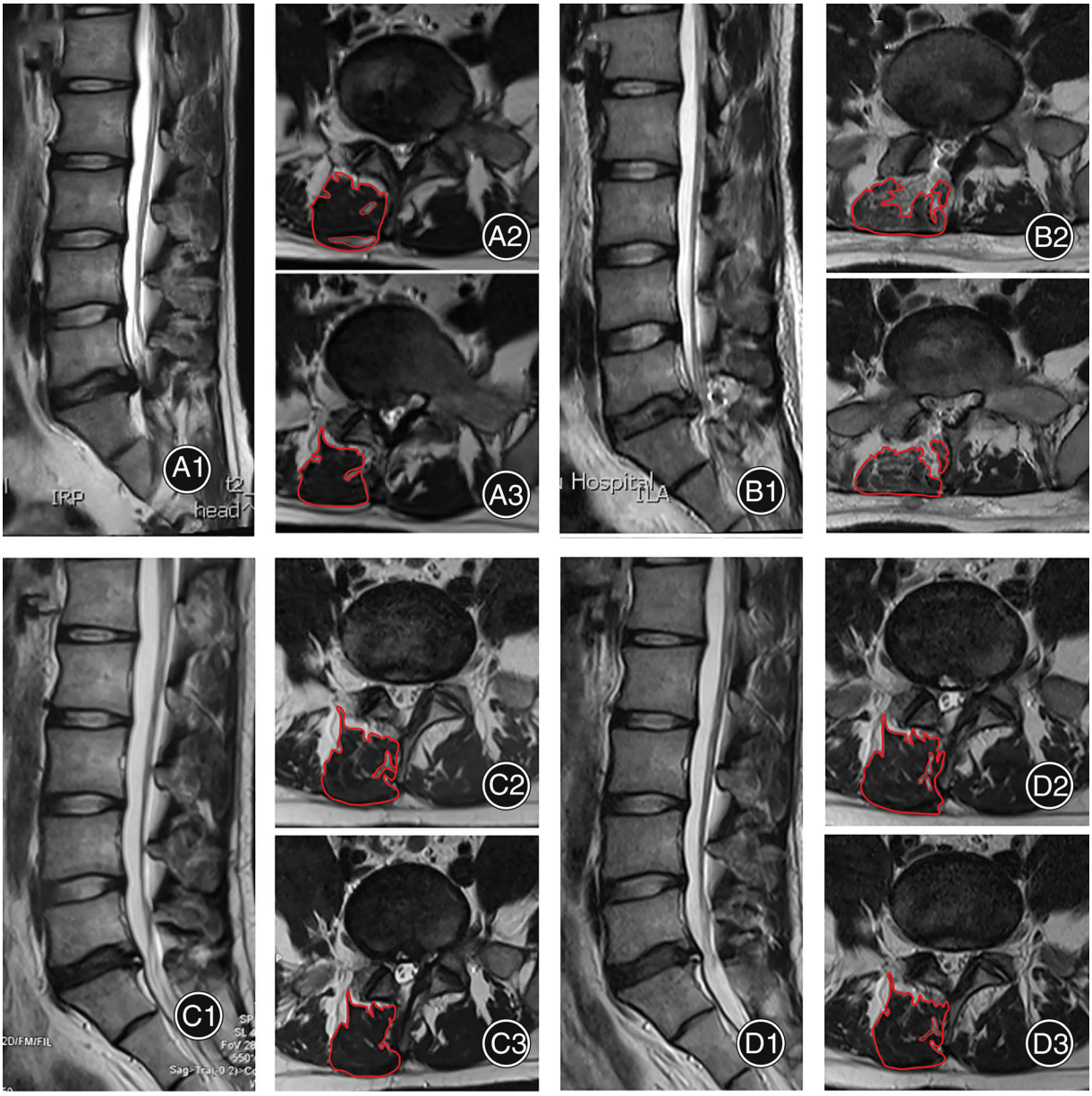

Fig. 3 A 23-year-old male patient with LDH of L5/S1 right side, treated with UBED surgery. A1-A3 were the preoperative MRI. B1-B3 were the MRI of post-operative 1st day. C1-C3 were the MRI at the 3-month follow-up. D1-D3 were the MRI at the last follow-up of 1-year. The figures showed that the protruded disc of L5/S1 right side was removed after UBED surgery and the changes of LMCSA during the follow-up. The LMCSA was outlined on preoperative and postoperative MRI image. LDH, lumbar disc herniation; MRI, magnetic resonance imaging; UBED, unilateral biportal endoscopic discectomy.

used to analyze the categorical data. $P< 0.05$ was considered as statistically significant. Statistical measures were performed using IBM SPSS Statistics 25.0 (SPSS Inc., Chicago, IL, USA).

Results

Patients Population

The patients' demographic and clinical characteristics are present in Table 1. There were no significant differences of age, sex, BMI, and duration of symptoms between the two groups. All patients were followed up for at least 1 year postoperatively and the mean follow-up time was 16.5 months (12–25 months). According to MSU classification, the types of disc herniation in the two groups were type 2 and type 3. The type 2-AB and 2-B were most common. In the UBED group, the case number of 2-A, 2-AB, 2-B, 3-A, 3-AB, and 3-B was 1, 18, 21, 3, 3, and 5, respectively. In the PEID group, the case number of 2-A, 2-AB, 2-B, 3-A, 3-AB, and 3-B were 1, 19, 23, 4, 2, and

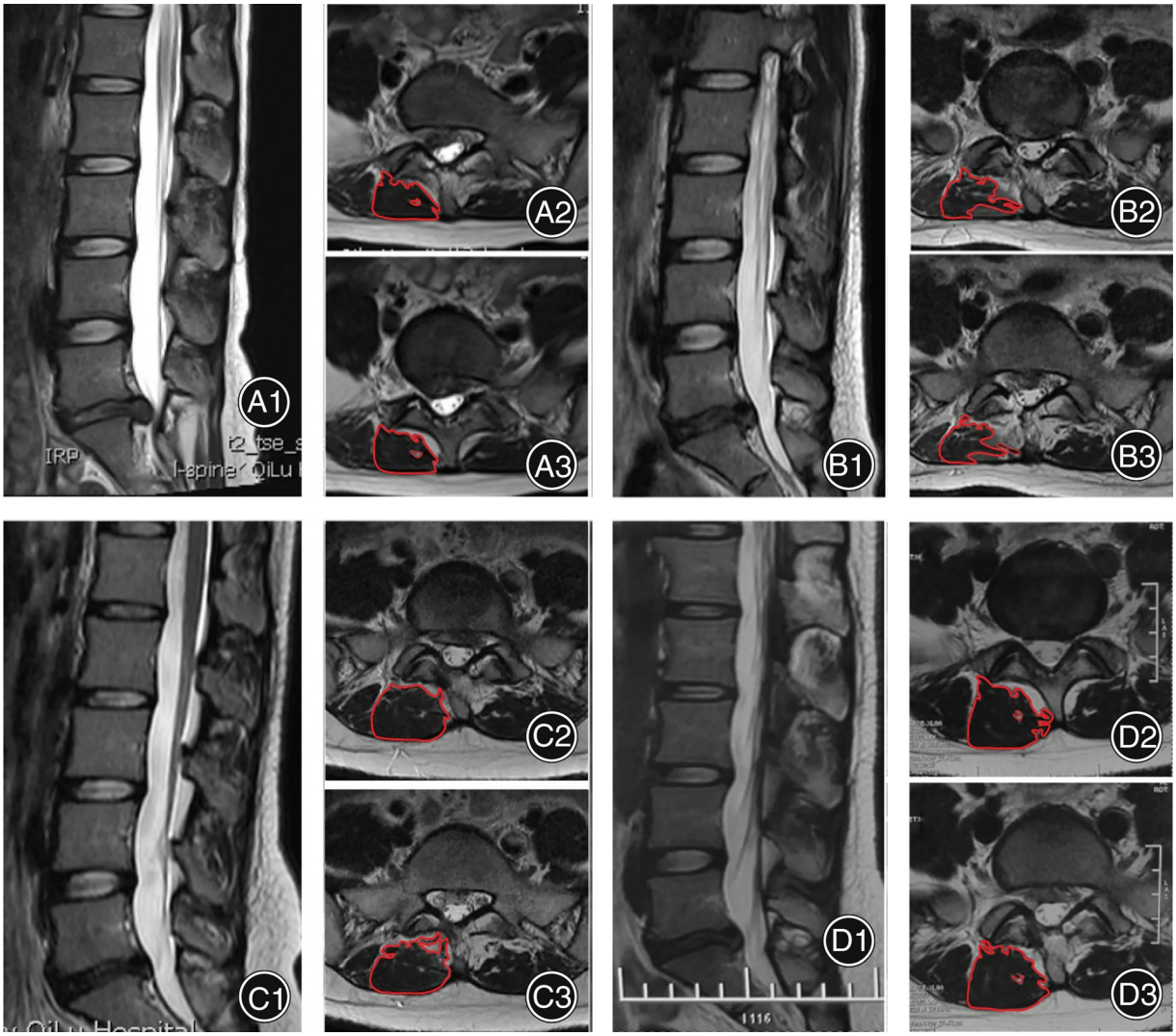

Fig. 4 A 20-year-old female patient with LDH of L5/S1 right side, treated with PEID surgery. A1-A3 were the preoperative MRI. B1-B3 were the MRI of post-operative 1st day. C1-C3 were the MRI at the 3-month follow-up. D1-D3 were the MRI at the last follow-up of 1-year. The figures showed that the protruded disc of L5/S1 right side was removed after PIED surgery and the changes of LMCSA during the follow-up. The LMCSA was outlined on preoperative and postoperative MRI image. LDH, lumbar disc herniation; LMCSA, lean multifidus cross sectional area; MRI, magnetic resonance imaging; PEID, percutaneous endoscopic interlaminar discectomy.

6, respectively. As for the localization of disc herniation based on MSU classification, there was no significance difference between the two groups.

Clinical Outcomes

There were no significant differences of VAS scores for back and leg pain and ODI preoperatively between the two groups ($P > 0.05$). In both groups, postoperative VAS score for back and leg pain and ODI were significantly improved ($P < 0.05$). There were no significant differences of the VAS scores and ODI at postoperative 1st day, 3-months and the final follow-up between the two groups ($P > 0.05$). The intraoperative anesthesia time in UBED group was significantly longer than that in PEID group ($P < 0.05$), but there was no significant difference of operative time ($P > 0.05$). As for intraoperative fluoroscopy times (2.5 *vs* 2.4), postoperative length of stay (2.1 *vs* 2.0 days), postoperative complications (5.9% *vs* 3.6%), including LDH recurrence (2.0% *vs* 3.6%), there were also no significant difference between the two groups ($P > 0.05$).

Complications

In the UBED group, three out of 51 cases developed postoperative complications, including one case of dura tear, one

case of nerve root injury, and one case of intervertebral infection. For the PEID, one case of dura tear and one case nerve root injury developed. All the clinical outcomes assessment were shown in Table 2. As for the intraoperative dura tear, the incision was compressed locally and no cerebrospinal fluid leakage occurred. As for the nerve root injury, conservative treatment was adopted and no obvious neurological symptoms remained. As for the case of intervertebral infection, antibiotics were used for 6 weeks and the infection was cured.

Surgical Invasiveness Assessment

There were no significant differences of preoperative serum CPK level and LMCSA between the two groups ($P > 0.05$). The CPK level at postoperative 1st day in UBED group was higher than that in PEID group (105.4 *vs* 90.1, $p = 0.042$). The CPK ratio was 1.4 ± 0.2 and 1.3 ± 0.3 for UBED and PEID group respectively ($P = 0.002$). At postoperative 1st day, the change rate of LMCSA in UBED group was significantly higher than that in PEID group (27.6% *vs* 12.1%, $P = 0.000$). At the 3-month follow-up, the change rate of LMCSA in the two groups decreased significantly but was still significantly higher in UBED group (12.6% *vs* 6.4%, $P = 0.000$). At the last follow-up, there was no significant difference between the two groups (3.9% *vs* 2.6%, $P = 0.096$). The detailed surgical invasiveness assessment was shown in Table 2. The radiological presentation of two cases were shown in Figure 3 and 4, including one case of UBED and one case of PEID.

Discussion

Nowadays, the development of minimally invasive concept and improvement of surgical techniques, combined with the patients' extraordinary demands of minimally invasive surgery, have promoted the rapid progress of endoscopic spinal surgery.[2,4] Compared to conventional open or microscopic discectomy, endoscopic discectomy has many advantages, including smaller skin incision, less bleeding, shorter length of stay, less tissue injury and rapid recovery, which has become the popular surgical choice to treat LDH.[1,12] This study compared the clinical outcomes and muscular invasiveness between two endoscopic discectomy methods of UBED and PEID for the L5/S1 LDH. Both of them could achieve favorable clinical outcomes and be good surgical choice with least 1 year follow-up.

Clinical Outcomes Assessment

As the representative of uniportal and biportal endoscopic techniques, PEID and UBED have been widely performed to directly removed the herniated disc and decompressed nerve root. Previous studies have also shown the great clinical effects of the two methods respectively.[3,7,13,14] In the current study, both UBED and PEID achieved favorable clinical outcomes immediately after surgery and at follow-up, including VAS and ODI. There was no significant difference between the two groups. As the mini-invasive endoscopic surgical techniques, both UBED and PEID could bring shorter hospital stay and faster postoperative fast recovery. In the current study, the postoperative hospital stay was similar for UBED and PEID.

The intraoperative anesthesia time for UBED was significantly longer than PEID, but there was no significant difference in operative time between the two groups, which was similar but had some differences with previous studies. Choi *et al.*[15] found operation time was 85.52 ± 17.79 minutes in the PEID group, and 96.15 ± 16.97 minutes in the UBED group, and the difference was statistically significant ($P < 0.05$). Heo *et al.*[3] found the mean operative time was 62.4 ± 5.7 minutes in the biportal endoscopy group and 61.6 ± 3.0 minutes in the uniportal endoscopy group. However, Wagala *et al.*[16] found a clear standardized definition of operative or surgical time in spine surgery does not exist, which results in differences between different literatures. In our study, the intraoperative anesthesia time and operative time was described respectively. The intraoperative anesthesia time for UBED was longer due to the longer time of preparation of surgical instruments before skin incision.

Surgery-related complications were an important point and have become more common and inevitable due to the wide spread of endoscopic surgery.[17,18] Complications include dura tear, nerve root injury, intervertebral infection, and so on. Kim *et al.*[19] made a multicenter retrospective analysis and found that the complication rate of single-level UBED was 3%. Soliman *et al.*[20] reported the incidence of complications in 43 cases receiving UBED was 11.6%, including two cases of dura tears, one case of transient urine retention, one recurrent disc herniation, and one case of persistent severe back pain. Dural tear was the most common complication following endoscopic spinal surgery. Lin *et al.*[18] performed a systematic review and found that the total mean incidence of dura tear was 4.1% (2.9%–5.8%) after UBE procedure in six studies. In the current study, the incidence of complications was 5.9% for UBED and 3.6% for PEID respectively, and there was no significant difference between the two groups ($P > 0.05$). In the UBED group, there was one case with dura tear, one case with nerve root injury, and one case with intervertebral infection. For the PEID, one case of dura tear and one case of nerve root injury developed. In fact, the intervertebral disc infection was not common following percutaneous endoscopic surgery due to the continuous irrigation. Carragee *et al.*[21] reported that the incidence of intervertebral disc infection was from 0.1% to 0.4%. Gu *et al.*[22] revealed that the incidence of intervertebral disc infection was 0.47% among 209 LDH patients underwent percutaneous endoscopic discectomy. LDH recurrence after discectomy could not be avoidable concern for surgeons and patients. The risk factors for LDH recurrence following endoscopic discectomy including male gender, inappropriate weight-bearing, old age (≥50 years), trauma history, and central disc herniation.[17] In the current study, the LDH recurrence rate at 1 year follow-up was 2.0% for UBED and 3.6% for PEID, but there was no statistical significance.

Nowadays, the radiation exposure associated endoscopic spinal surgery has become one of the concerns for surgeons. With the development of spinal surgical techniques, the more the level of invasiveness is reduced, the greater the exposure to radiation. Radiation has some widely known adverse effects for both surgeons and patients and exposure should be reduced as much as possible. Merter *et al.*[23] compared the radiation exposure among three different endoscopic discectomy techniques for LDH and found that the groups were listed as PELD > UBED > MED according to the duration and level of radiation exposure. In the current study, the number of intraoperative fluoroscopies was used to compare the intraoperative radiological exposure. The result demonstrated UBED requires more fluoroscopies than PEID (2.5 *vs* 2.4, $P>0.05$) but without statistical difference.

Surgical Invasiveness Assessment

Less muscle injury is one of the most important advantages of minimally invasive spinal surgery. Serum CPK level has been proved as an indicator of postoperative muscle injury and reaches the maximum at 24 hours after operation.[24] The increase of postoperative CPK level is related to the invasion and duration of operation. The muscle injury after surgery is mainly characterized by the decrease of cross-sectional area of multifida muscle and tissue edema.[25] Choi *et al.*[15] found that PEID had lower postoperative CPK level than UBED. In addition, the cross-sectional area of the high-intensity lesion in the paraspinal muscle measured on MRI was smaller than UBED, which demonstrated the less invasiveness and muscle injury of PEID over UBED. In the current study, we also found that the postoperative serum CPK level and CPK ratio for UBED was higher than PEID at postoperative 1st day. We used the LMCSA to evaluate the muscle injury and found that the change rate of LMCSA for UBED was significantly higher than PEID immediately after surgery. At postoperative 3-month follow-up, the change rate of LMCSA decreased in both groups but was still more severe for UBED. At the last follow-up, the change rate of LMCSA decreased to 3.9% for UBED and 2.6% for PEID without significant difference.

Surgical Strategies

The anatomic trajectory and endoscopic view of both UBED and PEID are similar to conventional posterior laminotomy and discectomy. Both UBED and PEID could achieve excellent clinical outcomes for LDH, especially for L5/S1 level. Compared with PEID, UBED has some unique features, including free handling of the scope and instruments in two separate portals, conventional surgical instruments usage like open surgery, protection of the neural structures with assistant retractor. These merits make UBED as a better choice than PEID for different type of LDH, including high-grade migrated LDH, LDH combined with calcification or spinal stenosis, recurrent LDH.[4,10] As for the UBED surgical technique, preoperative localization of target site is very important for skin incision and surgical procedure. The extent of laminectomy depends on the location of disc herniation. The lamina, facet joint and ligamentum flavum should be preserved as much as possible to protect the segmental stability and to prevent postoperative adhesions around the nerve root. All in all, endoscopic surgery should guarantee removal of herniated disc and adequate nerve root decompression.

Limitations and Strengths

There are some limitations for the current study. It was a retrospective study in a single center with limited case numbers. The selection bias seems to be intrinsic by the surgeon's experience and patients' preferences. In addition, the study's mean follow-up time was just 1 year, which was short for clinical outcomes evaluation, such as LDH recurrence. So, a randomized controlled clinical comparison study involving multi-centers, large sample size, and long-term follow-up are needed to comprehensively analyze the clinical outcomes of various endoscopic spinal surgeries. Despite these limitations, the current retrospective study comprehensively compared the clinical outcomes and muscle invasiveness of UBED and PEID for LDH at L5/S1 level, which could provide evidence support for surgeons' decisions.

Conclusion

As for the treatment of LDH at L5/S1 level, UBED and PEID could achieve similar and favorable clinical outcomes. The two surgical methods shared similar operative time, postoperative hospital stay, intraoperative fluoroscopy times and complications. Despite UBED being more muscle invasive than PEID, the MRI signal changes of paraspinal muscle become similar at last follow-up with at least 1 year. All in all, UBED is a safe and innovative alternative choice for treatment of LDH at L5/S1 level. Further research and long-term follow-up are needed to better appreciate the different endoscopic discectomy surgeries.

Authorship Declaration

All authors listed in this manuscript meet the authorship criteria according to the latest guidelines of the International Committee of Medical Journal Editors, and all authors are in agreement with the manuscript.

Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Author Contributions

Liang Wang: conception, investigation, resources, data curation, writing – original draft, writing – reviewing & editing, visualization, funding acquisition. Chao Li: methodology, software, investigation, resources, writing – original draft. Kaifei Han: software, investigation, resources. Yongqin Chen: investigation, resources, formal analysis. Xinyu Liu:

conception, data curation, writing – reviewing & editing, visualization, supervision, project administration. Lei Qi: conception, validation, data curation, writing – reviewing & editing, supervision, project administration.

Ethics statement

The study was approved by the ethics committee of Qilu Hospital of Shandong University (KYLL-202203-025). The informed consent was obtained from all patients before enrollment.

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