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Efficacy of different approaches of spinal endoscopy in the treatment of L4-5 intervertebral disc herniation

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Abstract: Objective To compare the clinical efficacy of two approaches under spinal endoscopy in the treatment of L4-5 intervertebral disc herniation. **Methods** A retrospective analysis was performed for 148 patients with L4-5 intervertebral disc herniation treated in The Affiliated Huai'an No.1 People's Hospital of Nanjing Medical University from January 2020 to June 2023. Among them, 68 cases were treated with percutaneous endoscopic transforaminal discectomy (PETD group), and 80 cases were treated with percutaneous endoscopic interlaminar discectomy (PEID group). Surgical time, intraoperative fluoroscopy frequency, intraoperative bleeding volume, and postoperative hospital stay were compared between two groups. Lumbar Oswestry Dysfunction Index (ODI), VAS score for lower back and leg pain, and surgical success rate at preoperative, postoperative day 1, 1 month, 3 months, and last follow-up were compared. **Results** Patients in both groups were followed up for at least 6 months. The operation time and number of intraoperative fluoroscopies in the PEID group were significantly lower than those in the PETD group (P<0.05), but there was no significant difference in intraoperative blood loss and postoperative hospital stay between the two groups. The VAS score of lumbar and leg pain and ODI score in the two groups at the first day, one month, three months and the last follow-up after operation were improved compared with those before operation (P<0.05), but there was no significant difference between the two groups (P>0.05). There was no significant difference in the excellent and good rate between the PETD group and PEID group (95.5% vs 93.8%, χ^2=0.016, P=0.898). **Conclusion** Both approaches under spinal endoscopy can effectively treat L4-5 intervertebral disc herniation, but the PEID group has shorter operation time and fewer fluoroscopic times, which can effectively shorten the operation time and anesthesia time, and is more friendly to patients.

Keywords: Lumbar intervertebral disc herniation; Spine endoscopy; Percutaneous endoscopy; Transforaminal approach; Discectomy; Interlaminar approach

Lumbar disc herniation (LDH) commonly occurs at the L4-5 level, often causing lower back and leg pain. Conservative treatments such as bed rest can alleviate symptoms in some patients, but surgical intervention may be necessary if conservative measures fail. Compared to traditional open surgery, percutaneous endoscopic lumbar discectomy (PELD) is becoming increasingly favored by clinicians due to its minimally invasive approach. The two main approaches for PELD are percutaneous endoscopic transforaminal discectomy (PETD) and percutaneous endoscopic interlaminar discectomy (PEID)[1]. This study retrospectively compares the clinical efficacy of these two approaches in treating L4-5 intervertebral disc herniation from January 2020 to June 2023.

1 Material and methods

1.1 General data

Inclusion criteria: (1) The main symptoms include accompanied or unaccompanied lower back pain, radiating pain in the lower limbs; (2) CT or MRI images show protrusion of the L4-5 intervertebral disc with nerve compression; (3) Symptoms persist after conservative treatment for 3 months.

Exclusion criteria: (1) Combined with lumbar spondylolisthesis, spinal deformity, spinal compression fracture; (2) X-ray showing excessive flexion or extension of the lumbar spine indicating instability; (3) Multi-level disc herniation; (4) Severe calcification or recurrent disc herniation.

A retrospective analysis was conducted on 148 patients treated at the First Hospital of Huai'an Affiliated to Nanjing Medical University from January 2020 to June 2023, aged 27 to 68 years, with an average age of 46.27 years. Among them, 68 cases were treated with PTED (PETD group) and 80 cases were treated with PEID (PEID group). The follow-up period ranged from 6 to 36 months, with an average of 21.6 months. All patients underwent lumbar spine anteroposterior and lateral X-rays, flexion and extension views, L3-S1 intervertebral disc CT scans, and lumbar spine MRI examinations preoperatively. All patients experienced varying degrees of lumbosacral pain. This study was approved by the Ethics Committee of the Affiliated Huai'an No.1 People's Hospital of Nanjing Medical University, and all patients were informed and consented.

1.2 Surgical methods

All patients underwent general anesthesia and were placed in the prone position.

PETD group: The C-arm machine was used to fluoroscopically locate the L4-5 intervertebral space and mark the puncture line. The puncture angle was approximately 5° to 10° relative to the intervertebral space, with a distance of 9 to 11 cm laterally from the spinous process line as the puncture point. The puncture needle was positioned at the tip of the upper articular process, and a transverse incision of about 1 cm was made at the puncture point. A guide wire was inserted, followed by gradual insertion of the dilation sleeve, working cannula, and then the reamer. Under the guidance of the C-arm machine, the L5 upper articular process was shaped using the reamer, and the endoscope was inserted. If necessary, secondary shaping of the ventral aspect of the upper articular process was performed. Partial ligamentum flavum was excised, and after satisfactory exposure of the surgical field, protruding disc tissue was grasped with a nucleus pulposus forceps to relieve nerve root compression. Hemostasis was achieved using a plasma knife, and the procedure was completed.

PEID group: The C-arm machine was used to fluoroscopically locate the intersection point of the L4-5 space. The puncture needle was slowly inserted at the localization point and stopped when it encountered hard bony structures or fibrous tissues. The inner core was withdrawn and a guide wire was inserted. A longitudinal oblique incision of about 1 cm was made at the puncture point to the level of the deep fascia. The dilation sleeve was inserted along the guide wire, reaching the edges of the upper and lower vertebral plates and the outer edge of the intervertebral space. The working cannula was inserted, and under endoscopic visualization, soft tissues were cleared using radiofrequency and forceps. The lateral edges of the upper and lower vertebral plates were exposed, the ligamentum flavum was exposed, and if the intervertebral space was narrow, the medial edge of the articular process was sequentially removed under endoscopic guidance. The ligamentum flavum was sequentially broken along the lateral edge of the vertebral plate to enter the spinal canal, exposing the nerve roots. The protruding nucleus pulposus was identified and removed. Hemostasis was achieved using a plasma knife, and the annulus fibrosus was shaped. The procedure was completed.

Both groups of patients were allowed to engage in rehabilitation exercises with lumbar support on the first day after surgery, with bed rest as the main activity within the first month and avoiding bending, lifting heavy objects, and strenuous exercise within three months.

1.3 Study indicators

(1) The surgical conditions of the two groups of patients were observed, including intraoperative blood loss, surgical time, number of fluoroscopic procedures, and length of postoperative hospital stay.

(2) The visual analogue scale (VAS) and Oswestry Disability Index (ODI) were used to evaluate lumbar and leg pain before surgery, on the first day after surgery, at one month after surgery, three months after surgery, and at the final follow-up.

(3) Clinical efficacy was evaluated using the MacNab criteria at the final follow-up.

1.4 Statistical analysis

Data were processed using SPSS 25.0 software, and measurement data were expressed as $\bar{x} \pm s$, and independent sample t-tests were used for inter-group comparisons. For comparisons at different time points, repeated measures analysis of variance (ANOVA) and pairwise comparisons were used for continuous data. Count data were expressed as case (%), and chi-square test was used. $P < 0.05$ indicated a statistically significant difference.

2 Results

2.1 General information

There was no statistically significant difference in sex, age and disease course between the PETD group and the PEID group ($P > 0.05$). **See Table 1.**

Tab. 1 Comparison of general information between two groups

Group	*n*	Male[case(%)]	Age(year, $\bar{x} \pm s$)	Course(month, $\bar{x} \pm s$)
PETD group	68	40(58.8)	50.25±15.76	3.28±1.47
PEID group	80	42(52.5)	47.80±14.12	3.78±1.88
χ^2/t **value**		0.595	0.997	1.814
***P* value**		0.440	0.320	0.072

2.2 Surgical-related indicators

Patients in the PEID group had significantly less intraoperative blood loss, shorter surgical times, fewer fluoroscopic procedures, and shorter hospital stays compared to those in the PETD group, with statistically significant differences ($P < 0.05$). **See Table 2.**

2.3 VAS and ODI scores

Compared with preoperative assessments, there were improvements in VAS scores for the lumbar back, leg, and ODI on the first day after surgery, one month after surgery, three months after surgery, and at the final follow-up, with statistically significant differences ($P < 0.05$). But, there were no statistically significant differences between the groups ($P > 0.05$). **See Table 3.**

2.4 MacNab efficacy assessment

At the final follow-up, clinical efficacy was evaluated using the modified MacNab criteria. The excellent and good rates were 95.6% (65/68) in the PETD group and 93.8% (75/80) in the PEID group, with no statistically significant difference between the groups (χ^2 = 0.016, P = 0.898). There were no cases of nerve root injury or dural sac rupture during surgery, and no complications or recurrence were observed during the follow-up period.

Tab. 2 Comparison of operation related indicators between two groups **($\bar{x}\pm s$)**

Group	*n*	Intraoperative blood loss (mL)	Surgical time （min）	number of fluoroscopic	postoperative hospital stay (d)
PETD group	68	13.9±2.1	57.5±6.2	6.6±2.4	1.4±0.6
PEID group	80	11.6±1.4	42.8±3.7	2.1±0.7	1.2±0.5
***t* value**		7.694	17.130	14.931	2.212
***P* value**		<0.001	<0.001	<0.001	0.029

Tab.3 Comparison of VAS score and ODI score between two groups **($\bar{x}\pm s$)**

Group	Time	Lumbar back pain VAS score	Leg pain VAS score	ODI score
PETD group (*n*=68)	Before surgery	6.32±2.11	8.27±1.72	58.62±8.52
	The first day after surgery	2.75±1.22[a]	1.93±0.58[a]	28.38±5.18[a]
	One month after surgery	3.06±0.82[a]	2.75±1.07[a]	13.72±4.92[a]
	Three months after surgery	2.85±0.48[a]	3.35±1.61[a]	11.06±3.64[a]
	Final follow-up	3.27±0.75[a]	3.49±1.25[a]	9.36±2.15[a]
PEID group (*n*=80)	Before surgery	5.82±1.48	7.28±1.29	62.53±10.73
	The first day after surgery	2.18±0.62[a]	2.39±0.74[a]	25.47±6.29[a]
	One month after surgery	2.72±0.79[a]	2.95±1.43[a]	16.38±5.24[a]
	Three months after surgery	3.17±0.59[a]	2.74±0.86[a]	13.26±3.29[a]
	Final follow-up	3.17±0.27[a]	3.07±0.71[a]	8.52±3.47[a]

Note: Compared with before surgery, [a]P<0.05.

3 Discussion

Intervertebral disc herniation often causes severe pain in patients due to mechanical compression or chemical inflammation stimulation, severely affecting their quality of life. Traditional open surgery, with its large trauma and bleeding, as well as nerve root separation, leads to increased postoperative complications. In recent years, with the popularization of the minimally invasive concept in spinal surgery and the continuous development of spinal instruments, percutaneous endoscopic lumbar discectomy has achieved good clinical efficacy in treating lumbar disc herniation [2-4]. Compared to traditional open surgery, PELD has the advantages of smaller incisions, less intraoperative bleeding, faster postoperative recovery, and fewer complications. Both PETD and PEID are commonly used procedures for treating lumbar disc herniation. PETD directly accesses the decompressed intervertebral disc through the "safe triangle" of the intervertebral foramen, better preserving the posterior spinal structures, maintaining spinal stability without disrupting the facet joints extensively, reducing damage to the paraspinal muscles and soft tissues, and minimizing vascular injury [5]. PEID sequentially remove obstructive bony structures under endoscopic visualization, effectively increasing the operative space and thoroughly removing the protruding and displaced intervertebral disc, making the surgery easier to complete.

PETD allows direct visualization of nerve roots and the intervertebral foramen, preserves the yellow ligament to reduce epidural scar formation, and alleviates symptoms [6]. However, it is technically challenging with a steep learning curve, demanding high surgical skills [7]. PEID, on the other hand, is simpler to perform, causes less trauma and bleeding, provides clear visualization of neural structures and lesion locations during surgery, and can address related structural abnormalities such as nerve roots and lamina simultaneously. However, due to restricted surgical views, direct visualization of the intervertebral foramen and nerve roots is challenging, requiring multiple adjustments of the endoscope or instrument changes during surgery, which may increase the risk of nerve root and dural sac overstretching and injury. Some studies suggest a higher risk of dural sac injury during PEID compared to PETD [8].

In our study, patients in the PEID group had significantly less intraoperative blood loss, shorter surgical times, fewer fluoroscopic procedures, and shorter hospital stays compared to those in the PETD group. This is because PEID through the intervertebral foramen can directly puncture and locate the posterior vertebral plate, accurately locate it, and do not blindly expand the removal structure. Therefore, the surgery time is shorter. Moreover, due to the less removal of the structure after surgery, although the intervertebral foramen approach may cause damage to the paraspinal muscles and surrounding soft tissues, compared to the heavier muscle and surrounding

soft tissues in PETD, PEID has relatively less pain in the lower back muscles and shorter hospital stay. No dural sac ruptures were observed during surgery in either group, possibly due to the skill level of the surgeons. Moreover, PEID appears to be easier to perform and learn clinically.

Research indicates that in patients with spinal canal stenosis, insertion of endoscopic instruments can lead to narrowing of the space, resulting in nerve root damage [9-10]. Because the L5-S1 segment is often obstructed by the high iliac crest, PEID is commonly used for this segment, while segments above L4-5 have narrower intervertebral spaces and are less frequently treated with PEID. To address this issue, the authors adjusted the surgical table during clinical operations, flexing the hip and knee while slightly bending the neck and chest to increase the L4-5 space. Additionally, when necessary, partial facet joint removal was performed under endoscopic visualization to increase the operative space, allowing for PEID application in patients with spinal canal stenosis. However, some studies suggest that in cases of L4-5 spinal canal stenosis, obstruction by the inner facet joints during sheath insertion and partial bone removal may cause greater patient damage [11]. Jiang *et al.* [12] found that when less than half of the facet joint is removed, the risk of postoperative lumbar instability is lower, and it does not worsen the degree of lumbar degenerative changes. Zhou et al. [13] suggested that significant effects on lumbar scoliosis and axial rotation occur only when more than half of the unilateral facet joint is missing. In this study, no patients exhibited symptoms of lumbar instability postoperatively, which may be attributed to effective removal of obstructive bony structures under endoscopic visualization. If inadequate operating space was encountered, multiple removals of bony structures were performed under direct visualization to minimize the amount of bone removed and preserve facet joints, thereby increasing lumbar stability. Compared to PETD, most orthopedic surgeons are more familiar with the anatomy of PEID and find it easier to operate.

This study found that VAS scores and ODI on the first day, first month, third month, and final follow-up after surgery were significantly lower than preoperative scores in both groups, with no statistically significant differences in postoperative VAS scores and ODI between the two groups, consistent with previous literature [14-15]. These results confirm that both transforaminal and interlaminar endoscopic approaches effectively alleviate symptoms of L4-5 intervertebral disc herniation.

In conclusion, with the advancement of endoscopic echniques and instrument development, both PEID and PETD treatments for L4-5 intervertebral disc herniation yield satisfactory clinical outcomes. However, PEID is more convenient to perform, minimally invasive, requires fewer intraoperative fluoroscopy exposures, and provides higher patient comfort compared to PETD.

In summary, with advancements in endoscopic technology and instrument development, both PEID and PETD are satisfactory in treating L4-5 intervertebral disc herniation. However, PEID is more convenient to perform, causes less trauma, requires fewer intraoperative fluoroscopic views, and provides higher patient comfort than PETD.

Conflict of interest: None

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·论　著·

不同入路脊柱内镜治疗 $L_{4\sim5}$ 椎间盘突出症的疗效

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摘要：目的　比较脊柱内镜下两种入路治疗 $L_{4\sim5}$ 椎间盘突出症的临床疗效。**方法**　回顾性选择 2020 年 1 月至 2023 年 6 月在南京医科大学附属淮安第一医院治疗的 148 例 $L_{4\sim5}$ 椎间盘突出症患者，其中 68 例采用经皮内镜椎间孔入路椎间盘切除术（PETD）治疗（PETD 组），80 例采用经皮内镜椎板间入路椎间盘切除术（PEID）治疗（PEID 组）。比较两组手术时间、术中透视次数、术中出血量、术后住院时间，临床疗效，及术前、术后腰椎 Oswestry 功能障碍指数（ODI）和腰腿痛 VAS 评分。**结果**　两组患者随访 6～36 个月，平均随访时间 21.6 个月。PEID 组手术时间、术中透视次数、术中出血量及术后住院时间少于 PETD 组，差异有统计学意义（$P<0.05$）。两组术后第 1 天、1 个月、3 个月以及末次随访时腰痛、腿痛 VAS 评分及 ODI 评分较术前改善（$P<0.05$），但两组间比较差异无统计学意义（$P>0.05$）。PETD 组优良率与 PEID 组比较差异无统计学意义（95.6% *vs* 93.8%，$\chi^2=0.016$，$P=0.898$）。**结论**　脊柱内镜下两种入路均可有效治疗 $L_{4\sim5}$ 椎间盘突出症，但 PEID 组手术时间更短，透视次数更少，能有效缩短手术时间及麻醉时间。

关键词：腰椎间盘突出症；脊柱内镜；经皮内镜；椎间孔入路；椎间盘切除术；椎板间入路
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Efficacy of different approaches of spinal endoscopy in the treatment of L_{4-5} intervertebral disc herniation

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Abstract: Objective　To compare the clinical efficacy of two approaches under spinal endoscopy in the treatment of L_{4-5} intervertebral disc herniation. **Methods**　A retrospective analysis was performed for 148 patients with L_{4-5} intervertebral disc herniation treated in The Affiliated Huai'an No.1 People's Hospital of Nanjing Medical University from January 2020 to June 2023. Among them, 68 cases were treated with percutaneous endoscopic transforaminal discectomy (PETD group), and 80 cases were treated with percutaneous endoscopic interlaminar discectomy (PEID group). Surgical time, intraoperative fluoroscopy frequency, intraoperative bleeding volume, postoperative hospital stay, and clinical efficacy were compared between two groups. Preoperative and postoperative lumbar Oswestry dysfunction index (ODI), VAS score for lower back and leg pain were compared. **Results**　Patients in both groups were followed up for 6-36 months, with an average of 21.6 month. The surgical time, intraoperative bleeding volume, postoperative hospital stay, and intraoperative fluoroscopy in the PEID group were significantly lower than those in the PETD group ($P<0.05$). The VAS scores of lower back and leg pain and ODI scores in the two groups at the first day, one month, three months and the last follow-up after operation were improved compared with those before operation ($P<0.05$), but there was no significant difference between the two groups ($P>0.05$). There was no significant difference in the excellent and good rate between the PETD group and PEID group (95.6% *vs* 93.8%, $\chi^2=0.016$, $P=0.898$). **Conclusion**　Both approaches under spinal endoscopy can effectively treat L_{4-5} intervertebral disc herniation, but the PEID group has shorter operation time and fewer fluoroscopic times, which can effectively shorten the operation time and anesthesia time.

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Keywords: Lumbar intervertebral disc herniation; Spine endoscopy; Percutaneous endoscopy; Transforaminal approach; Discectomy; Interlaminar approach

腰椎间盘突出症好发于 $L_{4\sim5}$ 节段，常引起腰腿痛，部分腰椎间盘突出症患者予卧床休息等保守治疗后可缓解症状，若保守治疗无效需及时手术治疗。相对于传统开放手术，内镜下腰椎间盘切除术因其微创理念，越来越受到临床医生偏爱。经皮内镜下腰椎间盘切除术常用的手术方式包括经皮内镜椎间孔入路椎间盘切除术（percutaneous endoscopic transforaminal discectomy, PETD）和经皮内镜椎板间入路椎间盘切除术（percutaneous endoscopic interlaminar discectomy, PEID）[1]。本研究回顾性比较自 2020 年 1 月至 2023 年 6 月采用脊柱内镜两种入路治疗 $L_{4\sim5}$ 椎间盘突出症的临床疗效。报道如下。

1　资料与方法

1.1　一般资料　纳入标准：（1）主要症状为伴或不伴腰痛、下肢放射性疼痛；（2）CT、MRI 影像显示 $L_{4\sim5}$ 椎间盘突出且压迫神经；（3）经保守治疗 3 个月后症状未缓解。排除标准：（1）合并腰椎滑脱、脊柱畸形、脊柱压缩骨折；（2）腰椎过伸过曲位 X 线片显示腰椎不稳；（3）多节段椎间盘突出；（4）严重钙化或复发椎间盘突出。回顾性分析南京医科大学附属淮安第一医院自 2020 年 1 月至 2023 年 6 月诊治符合上述标准的患者 148 例，年龄 27～68 岁。其中 68 例采用 PETD 治疗（PETD 组），80 例采用 PEID 治疗（PEID 治疗）。随访时间 6～36 个月，平均 21.6 个月。患者术前均行腰椎正侧位、过伸过屈位片、$L_3\sim S_1$ 椎间盘 CT 平扫及腰椎 MRI 检查。所有患者均有不同程度腰腿痛。本研究得到南京医科大学附属淮安第一医院伦理委员会批准，所有患者均知情同意。

1.2　手术方法　所有患者均行全身麻醉，取俯卧位。PETD 组：C 臂机透视定位 $L_{4\sim5}$ 椎间隙并标记穿刺线，选择穿刺线与椎间隙成角约 5°～10°，距棘突连线旁开 9～11 cm 作为穿刺点，穿刺针定位于上关节突尖端，穿刺点取横切口约 1 cm，置换导丝，逐级置入扩张套管，工作鞘管，再置入环锯，C 臂机透视辅助下，用环锯对 L_5 上关节突成形后置入内镜，必要时对上关节突腹侧二次成形，咬除部分黄韧带，术野显露满意后，用髓核钳抓取突出的椎间盘髓核组织，见神经根压迫解除，等离子刀止血，术毕。

PEID 组：C 臂机透视定位点在 $L_{4\sim5}$ 间隙交汇点，在定位点上缓缓插入穿刺针，触及坚硬骨性结构或韧性组织后停止进针，拔出内芯置入导丝，在穿刺点上做约 1 cm 纵斜形切口至深筋膜层，顺着导丝置入扩张套管，探及上下椎板缘及椎板间隙外缘，置入工作套管，内镜直视下用射频及咬钳清理镜下软组织，显露上下椎板外侧缘交汇处，暴露黄韧带，如果椎板间隙窄，可在内镜直视下用环锯适当分次去除关节突内缘，沿椎板间隙外侧缘紧贴关节突内侧逐层破开黄韧带进入椎管内，显露神经根，探查突出髓核并摘除；等离子刀止血，纤维环成形，术毕。

两组患者均可在术后第 1 天腰围保护下康复锻炼，1 个月内以卧床休息为主，3 个月内避免弯腰负重、剧烈运动等。

1.3　研究指标　（1）观察两组患者手术情况：术中出血量，手术时间，术中透视次数以及术后住院时间；（2）术前、术后第 1 天、术后 1 个月、术后 3 个月以及末次随访时采用疼痛视觉模拟评分（visual analogue scale, VAS）、Oswestry 功能评分（Oswestry disability index, ODI）评价腰腿痛情况。（3）末次随访采用 MacNab 标准评价临床疗效。

1.4　统计学方法　使用 SPSS 25.0 软件分析数据。计量资料使用 $\bar{x}\pm s$ 描述，组间比较采用独立样本 t 检验；不同时点资料比较采用重复测量资料的方差分析及两两比较；计数资料以例（%）表示，组间比较行 χ^2 检验。$P<0.05$ 为差异有统计学意义。

2　结　果

2.1　一般资料　两组患者一般资料比较差异无统计学意义（$P>0.05$）。见表 1。

2.2　手术相关指标　PEID 组术中出血量、术后住院时间、手术时间及术中透视次数少于 PETD 组（$P<0.05$）。见表 2。

2.3　VAS 评分和 ODI 评分　与术前评估相比，术后第 1 天、1 个月、3 个月以及末次随访时患者腰背部 VAS 评分、下肢 VAS 评分及 ODI 均显著改善，差异有统计学意义（$P<0.05$）；但是组间比较差异无统计学意义（$P>0.05$）。见表 3。

2.4　MacNab 疗效评估　末次随访时根据改良 MacNab 标准评价临床疗效，PETD 组患者优良率为 95.6%（65/68），PEID 组优良率为 93.8%（75/80），两组患者优良率差异无统计学意义（$\chi^2=0.016$，$P=0.898$）。两组患者术中均未出现神经根损伤、硬膜

囊破裂等，术后也未出现相关并发症，随访期间也未见复发情况。

表 1　两组一般资料比较

Tab. 1　Comparison of general information between two groups

组别	例数	男性［例(%)］	年龄（岁，$\bar{x}\pm s$）	病程（月，$\bar{x}\pm s$）
PETD 组	68	40(58.8)	50.25±15.76	3.28±1.47
PEID 组	80	42(52.5)	47.80±14.12	3.78±1.88
χ^2/t 值		0.595	0.997	1.814
P 值		0.440	0.320	0.072

表 2　两组手术相关指标比较　（$\bar{x}\pm s$）

Tab. 2　Comparison of operation related indicators between two groups　（$\bar{x}\pm s$）

组别	例数	术中出血量(mL)	手术时间(min)	术中透视次数	术后住院天数(d)
PETD 组	68	13.9±2.1	57.5±6.2	6.6±2.4	1.4±0.6
PEID 组	80	11.6±1.4	42.8±3.7	2.1±0.7	1.2±0.5
t 值		7.694	17.130	14.931	2.212
P 值		<0.001	<0.001	<0.001	0.029

表 3　两组 VAS 评分和 ODI 评分比较　（分，$\bar{x}\pm s$）

Tab. 3　Comparison of VAS score and ODI score between two groups　（point, $\bar{x}\pm s$）

组别	时间	腰背痛 VAS 评分	腿痛 VAS 评分	ODI 评分
PETD 组（n=68）	术前	6.32±2.11	8.27±1.72	58.62±8.52
	术后第 1 天	2.75±1.22[a]	1.93±0.58[a]	28.38±5.18[a]
	术后 1 个月	3.06±0.82[a]	2.75±1.07[a]	13.72±4.92[a]
	术后 3 个月	2.85±0.48[a]	3.35±1.61[a]	11.06±3.64[a]
	末次随访	3.27±0.75[a]	3.49±1.25[a]	9.36±2.15[a]
PEID 组（n=80）	术前	5.82±1.48	7.28±1.29	62.53±10.73
	术后第 1 天	2.18±0.62[a]	2.39±0.74[a]	25.47±6.29[a]
	术后 1 个月	2.72±0.79[a]	2.95±1.43[a]	16.38±5.24[a]
	术后 3 个月	3.17±0.59[a]	2.74±0.86[a]	13.26±3.29[a]
	末次随访	3.17±0.27[a]	3.07±0.71[a]	8.52±3.47[a]

注：与术前比较，[a]P<0.05。

3　讨　论

腰椎间盘突出症多因机械性压迫或化学炎症刺激导致患者剧烈疼痛，严重影响生活质量。传统开放手术由于创伤大、出血多、分离神经根等使术后并发症增多。近年来随着脊柱微创理念的普及以及脊柱器械的不断发展，经皮内镜下腰椎间盘切除术治疗腰椎间盘突出症取得了很好的临床疗效[2-4]。其较传统开放手术创伤小，术中出血少，术后恢复快，术后并发症少。PETD 和 PEID 为治疗腰椎间盘突出症的常用术式。PETD 通过椎间孔的“安全三角”直接进入减压椎间盘，能更好地保留脊柱后方结构，不破坏关节突的前提下保留脊柱的稳定性，避免广泛剥离椎旁肌，降低对肌肉软组织及血管的损伤[5]；PEID 可在内镜直视下分次去除阻挡的骨性结构，不盲目扩大去除结构，有效增加操作空间，更加彻底地摘除突出移位的椎间盘，使手术更容易完成。

PETD 可直接观察到神经根和椎间孔，可保留黄韧带并减少硬膜外疤痕形成，缓解症状[6]；但操作复杂，学习曲线陡峭，对手术操作者技术要求高[7]。PEID 操作简便、创伤小、出血少，术中可清晰观察到神经结构及病变位置，可同时处理神经根、椎板等相关结构异常。但由于手术视角限制，直接观察椎间孔及神经根困难，需要多次调整内镜或反复更换器械来完成手术，对神经根及硬膜囊过度牵拉，增加损伤风险。因此，有学者研究指出 PEID 术中损伤硬膜囊的风险比 PETD 高[8]。PEID 组患者术中出血量、手术时间、术中透视次数以及术后住院时间均少于 PETD 组患者，因为 PEID 可直接穿刺定位后路椎板，精确定位，不盲目扩大去除结构，所以手术时间更短，且术后因为去除结构较少，虽然 PEID 对于椎旁肌肉及周围软组织有损伤，但相较 PETD 穿刺肌肉及周围软组织较重，患者术后腰背部肌肉疼痛相对减轻，术后住院时间缩短。两组患者术中也未发现硬膜囊破裂，这可能与手术者操作熟练度有关；而且根据术中操作流程看，PEID 更易于临床操作与学习。两组患者术后均未出现并发症。

研究表明，椎板间隙狭窄患者，在内镜通道置入后，会由于空间狭窄引起神经根损伤[9-10]。因 $L_5\sim S_1$ 节段有高髂嵴阻挡，所以 PEID 常应用于 $L_5\sim S_1$ 节段，而 $L_{4\sim5}$及以上节段椎板间隙较窄，应用较少。针对这个问题，笔者在临床操作中将手术床调整，屈髋屈膝且颈胸部稍屈曲状态，增大 $L_{4\sim5}$间隙，同时必要时根据操作需要，在内镜直视下咬除部分上关节突，增加操作空间，可使 PEID 应用于椎板间隙狭窄患者。但是有研究提出，$L_{4\sim5}$椎板间隙狭窄及内侧小关节阻碍工作套管置入，咬除部分骨性结构对患者损伤较大[11]。蒋强等[12]研究发现，当关节突切除体积不超过 1/2，术后发生腰椎不稳的概率较低，且不会加重腰椎退行性改变程度。周跃等[13]研究提示当单侧小关节突缺失超过一半时，腰椎侧弯和轴向旋转才会受到显著影响。本研究中术后随访阶段未发现患者出现腰椎不稳症状，这与术中内镜直视下有效去除阻挡的骨性结构有关，如果发现操作空间不够，会多次直视下进行骨性结构的去除，尽可能减少去除的骨性结构，尽可能保留关节突，增加腰椎稳定性。相比较于 PETD，绝大多数骨科医生对 PEID 的解剖结构更熟悉，操作起来更得心应手。

本研究发现，两组患者术后第 1 天、1 个月、3 个

月以及末次随访时，VAS 评分和 ODI 均显著低于术前，术后的 VAS 评分和 ODI 两组差异无统计学意义，与之前文献报道一致[14-15]。结果再次证实脊柱内镜下两种入路均能有效缓解 $L_{4\sim5}$ 椎间盘突出症状。

综上所述，随着内镜技术水平提高以及器械的发展，PEID 及 PETD 治疗 $L_{4\sim5}$ 椎间盘突出症均有满意的临床疗效，但 PEID 较 PETD 操作方便，创伤小，术中透视次数更好，患者舒适度更高。

利益冲突　无

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