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Original Article

Comparison of the Safety and Effectiveness of Percutaneous Endoscopic Lumbar Discectomy for Treating Lumbar Disc Herniation Under Epidural Anesthesia and General Anesthesia

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Objective: To assess the safety and effectiveness of percutaneous endoscopic lumbar discectomy (PELD) under epidural anesthesia (EA) and general anesthesia (GA) for treating lumbar disc herniation (LDH).
Methods: A retrospective study involving 86 patients with LDH managed by PELD under EA and GA was conducted from July 2018 to March 2019. These patients were divided into 2 groups according to the type of anesthesia. Patient's demographics data as well as the operation time, complications, fluoroscopy shots, visual analog scale (VAS), Oswestry Disability Index (ODI), Japanese Orthopaedic Association (JOA), and MacNab scores of the 2 groups were recorded. All of the patients were followed-up at 6 months after operation.
Results: There were no significant differences were detected in the preoperative demographics between the groups ($p > 0.05$). Two cases (4.8%) under GA developed transient motor weakness, 3 cases (7.4%) presented numbness of lower limb, and 1 case (2.4%) had cauda equina syndrome after operation. In EA group, 1 case (2.2%) had motor weakness and 3 cases (6.7%) had lower limb numbness, which resolved completely at the last follow-up. There was significant difference between preoperative VAS, JOA, and ODI scores and postoperative scores ($p < 0.01$). Moreover, there were no differences in the operation time, fluoroscopy shots, and MacNab scores between the 2 groups ($p > 0.05$).
Conclusion: EA and GA in PELD are effective and safe, and no significant difference in complications was observed. Based on our experience, we recommended junior surgeons to perform PELD under EA for getting feedback from the patient to avoid nerve injury and reduce the radiation dose. The concentration of ropivacaine in EA should be considered carefully.

Keywords: Epidural anesthesia, General anesthesia, Percutaneous endoscopic lumbar discectomy, Lumbar disc herniation

INTRODUCTION

Symptomatic lumbar disc herniation (LDH) is the most common cause of low back pain and radiating pain with lower limbs.[1,2] Patient who suffer from progressive low back pain and neurological deficits usually require surgical interventions, when conservative treatment has failed. With the rapid development of minimally invasive spinal surgery, percutaneous endoscopic

lumbar discectomy (PELD) is getting more popular among minimal invasion surgeries such as microendoscopic discectomy, adiofrequency ablation, collagenase discolysis, and so on. It has been recently performed as an alternative to classic open discetomy with advantage of less muscular injury, short recovery and shorter hospital day.[3,4] Local anesthesia (LA) for PELD is recommended but is still controversial. Some patients could not tolerate the pain caused by insertion of instruments during surgery. Besides, there was a reported study that the procedure may have to be stopped because of severe pain.[5] Epidural anesthesia (EA) or general anesthesia (GA) is another major method which can keep patients awake during surgery. However, few studies have focused on the safety and effectiveness of PELD under GA and EA. The aim of this study is to evaluate the safety and efficacy of PELD under GA and EA.

MATERIALS AND METHODS

From July 2018 to March 2019, 86 patients with symptomatic LDH were enrolled in the study. The patients undergoing PELD under GA were defined as group A (41 cases) and those with EA were defined as group B (45 cases). All patients completed at least 6 months of follow-up via telephone or outpatient. The study design was approved by medical ethics committee of our hospital. All participants provided written informed consent. We have received Institutional Review Board (IRB) approval (Ethics Committee of Shenzhen Traditional Chinese Medicine Hospital, 2019IRB05) for the study and written informed consent for publication from the patient.

1. Inclusion and Exclusion Criteria

Inclusion criteria included: Single-level symptomatic LDH (limited to L3–4, L4–5, or L5–S1 as demonstrated on magnetic resonance imaging scans) with typical symptoms of low back pain and leg pain; Physical examination showed positive Lasegue's sign, motor weakness, or sensory changes; Conservative treatment was ineffective for more than 4 weeks.

Exclusion criteria: Patients with multilevel disc herniation, severe spinal stenosis, Modic type endplate changes, cauda equina syndrome (CES), spondylolisthesis, or any other significant lumbar spinal instability were not considered eligible for the study.

2. Criteria for GA

Usually, we make EA a high priority. In such cases, however, our priority was GA: The patient who cannot cooperate during operation or requires to participate in GA. Those who suffer from LDH at L5/S1 with high iliac crest, interlaminar endoscopic lumbar discectomy usually require GA to access the spinal canal because the transforaminal approach is technically and anatomically difficult. Patients with skin infection at the puncture site. Patients with severe coagulation dysfunction or undergoing anticoagulant therapy. Patients with central nervous system disease and intracranial hypertension.

3. Surgical Methods

The procedure was performed according to the standard PELD technique. The total 86 consecutive PELD procedures were performed by the same spine surgeon who had experience with PELD more than 11 years. PELD was performed as the "outside-in" technique. A 0.8-cm incision was first made in the skin. With the help of C-arm fluoroscopic guidance, foraminoplasty was performed using a high-speed drill for safer insertion of the cannula into the disc. Discectomy and nerve root decompression were then performed as routine PELD procedure. Ropivacaine 0.375% was administered to EA to keep patients conscious during surgery. Thus, the surgeon can get feedback from patients when interfering with the nerve during surgery.

4. Postoperative Management

On the day after operation, the 5-mg dexamethasone and analgesic drugs were given as symptomatic treatment, and the next day, the patient was discharged from hospital. The patients were told to get out of bed with waistline and stay in bed for about 4 weeks to prevent recurrence. During the period, they were asked to do back and abdominal muscles exercises and raise limb.

5. Evaluations

Basic patient information, such as sex, age, body mass index, levels of LDH and disc herniation type was recorded. We also recorded the operation time, fluoroscopy shots, complications, preoperative and postoperative VAS, ODI, and JOA scores. We measured MacNab scores (excellent, good, fair, poor) at 6-month follow-up to assess patients' satisfaction. Neurological symptoms such as motor weakness, sensory disturbance, and bladder and rectum dysfunction were recorded. Motor weakness was assessed according to the Manual Muscle Testing for muscle strength ranging from 0 to 5. The muscle strength and sensory function were tested before and after operation in all patients. Neurological deficits were considered when there was a reduction in motor score or sensory disturbance was observed after operation compared with the preoperative state.

6. Statistical Analysis

The statistical analysis was carried out by using SPSS ver. 17.0 (SPSS Inc., Chicago, IL, USA). All the data were shown in the form of mean ± standard deviation. The Student t-test was used to compare the continuous variables such as age, operation time, VAS scores, and so on. The chi-square test was used to compare the enumeration data between the 2 groups. A p-value of less than 0.05 was considered statistically significant difference.

RESULTS

1. Patient's Demographics

In group A, the mean age was 48.8 years; the mean duration of history was 8.9 months and the herniated disc was localized at the L3–4 level (4 cases), L4–5 level (20 cases), and L5/S1 level (17 cases); 18 patients had central disc herniation and 23 patients had paramedian herniation. In group B, the mean age was 46.2 years; the mean duration of history was 9.2 months; the herniated disc was localized at the L3–4 level (6 cases), L4–5 level (25 cases), and L5/S1 level (14 cases); 20 patients had central disc herniation and 26 patients had paramedian herniation. There were no significant differences were detected in the preoperative demographics between the groups ($p > 0.05$). Demographic data were summarized in Table 1.

2. Postoperative Results of Groups A and B

As shown in Table 2, there was no significant difference between the operation time (68.59 ± 16.38 minutes; range, 39–100 minutes) in group A and group B (69.07 ± 18.37 minutes; range, 35–120 minutes; $p > 0.05$). The fluoroscopy shots of group A was 7.15 ± 2.77, and 6.73 ± 2.45 in group B. In group A, 90.2% of good to excellent result was obtained as per MacNab criteria and 93.3% in group B. There was no significant difference in MacNab scores between the 2 groups ($p = 0.760$). In terms of postoperative complications, 2 cases (4.8%) under GA developed transient motor weakness, 3 cases (7.4%) presented numb-

Table 1. Characteristics of patients with GA (group A) and EA (group B) groups

Variable	Group A	Group B	p-value
Number	41	45	45
Age (yr)	48.83 ± 16.94	46.22 ± 16.19	0.648
Body mass index (kg/m^2)	22.59 ± 2.79	22.86 ± 3.63	0.204
Sex, male:female	19:22	20:25	0.516
History time (mo)	8.89 ± 6.48	9.22 ± 6.33	0.653
Level of LDH			0.588
L3–4	4 (9.8)	6 (13.3)	
L4–5	20 (48.8)	25 (55.6)	
L5–S1	17 (41.4)	14 (31.1)	
Location of disc herniation	18 (43.9)	20 (44.4)	0.566

Values are presented as mean ± standard deviation or number (%).
GA, general anesthesia; EA, epidural anesthesia; LDH, lumbar disc herniation.

Table 2. Comparison of postoperative results between GA (group A) and EA (group B) groups

Items	Group A	Group B	p-value
Complications	6 (14.6)	4 (8.9)	0.508
Motor weakness	2 (4.8)	1 (2.2)	
Sensory disturbance	3 (7.4)	3 (6.7)	
Cauda equina syndrome	1 (2.4)	0 (0)	
Operation time (min)	68.59 ± 16.38 (39–100)	69.07 ± 18.37 (35–120)	0.348
Fluoroscopy shots	7.15 ± 2.77 (2–15)	6.73 ± 2.45 (2–12)	0.611
MacNab criteria			0.760
Excellent:good:fair:poor	28:9:3:1	31:11:3:0	

Values are presented as number (%) or mean ± standard deviation (range).
GA, general anesthesia; EA, epidural anesthesia.

Table 3. Comparison of clinical results between GA (group A) and EA (group B) groups

Variable	Group A		p-value	Group B		p-value
	Preop	Postop		Preop	Postop	
VAS of low back	4.07 ± 1.98	1.44 ± 1.05	< 0.01	4.07 ± 1.88	1.62 ± 1.01	< 0.01
VAS of leg	5.34 ± 1.96	1.22 ± 0.85	< 0.01	5.78 ± 1.76	1.40 ± 1.03	< 0.01
JOA	15.98 ± 4.06	22.05 ± 2.73	< 0.01	14.40 ± 1.95	21.53 ± 2.36	< 0.01
ODI	64.80 ± 15.87	19.41 ± 4.99	< 0.01	66.98 ± 14.32	18.51 ± 7.27	< 0.01

Values are presented as mean ± standard deviation.
GA, general anesthesia; EA, epidural anesthesia; Preop, preoperative; Postop, postoperative; VAS, visual analog scale; JOA, Japanese Orthopaedic Association; ODI, Oswestry Disability Index.

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ness of lower limb, and 1 case (2.4%) had CES after operation. In EA group, 1 case (2.2%) had motor weakness and 3 cases (6.7%) had lower lib numbness, which improved greatly in 1 month and resolved completely at the last follow-up. No recurrence was observed at the last follow-up.

3. Surgical Outcomes

Surgical outcomes are shown in Table 3, the VAS scores for low back and leg pain, JOA and ODI scores improved significantly in both groups after operation. In group A, VAS of low back and leg decreased remarkably from preoperative 4.07 ± 1.98 to 1.44 ± 1.05, 5.34 ± 1.96 to 1.22 ± 0.85 at last follow-up. ODI and JOA improved significantly from 64.80 ± 15.87 to 19.41 ± 4.99, 15.98 ± 4.06 to 22.05 ± 2.73. In group B, VAS of low back and leg decreased remarkably from 4.07 ± 1.88 to 1.62 ± 1.01 and 5.78 ± 1.76 to 1.40 ± 1.03. ODI and JOA improved significantly from 66.98 ± 14.32 to 18.51 ± 7.27 and 14.40 ± 1.95 to 21.53 ± 2.36.

DISCUSSION

1. Anesthesia Selection in the Treatment of LDH With PELD

LDH is a common condition among middle-age and older patients, which cause low back and leg pain due to nerves compression. Posterior lumbar interbody fusion can decompression the spinal cord and nerve root, but the traditional lumbar surgery causes too much soft tissue damage and high medical costs. PELD is a new minimally invasive technique and is constantly developing and progressively becoming common techniques for treating LDH.[6,7] This technique has relatively high requirements for anesthesia, and the choice of anesthesia plays an important role in performing the surgery successfully. In the present study, PELD was mainly performed under LA, GA, or EA. LA has been widely reported to avoid nerve injury.[8,9] However, the pain caused by LA during operation often troubles the patients and poses great challenges for junior surgeons. According to the recent reports, PELD under GA or EA for treating LDH could help patients enjoy a better painless experience as an alternative technology.[10,11] Relevant studies[12] showed GA more effectively manage the intraoperative pain but may have greater risk of neurological complications, rendering patients unable to cooperate with the surgery. According to the aforementioned study, the complications include dorsal root ganglion injury, postoperative cognitive dysfunction, dural sac tear or infection.[13-15] Ye et al.[16] found that patients underwent PELD under GA had a lower score of postoperative cognitive function than EA group and it was demonstrated that EA had positive significance for the improvement of cognitive function. In our study, we found the incidence of neurological deficits in GA group was much more than EA group. In GA group, 2 cases developed transient motor weakness, 3 cases presented numbness of lower limb, and 1 case had CES after operation, which accounted for 14.6%. In EA group, 1 case with motor weakness and 3 patients with lower extremity numbness were observed, which accounted for 8.9%. Lots of studies have assessed the safety of PELD under GA or EA, but few studies focus on a comparison of the safety between EA and GA. In our study, no significant difference in complications was detected between the 2 groups ($p = 0.508$). We believe future studies with larger samples are needed to compare the difference between these 2 anesthesia techniques.

2. The Concentration of Ropivacaine in EA

Both EA and GA can prevent the pain but EA also can maintain the function of motor of lower limbs which is called sensory-motor separation.[17] Currently, the use of EA is comparatively infrequent. Ropivacaine has a stronger ability to inhibit nerve conduction in pain sensing fibers and low concentration medications can preserve motor function and only blocks sensation during surgery. According to the literature, the concentration of ropivacaine played a very important part in the alleviation of pain.[18] Low concentrations of ropivacaine such as 0.25% or 0.375% can only block the sensory nerves, but cannot or cannot completely block the motor nerves, thus meeting the surgeon's requirements.[19] Zhu et al.[20] found that 0.25% ropivacaine had better effectiveness in pain management when used in EA. Luo found that 0.3% ropivacaine in PELD under EA was better to prevent pain than LA.[21] However, we should realize that low concentration of ropivacaine cannot completely block the sensory nerves, thus patient can still encounter pain during surgery. There are some structures such as the surface of facet joint, posterior longitudinal ligament, and annulus fibrosus can evoke pain during performing PELD, but we can minimize the pain by local infiltration of lidocain to such structures. We observed higher rates of intraoperative pain in patients whose nerve root was compressed by surgical instruments. Efforts such as remove or relocate the instrument can overcome and minimize most of discomfort which patient can encounter during operation. In our study, ropivacaine 0.375% was used in EA and satisfactory analgesic effect was observed. We believed more studied should be carried out to find out the best concentration of ropivacaine in EA to achieve a better sensory-motor separation.

3. Fluoroscopy Shots During Surgery

To accurately target the disc, repeated fluoroscopic scanning is essential for the puncture and cannulation during surgery. Fan found that the average of 34.3 fluoroscopy shots was needed in PELD.[22] Repeated fluoroscopy results in an increase of the radiation dose during operation and poses a threat to human health.[23] Wu et al.[24] found that patients who had operation performed by routine endoscopic technique under LA received more radioactive exposure (10.12 ± 3.24 seconds) than those who operated by visualized endoscopic technique under GA (1.06 ± 0.18 seconds). In our study, patients in general group received 7.15 ± 2.77 shots of fluoroscopy, and 6.73 ± 2.45 shots in group B. There was no significant difference in fluoroscopy shots between the 2 groups. The average fluoroscopy shots in GA group were a little more than EA group. The main reason was that because the patient was unconscious under GA and information of nerve injury could not be sent back to the surgeon. Thus we had to check whether the working cannula was located at the right place under repeated C-arm fluoroscopic guidance, especially when we had a suspicion that the spinal cord might be compressed by work channel. In our opinion, PELD under EA can help to reduce the radiation dose because patients under EA could provide immediate pain responses and move their lower limbs when the surgeons required, a good means of identifying nerve injury.

CONCLUSION

The study showed that EA and GA in PELD are effective and safe, and no significant difference in neurological complications was observed between the 2 groups. EA was recommended to junior surgeons for better effectiveness in pain management during surgery but maintaining the motor function of lower limbs, thus the surgeon can still get feedback from the patient to avoid the nerve injury and reduce the radiation dose. What's more, the concentration of ropivacaine in EA should be considered carefully.

CONFLICT OF INTEREST

The authors have nothing to disclose.

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