Observational Report

Percutaneous Endoscopic Interlaminar Lumbar Discectomy with Local Anesthesia for L5-S1 Disc Herniation: A Feasibility Study

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Background: General anesthesia (GA), which is routinely applied in patients who undergo percutaneous endoscopic interlaminar lumbar discectomy (PEILD) of L5-S1 disc herniation, is closely associated with postoperative cognitive dysfunction (POCD) in the elderly. Local anesthesia (LA) is an alternative pain control protocol that has not yet been fully evaluated.

Objectives: To evaluate the feasibility of LA in PEILD compared with GA.

Study Design: A retrospective study.

Setting: This study took place at the First Affiliated Hospital of Harbin Medical University.

Methods: A total of 120 patients (aged 60-85 years) diagnosed with L5-S1 disc herniation and with American Society of Anesthesiologists fitness grade I or II between March 2016 and August 2017 were enrolled in the current study. Patients were randomly divided into LA group and GA group. For LA, 0.25% lidocaine was injected layer-by-layer into skin, subcutaneous tissue, fasciae, lumbar facet joint, muscle, and ligamentum flavum followed by injection of 1.33% lidocaine into epidural space; for GA, propofol, sufentanil, and cisatracurium were infused intravenously at 1 to 2 mg/kg, 0.3 μg/kg, and 0.15 mg/kg, respectively. Visual Analog Scale (VAS), Oswestry Disability Index (ODI), and MacNab Criteria (MNC) evaluated the feasibility of LA as pain control protocol in comparison to GA before and after operation. The development of POCD was assessed by the Mini-Mental State Examination 1 and 7 days postsurgery. Feasibility of LA as a pain control protocol was also evaluated by patient's willingness to receive the same surgical procedure immediately and 24 hours after the surgery, and intraoperative fluoroscopy use, blood loss, surgery duration, postoperative bed confinement, and duration and cost of hospital stay were also evaluated.

Results: Patients in both LA and GA groups had comparable VAS grade, ODI, and MNC pre- and post-PEILD, with significant pain reduction after operation. However, POCD developed only in GA group but not in LA group. In addition, compared with GA, LA group did not require postoperative bed confinement, had significantly shorter hospital stay, and lower hospital cost. Low intraoperative VAS grade and willingness to receive the same procedure reflected the acceptance of LA by patients.

Limitations: The development of POCD was examined only 7 days after operation. The follow-up should be extended to 3 months and 2 years postoperation.

Conclusions: LA has satisfactory pain control and low-risk of POCD in PEILD and is well accepted by patients. The benefits of LA are no postoperative bed confinement, faster recovery, shorter hospital stay, and lower hospital cost.

Key words: L5-S1 disc herniation, older patients, percutaneous endoscopic interlaminar lumbar discectomy, local anesthesia, general anesthesia, postoperative cognitive dysfunction, American Society of Anesthesiologists grade, Oswestry Disability Index, MacNab Criteria, Mini-Mental State Examination

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Percutaneous endoscopic lumbar discectomy (PELD) is an operative procedure used for treating lumbar disc herniation, and commonly performed by using the transforaminal (PETLD) or interlaminar (PEILD) route (1-3). For L5-S1 disc herniation, the PEILD is preferred to PETLD due to special anatomic features of L5-S1, including large facets overlapping the disc space, narrow foramen, small disc height, inclined disc space, and iliac crest concealing the L5–S1 foramen (1,4).

General anesthesia (GA) is recommended for PEILD due to pain resulting from scissoring the ligamentum flavum, rotating the working channel, and manipulating the disc annulus fibrosus. However, local anesthesia (LA) may be beneficial for older patients to reduce the risk of postoperative cognitive dysfunction (POCD), which is a postoperative complication of the central nervous system that commonly occurs in patients after GA (5-7). Symptoms of POCD include confusion, anxiety, personality change, and impairment of cognition, memory, concentration, and sexual capability, which compromise the quality of life and increase the rates of complication and mortality, as well as medical cost. Moreover, LA allows real-time communication with the patient, which enhances surgical safety and efficiency (4,8,9).

In the present study, we tested the feasibility of PEILD with LA in patients (aged 60 years or older) with L5-S1 disc herniation in comparison with GA.

Methods

Patients

A total of 120 patients diagnosed with L5-S1 disc herniation and with American Society of Anesthesiologists fitness grade I or II between March 2016 and August 2017 were enrolled in the current study. The inclusion criteria were patients diagnosed as L5-S1 disc herniation, which was confirmed by computed tomography and magnetic resonance imaging (Fig. 1); those who

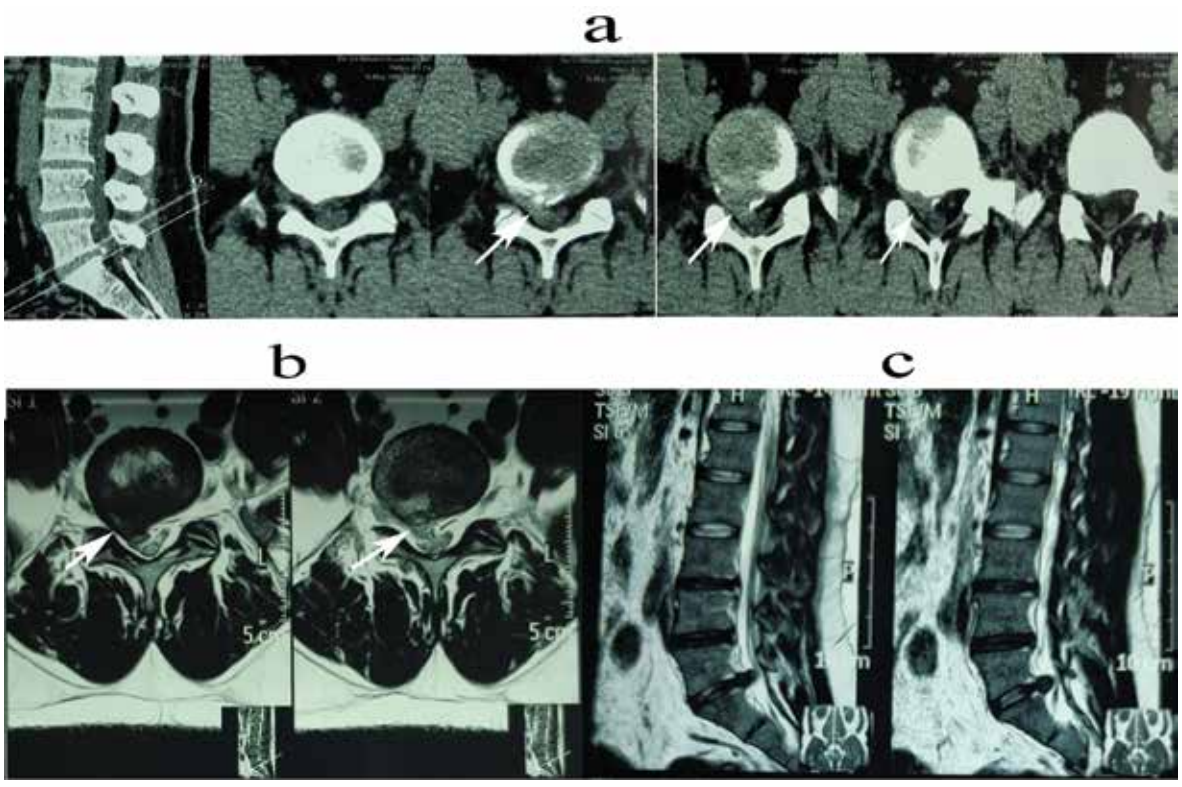

Fig. 1. *L5-S1 paracentral lumbar disc herniation confirmed by imaging tools. (A) Sagittal and transverse planes of computed tomography images at L5-S1; the white arrow is pointing to the paracentral lumbar disc herniation with partial calcification. (B and C) Respective transverse and sagittal planes of magnetic resonance imaging at L5-S1; the paracentral lumbar disc herniation is indicated with the white arrow.*

agreed to receive PELD and had no history of previous surgical innervations that included the L5-S1 region, for example radiofrequency pulse, ozone treatment, and collagenase injection; and patients who were aged 60 years or older. The exclusion criteria were patients with lumbar spinal stenosis, extreme lateral or central lumbar disc protrusion; those who previously received surgery or interventional treatment; had a history of kidney, liver, hematopoietic, or cardiovascular disease, or psychotic disorder; or were unwilling to receive PELD (10).

After obtaining the informed consent, patients were randomly divided into LA group and GA group, with 60 patients per group. No significant difference in age, gender, body weight, type of herniation, clinical symptoms, and physical signs were observed between groups (Table 1).

This study was approved by institutional review board of The First Affiliated Hospital of Harbin Medical University, Nangang, Harbin, PR China.

PEILD under LA

Patient was placed in a prone position. Next, 0.25% lidocaine 15 to 20 mL was injected layer-by-layer into the skin, subcutaneous tissue, fasciae, muscle, lumbar facet joint, and then the ligamentum flavum to prevent pain from ligament cutting. Next, the working channel was placed, and the endoscope (Spinendos GmbH, München, German) was in place. Translaminar space was then enlarged by removing part of the superior articular process next to the working channel using an endoscopic drill, and the nerve root canal was exposed. The ligamentum flavum was then cut open, epidural space exposed, and 1.33% lidocaine 3 to 5 mL was injected into the epidural space via the working channel (Fig. 2A). Soon after the pain release, the working channel was rotated, and the nerve root was pushed gently away from the channel to avoid nerve damage (Fig. 2B). Finally, the herniated discs were exposed and removed (11-14).

Table 1. *Demographic and clinical information of study patients.*

	GA (n = 60)	LA (n = 60)	*P* Value
Demographics			
Male	22	26	0.456
Female	38	34	
Body weight (kg)	55.2 ± 6.8	55.7 ± 7.1	0.934
Age (years)	73.8 ± 13.1	74.2 ± 12.6	0.971
Type of herniation			
Lateral	18	16	0.685
Paracentral	42	44	
Symptom			
Low back pain	26	28	0.714
Leg pain	48	52	0.327
Physical sign			
Straight leg raising positive	48	52	0.327
Bragard sign	46	50	0.361
Calf numbness	48	52	0.327
Lower extremity weakness	42	44	0.685
Diminished tendon reflexes	38	36	0.707

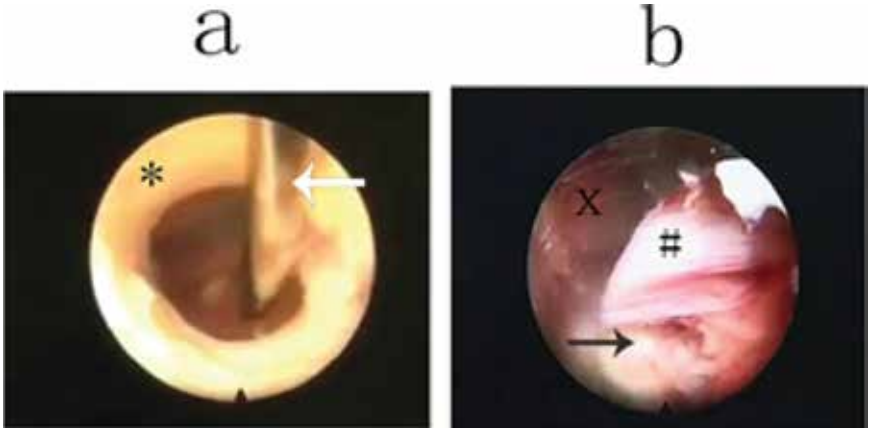

Fig. 2. *Lidocaine injection and nerve root rotation during PEILD. Images were captured by the monitor during operation. (A) Injecting lidocaine into epidural space with a long needle (white arrow) via transforaminal endoscope. Asterisk shows the ligamentum flavum. (B) Rotating the working channel (black X) and pushing the nerve root (#) away from the working channel after epidural injection of lidocaine. The black arrow points to the disc herniation.*

PEILD under GA

For GA, propofol, sufentanil, and cisatracurium were infused intravenously at 1 to 2 mg/kg, 0.3 μg/kg, and 0.15 mg/kg, respectively. The rest of the procedure was the same as explained earlier (see PEILD under LA section).

Assessment of Pain Control and Tolerance

Postoperative Visual Analog Scale (VAS) (15) was used to evaluate the pain control. VAS was used to access pain tolerance by LA patients during PEILD when the ligamentum flavum was opened with scissors, nerve root rotated, and the disc annulus fibrosus was opened and removed. VAS is a psychometric response scale in which a score of 0 indicates no pain, and 10 indicates severe pain. Patients were asked to specify their pain level by indicating a position along a continuous line between the 2 endpoints. Mean scores of mild, moderate, and severe pain levels were 2.57 ± 1.04, 5.18 ± 1.41, and 8.41 ± 1.35, respectively (15).

Pain control by LA versus GA was also evaluated by the Oswestry Disability Index (ODI) and the MacNab Criteria (MNC) before and after operation. ODI is a clinical gold standard used to measure the degree of disability and to estimate the quality of life in a person with lower back pain. It is a questionnaire that includes 10 questions concerning the intensity of pain, ability of self-care, ability to lift, sit, stand, walk, and travel, sexual function, social life, and sleep quality. Each question is followed by 6 statements; the first statement (score 0) indicates the least severe disability, whereas the last one (score 5) indicates the most severe disability. The patient checked the statement that most closely resembled his or her situation. The scores for all questions were summed and multiplied by 2 to obtain the index ranging from 0 to 100, in which 0 indicated no disability and 100 indicated the maximum disability.

The MNC is used clinically to assess the therapy efficacy with "excellent" as asymptomatic with normal life and work restored; "good" as symptoms mild and activities slightly limited with life and work unaffected; "fair" as symptoms relieved and activities limited with physical restrictions in daily life; "poor" as postoperative symptoms the same or even worse than preoperative. Patients were asked to self-evaluate (16).

Evaluation of POCD

The Mini-Mental State Examination (MMSE) was performed at one and 7 days after surgery to evaluate the development of acute POCD. MMSE is the most pervasive method for screening cognitive functions and intelligence worldwide. It includes 30 questions that are used to examine 7 aspects including registration (repeating named prompts) (17), attention, calculation, recall, language, ability to follow simple commands and orientation, with one point per correct answer for each question (maximum score 30). The subject gets a point if he or she correctly answers a question, and he or she gets no points if the answer is wrong or "don't know" (18,19).

Other Feasibility Assessments

Patients were queried for their willingness to receive the same surgical procedure immediately and 24 hours after the surgery. In addition, intraoperative G-Arm fluoroscopy use and blood loss, duration of surgery, postoperative bed confinement, and duration and cost of hospital stay were also analyzed to assess feasibility of LA in PEILD.

Statistical Analysis

Comparisons of age and body weight between the 2 groups were performed using an unpaired t test. Comparisons of clinical symptoms and physical signs were carried out using the Fisher exact test. P value < 0.05 was considered statistically significant.

Results

Pain was Well Controlled and Tolerated by LA

One day before surgery, no difference in pain level (VAS grade: 9.0 ± 1.5 vs. 8.8 ± 0.8; $P = 0.848$), ODI (53.6 ± 18.1 vs. 52.3 ± 15.8; $P = 0.930$), and MNC for "excellent" plus "good" (93.3% vs. 90.0; $P = 0.288$) were observed in the LA and GA groups, respectively. One day after operation, VAS grade was 2.4 ± 1.0 and 2.4 ± 0.8 in LA and GA groups, respectively ($P = 1.00$). Similar levels were observed 7 days after surgery; VAS grades (1.7 ± 1.5 vs. 1.6 ± 1.0; $P = 0.928$), ODI (11.5 ± 7.2 vs. 12.3 ± 8.1; $P = 0.904$), and MNC (93.3% vs. 90.0%; $P = 0.447$) were found in LA and GA groups. Importantly, a significant pain reduction was achieved after surgery in both anesthetic groups in comparison to before operation ($P < 0.05$, respectively).

During surgery, pain was well tolerated in LA patients. The average and highest VAS scores were 1.0 ± 0.3 and 1.2 ± 0.5 when the ligamentum flavum was exposed; 2.2 ± 0.4 and 2.6 ± 0.8 when the nerve root was rotated; and 1.8 ± 0.7 and 2.0 ± 0.9 when the disc annulus fibrosus was exposed, opened, and removed,

respectively, which suggested that the patients who underwent PEILD under LA experienced mild pain.

POCD was Developed only in GA Group

Development of POCD was evaluated by MMSE. Before surgery, similar MMSE grades, that is, 24.46 ± 2.35 and 24.55 ± 1.80 were observed for LA and GA groups, respectively (P = 0.961). However, one day and 7 days after operation, MMSE grade significantly decreased in GA group with 14.58 ± 1.85 (P = 0.042) and 16.00 ± 1.51 (P = 0.043), suggesting the development of POCD in GA patients. By contrast, no difference in MMSE grades were observed before and after the operation (before: 23.93 ± 1.94, P = 0.816; after: 24.05 ± 2.26, P = 0.862). The morbidity of POCD in GA group was 42% (13 of 60) and 16% (5 of 60) at one day and 7 days postoperation, respectively, whereas the presence of POCD was not observed in the LA group.

Willingness to Receive the Same Procedure was Similar Between LA and GA Groups

The willingness to receive the same procedure again was investigated immediately and 24 hours after operation. The rate of positive answer was similar between LA and GA groups with 86.7% (52 of 60) and 90.0% (54 of 60), respectively, immediately after operation (P = 0.570), and 93.3% (56 of 60) and 96.6% (58 of 60), respectively, 24 hours after surgery (P = 0.675), which suggests that PEILD under LA was well tolerated and accepted by most patients.

Intraoperative G-Arm Use, Blood Loss, Duration of Surgery, Postoperative Bed Confinement, Hospital Stay, and Costs

No difference in surgery duration (47.6 ± 15.7 minutes vs. 45.4 ± 15.5 minutes; P = 0.871), intraoperative G-Arm usage (6.4 ± 0.5 minutes vs. 6.3 ± 0.2 minutes; P = 0.764), and blood loss (7.0 ± 2.0 mL vs. 7.0 ± 2.5 mL; P = 1.00) were observed in LA and GA groups, respectively. Compared with patients who received GA, LA patients did require bed confinement, and had a significantly shorter hospital stay and lower costs. The duration of postoperative bed confinement was 0 hours for LA group and 8.0 ± 2.0 hours for GA group (P = 0.006); the hospital stay was 3.0 ± 0.5 days and 7.0 ± 0.5 days for LA and GA groups, respectively (P = 0.001); the hospital cost was 2.4 x 104 ± 0.22 x 104 Chinese yuan and 3.2 x 104 ± 0.32 x 104 Chinese yuan for LA and GA groups, respectively (P = 0.025).

Discussion

GA has been closely associated with the development of POCD in patients older than age 60 years who undergo PEILD of L5-S1 disc herniation. The results of this study suggested that LA is safe, has satisfactory pain control and low-risk of POCD in PEILD, and is well accepted by patients.

Pain control was evaluated using VAS, ODI, and MNC: 3 methods measuring pain level and disability. All 3 measures were self-assessed by patients, and thus were unbiased by investigators. No significant differences in pain levels were observed between groups, although a significant pain reduction was achieved after surgery in both anesthetic groups in comparison to before operation. In addition, low VAS scores were detected when the ligamentum flavum was exposed, the nerve root was rotated, and the disc annulus fibrosus was exposed and consequently removed. This further suggested that patients who received LA could tolerate the pain, which was further supported by the willingness of LA patients to undergo the same procedure again. Most importantly, POCD developed only in GA patients, but not in the LA group, indicating that LA may significantly diminish the risk of POCD in older patients (20). However, the development of POCD was examined only 7 days after operation. The follow-up should be extended to 3 months and 2 years postoperation to identify intermediate and long-term POCD, respectively (21).

In addition, LA enables real-time pain report from patients during surgery, and thus helps to avoid nerve damage and significantly enhances the safety (22). Moreover, LA does not require postoperative bed confinement, and significantly reduces the hospital stay and costs (23).

Conclusions

LA provides satisfactory pain control and tolerance of PEILD, and significantly reduces the risk of POCD in patients who undergo PEILD of paracentral disc herniations at L5-S1. In addition, LA decreased the hospital stay and hospital costs. PEILD under LA may be extended to younger patients.

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