ORIGINAL CLINICAL RESEARCH

Lumbar Epidural Analgesia versus Local Analgesia with Dexmedetomidine Infusion in Endoscopic Lumbar Discectomy: A Randomized Controlled Trial

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Abstract

Background: This study assessed the efficacy and safety of local anesthesia combined with dexmedetomidine, epidural anesthesia, and general anesthesia for pain control in patients undergoing percutaneous transforaminal endoscopic discectomy (PTED).

Methods: This single-blinded, parallel-group, randomized, clinical trial enrolled 78 adult patients of both genders, aged between 18 and 50 years, with American Society of Anesthesiologists physical status I or II who were scheduled for PTED. The participants were randomly assigned to one of three groups (26 patients each). The first group (A) received local skin infiltration with lidocaine 1% plus intravenous dexmedetomidine, while the second group (B) received epidural anesthesia with bupivacaine 0.25%. The control group patients were administered general anesthesia. The study evaluated Visual Analog Scale (VAS) and hemodynamic parameters as primary outcomes, and the rate of conversion to general anesthesia, patients' satisfaction, and postoperative complications as secondary outcomes.

Results: Compared to general anesthesia, local anesthesia/dexmedetomidine combination and epidural anesthesia had significantly lower VAS score, heart rate, and mean arterial pressure. During the intraoperative and postoperative periods, epidural anesthesia significantly lowered the VAS score and mean blood pressure compared to local anesthesia/dexmedetomidine. The rate of conversion to general anesthesia and the prevalence of complications were comparable between groups. The patients' satisfaction was better in group A but without a statistically significant difference.

Conclusion: In percutaneous endoscopic lumbar discectomy, local anesthesia combined with dexmedetomidine, and epidural anesthesia are effective and safe to achieve pain control and optimize hemodynamics. Epidural anesthesia shows better pain control both intraoperatively and postoperatively.

Keywords: Dexmedetomidine; Endoscopic Lumbar Discectomy; Epidural Anesthesia; General Anesthesia; Local Anesthesia.

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Introduction

Percutaneous transforaminal endoscopic discectomy (PTED) is a common treatment for lumbar disc herniation because of its advantages over traditional surgery,[1] including less blood loss, shorter operative time, shorter hospital stays, and faster return to work.[2]

Effective anesthesia requires optimal intraoperative hemodynamic conditions with minimal blood transfusion, prompt discharge from the post-anesthesia care unit, and low incidence of typical postoperative problems such as pain, nausea, and vomiting.[3-5]

General anesthesia can provide patients with a highly satisfactory surgical experience.[6] However, it may increase the surgical risk associated with percutaneous endoscopic lumbar discectomy due to the lack of real-time information available to the surgeon during the procedure, which can result in an inability to communicate potential nerve root or spinal cord injuries in unconscious patients.[7]

Local anesthesia is commonly used for endoscopic lumbar discectomy, as first reported by Yeung.[8] Percutaneous transforaminal endoscopic discectomy is performed under local anesthesia as a safety precaution. The patient remains conscious during the procedure, allowing the surgeon to receive direct feedback regarding any nerve interference.[9] However, PTED may cause discomfort for patients who are sensitive to pain, leading to anxiety and psychological distress. This can result in elevated blood pressure and heart rate, and in severe cases, cardiovascular or cerebrovascular events. Therefore, it is still necessary to establish effective pain management, provide immediate feedback during surgery, and ensure a positive surgical experience for patients undergoing percutaneous endoscopic lumbar discectomy for lumbar disc herniation.[10]

To address the gap in pain management, a combination of intravenous sedation and local anesthesia is typically used to ensure patient comfort and safety during surgery. The sedation level can be adjusted to maintain patient responsiveness and comfort.[7] Dexmedetomidine, a potent alpha-2 adrenoreceptor agonist, has distinct properties to induce sedation and analgesia. Dexmedetomidine induces drowsiness, antinociception, and anxiolysis through its central sympatholytic effect. It also reduces the incidence of intraoperative episodes of hypertension and tachycardia.[11]

Epidural anesthesia is a commonly used technique in surgical procedures, particularly in deliveries and surgeries involving the lower limbs. It involves injecting an anesthetic into the epidural area to block the spinal nerve root and induce anesthesia. An anesthesiologist can also insert an epidural catheter to adjust the level, duration, and dosage of anesthesia.[12, 13] Epidural anesthesia allows patients to remain conscious during surgery and allows surgeons to assess nerve function by monitoring the motor function of the patient's lower limbs.[9] However, there is lack of high-quality research to support its effectiveness and safety for PTED.[7]

Moreover, the feasibility, safety, and efficacy of local, epidural, and general anesthesia for patients undergoing lumbar interlaminar endoscopic surgery are still controversial. Nevertheless, dexmedetomidine has not been frequently compared with local anesthesia. This study was conducted to assess efficacy and safety of local anesthesia combined with dexmedetomidine compared to epidural anesthesia and general anesthesia for patients undergoing PTED.

Materials And Methods

Ethical considerations

The study protocol was approved by the Ethics Committee of the Faculty of Medicine, Ain Shams University, Egypt (ID: FAMSU R280/2022/2023, Date: 19/1/2023). We obtained informed written consents from the study participants or their legally authorized representatives. This trial was registered at the ClinicalTrials.gov registry (ID: NCT05850455, Date: 19/4/2023). We ensured the confidentiality of the participants' information.

Study design and setting

This single-blinded, parallel-group (1:1:1), randomized, clinical trial was conducted at the Ain Shams University Hospital, Egypt between 20/5/2023 and 30/11/2023.

Eligibility criteria

The study enrolled 78 adult patients of both genders, aged between 18 and 50 years, with American Society of Anesthesiologists (ASA) physical status I or II who had clinical and radiological evidence of soft disc herniation in a single lumbar segment and were scheduled for PTED. Exclusion criteria included the presence of spinal malformation, recurrent or multi-segment lumbar disc herniation, age below

18 or above 50 years, hypersensitivity to any of the drugs used, and refusal to participate.

Randomization

A computer-generated table was utilized to randomly allocate 78 patients into one of three groups of 26 patients each. The randomization sequence was concealed using the sealed, opaque envelope method.[14] Only the participants were blinded to the allocation of intervention.

Procedures and interventions

Seventy-eight patients were randomly allocated into groups A, B, and control. All patients underwent PTED. Group A received local skin infiltration with lidocaine plus intravenous dexmedetomidine, while group B received epidural anesthesia with bupivacaine 0.25%. Patients in the control group were administered general anesthesia.

Preoperatively, all patients were assessed and instructed to fast for 8 hours for solids and 2 hours for clear fluids. Upon arrival to the operating room, intravenous access was established, and acetated Ringer's solution was infused at a rate of 10 mL/kg. Electrocardiography, noninvasive blood pressure, and arterial oxygen saturation were routinely monitored.

In group A, dexmedetomidine was loaded at a dose of 1 µg/kg over 10 minutes, followed by a continuous infusion at a rate of 0.5 µg/kg/hour.[15] Next, the skin was infiltrated with 2-3 mL of 1% lidocaine, and an 18-gauge needle was inserted to anesthetize the trajectory with 8-10 mL of 1% lidocaine. Upon reaching the superior articular process, 2-3 mL of 1% lidocaine was administered to anesthetize the facet joint. Intraoperative administration of lidocaine was considered if necessary.[16]

In group B, the epidural insertion point was 2 segments above the surgical site. To adjust the sensory level, 10 mL of bupivacaine 0.25% was injected into the epidural space.[16]

The control group received propofol (2–3 mg/kg), fentanyl (2 µg/kg), and cisatracurium (0.2 mg/kg) to facilitate endotracheal intubation. Ventilation was controlled to maintain the end-tidal carbon dioxide at 32–38 mmHg. Sevoflurane 2-3% and cisatracurium (0.05 mg/kg) were added at 40-minute intervals for maintenance of anesthesia, based on the operation's conditions.[17]

The surgical procedure was performed using the standard percutaneous transforaminal endoscopic spine system by an experienced surgeon.[18]

The back and leg pain were evaluated using the Visual Analog Scale (VAS) before and one hour after surgery in the three groups. Intraoperative VAS was collected from groups A and B. The heart rate and blood pressure were monitored for all groups every 30 minutes intraoperatively and every hour postoperatively for 6 hours. The rate of conversion to general anesthesia was observed in groups A and B. Patient satisfaction with anesthesia was evaluated one hour postoperatively, and anesthetic complications were noticed for two successive days postoperatively.

Study outcomes

The primary outcomes were the VAS and the changes in heart rate and mean arterial pressure. The secondary outcomes were the rate of conversion to general anesthesia, patients' satisfaction with anesthesia, and postoperative complications.

Sample size

The required sample size to achieve a power of 99% and an alpha error of 5% was calculated using Power Analysis and Sample Size software (PASS 15) (Version 15.0.10). After reviewing the results of a previous study conducted by Zhu et al.,[19] it was found that the mean level of VAS for measuring lumbar pain 1 hour postoperatively was higher among patients who underwent PTED with local anesthesia compared to those with epidural anesthesia. Therefore, an estimated sample size of 78 patients. The participants were divided into three groups, each with 26 patients.

Statistical analysis

Data analysis was carried out using the Statistical package for social sciences (SPSS), version 28 (IBM Corp., Armonk/NY/USA). Numerical variables (e.g., age, heart rate, VAS scores) were summarized as means and standard deviations, while categorical variables (e.g., gender, ASA class) were expressed as counts and percentages. One-way analysis of variance (ANOVA) test was used to compare numerical variables among the three groups, with the conduction of Tukey's post hoc test if the ANOVA test was significant. To assess the association between categorical variables, either Pearson's chi-squared test or Fisher-Freeman-Halton exact test was used as appropriate. The P values below 0.05 were interpreted as statistically significant.

Results

Seventy-eight patients were assessed for eligibility. No patients were excluded.

Seventy-eight patients were randomly allocated to one of three groups:

A, B, and control (26 patients each). All patients underwent PTED. Patients in groups A and B received local anesthesia/dexmedetomidine and epidural anesthesia, respectively. The control group patients were administered general anesthesia (Figure 1).

The baseline characteristics of the enrolled patients are presented in Table 1. Patients were significantly younger in the control group compared to the other two groups ($P = 0.003$). Gender distribution was comparable among the groups, with men representing slightly more than half the participants in each group ($P = 0.854$). The mean body mass index was significantly ($P = 0.010$) higher in the control group (32.50 ± 5.60 kg/m^2) compared to groups A (29.19 ± 2.86) and B (29.65 ± 3.41). There was no significant difference among the three groups regarding the ASA classification of the patients ($P = 0.376$).

Comparison of the heart rates among the three groups during and after surgery is presented in Table 2. At the start of surgery, the three groups had comparable heart rates, with no statistically significant differences ($P = 0.367$). Half an hour after induction of anesthesia, the mean heart rate decreased in groups A and B to reach average values between 60 and 70 beats/minute, whereas the heart rates were maintained close to preoperative values in the control group. The differences between the control group and the two test groups were statistically significant ($P < 0.001$) and persisted till six hours after surgery. There were no significant differences between groups A and B.

Comparison of the mean arterial pressures among the three groups during and after surgery is presented in Table 3. At the start of surgery, the three groups had comparable average values of mean arterial pressures, with no statistically significant difference. Starting from half an hour after induction of anesthesia and till one hour after surgery, the mean arterial pressures decreased in groups A and B. Furthermore, the mean arterial pressures decreased slightly but close to preoperative values in the control group. There were significant differences among the three groups with the decrease in the mean arterial pressure being most marked in group B. At two, four, and six hours after surgery, the mean arterial pressure levels were comparable in the three groups with no significant difference. However, the mean arterial pressure decreased in groups A and B groups at three and five hours after surgery, with significant differences among all groups ($P < 0.001$).

The preoperative VAS scores were significantly higher in the control group compared to groups A and B (P = 0.006 and 0.016, respectively) (Table 4). Intraoperatively, the mean VAS scores were significantly lower in group B than in group A (0.32 ± 0.48 vs. 0.96 ± 0.61, P < 0.001). One hour after surgery, the mean VAS scores were significantly lower in group B compared to groups A (P = 0.003) and the control group (P < 0.001). Conversion to general anesthesia occurred in one patient in group A and one patient in group B, with no significant differences between the two groups. Postdural puncture headache occurred only in one patient in group B on the first postoperative day and two patients on the second postoperative day (P values > 0.05). Spinal hematoma did not occur in any of the patients. Patients in group A reported a higher satisfaction rate than patients in group B and the control group (92.3% vs. 80.8%, and 80.8%, respectively), but the difference did not reach statistical significance (P = 0.462).

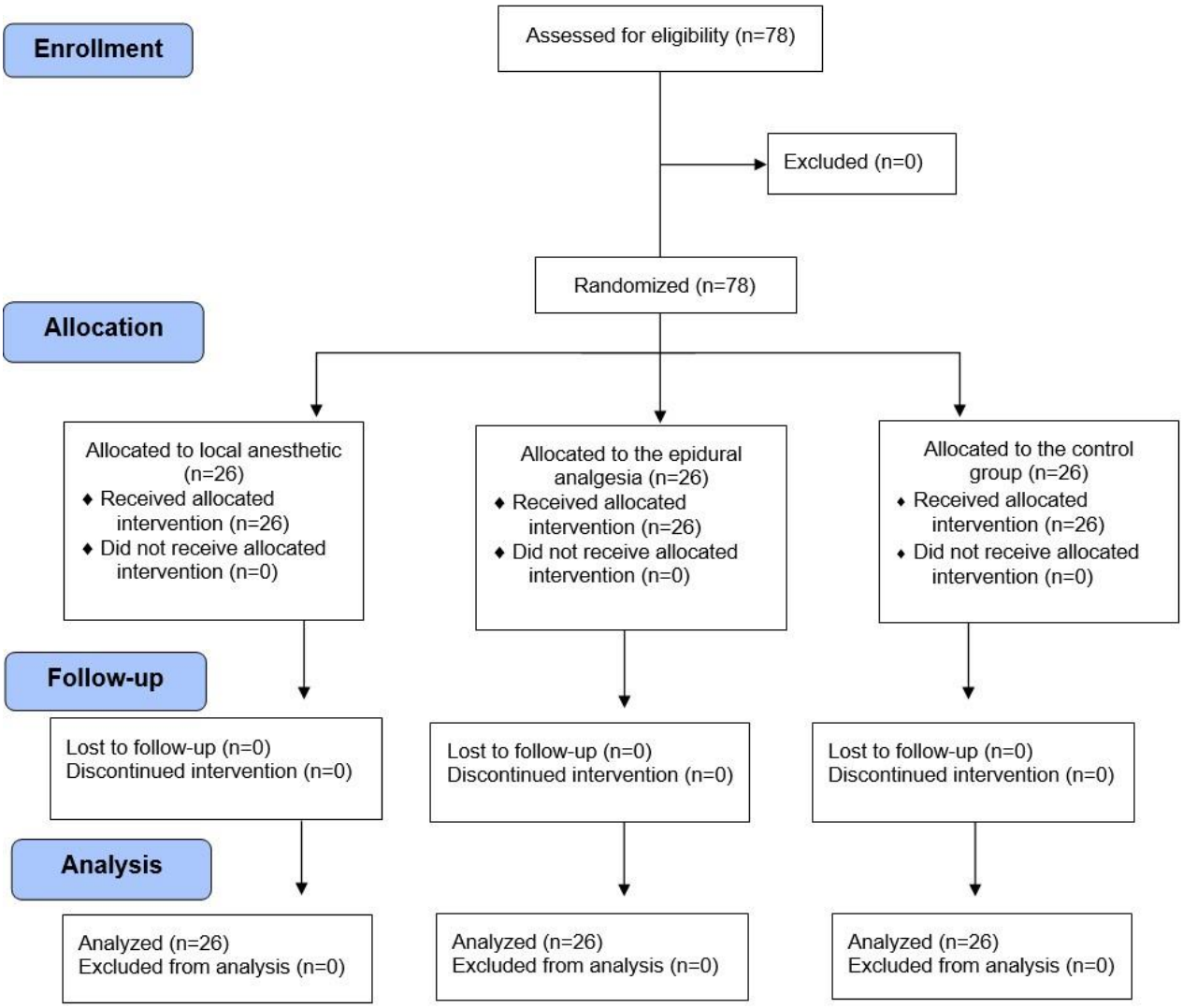

Figure 1. CONSORT flow chart of the study.

Table 1. Baseline characteristics of all patients.

		Group A (n = 26)	Group B (n = 26)	Control group (n = 26)	*P*-value	*P*1	*P*2	*P*3
Age, year	**Mean ± SD (Min - Max)**	39.04 ± 8.68 (22.00 - 56.00)	37.92 ± 8.22 (20.00 - 50.00)	31.58 ± 7.55 (19.00 - 47.00)	0.003	0.875	0.004	0.018
Gender	**Female**	11 (42.3%)	10 (38.5%)	12 (46.2%)	0.854	NA	NA	NA
	Male	15 (57.7%)	16 (61.5%)	14 (53.8%)				
BMI, kg/m^2	**Mean ± SD (Min - Max)**	29.19 ± 2.86 (25.00 - 35.00)	29.65 ± 3.41 (23.00 - 35.00)	32.50 ± 5.60 (23.00 - 40.00)	0.010	0.914	0.014	0.040
ASA physical status	**I**	11 (42.3%)	16 (61.5%)	14 (53.8%)	0.376	NA	NA	NA
	II	15 (57.7%)	10 (38.5%)	12 (46.2%)				

BMI: body mass index; ASA: American Society of Anesthesiologists; Max: maximum; Min: minimum; n: number; SD: standard deviation; *P*1: *P* value from the post hoc Tukey's test comparing groups A and B; *P*2: *P* value from the post hoc Tukey's test comparing group A and control group; *P*3: *P* value from the post hoc Tukey's test comparing group B and control group; NA: non-applicable.

Table 2. Intraoperative and postoperative heart rate in all groups.

Heart Rate (b/min)		**Group A (n = 26)**	**Group B (n = 26)**	**Control group (n = 26)**	***P* value**	***P*1**	***P*2**	***P*3**
0 intraoperative	Mean ± SD (Min - Max)	91.04 ± 7.20 (78.00 -110.00)	87.31 ± 14.18 (55.00 -110.00)	87.50 ± 9.24 (67.00 - 102.00)	0.367	NA	NA	NA
30 min intraoperative	Mean ± SD (Min - Max)	70.96 ± 9.83 (55.00 - 87.00)	64.27 ± 16.90 (34.00 - 110.00)	86.88 ± 10.94 (69.00 - 120.00)	<0.001	0.156	<0.001	<0.001
1 h intraoperative	Mean ± SD (Min - Max)	63.85 ± 9.37 (42.00 - 77.00)	62.20 ± 12.09 (40.00 -77.00)	84.19 ± 10.76 (65.00 - 110.00)	<0.001	0.849	<0.001	<0.001
1.5 h intraoperative	Mean ± SD (Min - Max)	59.68 ± 8.61 (42.00 - 80.00)	61.38 ± 10.28 (39.00 - 77.00)	85.77 ± 10.66 (54.00 - 105.00)	<0.001	0.813	<0.001	<0.001
2 h intraoperative	Mean ± SD (Min - Max)	64.04 ± 7.38 (52.00 - 87.00)	60.46 ± 11.26 (34.00 - 80.00)	86.88 ± 10.94 (69.00 - 120.00)	<0.001	0.407	<0.001	<0.001
2.5 h intraoperative	Mean ± SD (Min - Max)	63.85 ± 9.37 (42.00 - 77.00)	63.50 ± 11.25 (42.00 - 77.00)	84.19 ± 10.76 (65.00 - 110.00)	<0.001	0.992	<0.001	<0.001
3 h intraoperative	Mean ± SD (Min - Max)	59.31 ± 8.65 (42.00 - 80.00)	61.38 ± 10.28 (39.00 - 77.00)	85.77 ± 10.66 (54.00 - 105.00)	<0.001	0.731	<0.001	<0.001
1 h postoperative	Mean ± SD (Min - Max)	65.88 ± 8.99 (54.00 - 87.00)	62.85 ± 8.48 (48.00 - 80.00)	84.23 ± 8.13 (68.00 - 100.00)	<0.001	0.409	<0.001	<0.001
2 h postoperative	Mean ± SD (Min - Max)	72.88 ± 7.74 (58.00 - 85.00)	69.96 ± 7.01 (57.00 - 85.00)	84.69 ± 6.64 (74.00 - 102.00)	<0.001	0.309	<0.001	<0.001
3 h postoperative	Mean ± SD (Min - Max)	72.88 ± 7.74 (58.00 - 85.00)	69.96 ± 7.01 (57.00 - 85.00)	84.69 ± 6.64 (74.00 - 102.00)	<0.001	0.309	<0.001	<0.001
4 h postoperative	Mean ± SD (Min - Max)	72.88 ± 7.74 (58.00 - 85.00)	69.96 ± 7.01 (57.00 - 85.00)	84.69 ± 6.64 (74.00 - 102.00)	<0.001	0.309	<0.001	<0.001
5 h postoperative	Mean ± SD (Min - Max)	72.88 ± 7.74 (58.00 - 85.00)	69.96 ± 7.01 (57.00 - 85.00)	84.69 ± 6.64 (74.00 - 102.00)	<0.001	0.309	<0.001	<0.001
6 h postoperative	Mean ± SD (Min - Max)	72.88 ± 7.74 (58.00 - 85.00)	69.96 ± 7.01 (57.00 - 85.00)	84.69 ± 6.64 (74.00 - 102.00)	<0.001	0.309	<0.001	<0.001

Max: maximum; Min: minimum; n: number; SD: standard deviation; p1: p-value from the post hoc Tukey's test comparing groups A and B; p2: p-value from the post hoc Tukey's test comparing group A and control group; p3: p-value from the post hoc Tukey's test comparing group B and control group; NA: non-applicable.

Table 3. Intraoperative and postoperative mean arterial pressure in all patients.

Mean arterial pressure (mmHG)		Group A (n = 26)	Group B (n = 26)	Control group (n = 26)	*P*-value	*P*1	*P*2	*P*3
0 intraoperative	Mean ± SD (Min - Max)	82.19 ± 7.26 (65.00 - 95.00)	81.27 ± 7.05 (69.00 - 95.00)	81.81 ± 7.23 (68.00 - 98.00)	0.897	NA	NA	NA
30 min intraoperative	Mean ± SD (Min - Max)	63.81 ± 9.26 (40.00 - 80.00)	47.31 ± 7.00 (36.00 - 60.00)	73.85 ± 7.91 (59.00 - 90.00)	<0.001	<0.001	<0.001	<0.001
1 h intraoperative	Mean ± SD (Min - Max)	59.35 ± 9.66 (38.00 - 74.00)	48.35 ± 5.40 (37.00 - 58.00)	73.19 ± 6.97 (60.00 - 92.00)	<0.001	<0.001	<0.001	<0.001
1.5 h intraoperative	Mean ± SD (Min - Max)	63.81 ± 9.26 (40.00 - 80.00)	47.31 ± 7.00 (36.00 - 60.00)	73.85 ± 7.91 (59.00 - 90.00)	<0.001	<0.001	<0.001	<0.001
2 h intraoperative	Mean ± SD (Min - Max)	59.35 ± 9.66 (38.00 - 74.00)	48.35 ± 5.40 (37.00 - 58.00)	73.19 ± 6.97 (60.00 - 92.00)	<0.001	<0.001	<0.001	<0.001
2.5 h intraoperative	Mean ± SD (Min - Max)	63.81 ± 9.26 (40.00 - 80.00)	47.31 ± 7.00 (36.00 - 60.00)	73.85 ± 7.91 (59.00 - 90.00)	<0.001	<0.001	<0.001	<0.001
3 h intraoperative	Mean ± SD (Min - Max)	59.35 ± 9.66 (38.00 - 74.00)	48.35 ± 5.40 (37.00 - 58.00)	73.19 ± 6.97 (60.00 - 92.00)	<0.001	<0.001	<0.001	<0.001
1 h postoperative	Mean ± SD (Min - Max)	71.88 ± 5.96 (60.00 - 85.00)	64.92 ± 7.09 (49.00 - 78.00)	80.23 ± 6.60 (69.00 - 90.00)	<0.001	0.001	<0.001	<0.001
2 h postoperative	Mean ± SD (Min - Max)	82.19 ± 7.26 (65.00 - 95.00)	81.27 ± 7.05 (69.00 - 95.00)	81.81 ± 7.23 (68.00 - 98.00)	0.897	NA	NA	NA
3 h postoperative	Mean ± SD (Min - Max)	71.88 ± 5.96 (60.00 - 85.00)	64.92 ± 7.09 (49.00 - 78.00)	80.23 ± 6.60 (69.00 - 90.00)	<0.001	0.001	<0.001	<0.001
4 h postoperative	Mean ± SD (Min - Max)	82.19 ± 7.26 (65.00 - 95.00)	81.27 ± 7.05 (69.00 - 95.00)	81.81 ± 7.23 (68.00 - 98.00)	0.897	NA	NA	NA
5 h postoperative	Mean ± SD (Min - Max)	71.88 ± 5.96 (60.00 - 85.00)	64.92 ± 7.09 (49.00 - 78.00)	80.23 ± 6.60 (69.00 - 90.00)	<0.001	0.001	<0.001	<0.001
6 h postoperative	Mean ± SD (Min - Max)	82.19 ± 7.26 (65.00 - 95.00)	81.27 ± 7.05 (69.00 - 95.00)	81.81 ± 7.23 (68.00 - 98.00)	0.897	NA	NA	NA

Max: maximum; Min: minimum; n: number; SD: standard deviation; P1: P value from the post hoc Tukey's test comparing groups A and B; P2: P value from the post hoc Tukey's test comparing group A and control group; P3: P value from the post hoc Tukey's test comparing group B and control group; NA: non-applicable.

Table 4. Visual analog scale score, rate of conversion to general anesthesia, complications, and patients' satisfaction in all groups.

Outcomes		Group A (n = 26)	Group B (n = 26)	Control group (n = 26)	*P*-value	*P*1	*P*2	*P*3
VAS preoperative	Mean ± SD (Min - Max)	4.96 ± 1.00 (3.00 - 7.00)	5.08 ± 1.23 (3.00 - 7.00)	6.00 ± 1.26 (4.00 - 8.00)	0.003	0.933	0.006	0.016
VAS intraoperative	Mean ± SD (Min - Max)	0.96 ± 0.61 (0.00 - 2.00)	0.32 ± 0.48 (0.00 - 1.00)	-	<0.001	NA	NA	NA
VAS 1 h postoperative	Mean ± SD (Min - Max)	2.42 ± 0.90 (0.00 - 4.00)	1.62 ± 0.90 (0.00 - 4.00)	2.62 ± 0.75 (1.00 - 4.00)	<0.001	0.003	0.697	<0.001
Conversion to general anesthesia		1 (3.8%)	1 (3.8%)	-	1.000	NA	NA	NA
Patients' satisfaction	No	2 (7.7%)	5 (19.2%)	5 (19.2%)	0.462	NA	NA	NA
	Yes	24 (92.3%)	21 (80.8%)	21 (80.8%)				
PDPH 1 day postoperative	No	26 (100.0%)	25 (96.2%)	26 (100.0%)	1.000	NA	NA	NA
	Yes	0 (0.0%)	1 (3.8%)	0 (0.0%)				
PDPH 2 days postoperative	No	26 (100.0%)	24 (92.3%)	26 (100.0%)	0.325	NA	NA	NA
	Yes	0 (0.0%)	2 (7.7%)	0 (0.0%)				
Spinal hematoma 1 day postoperative	No	26 (100.0%)	26 (100.0%)	26 (100.0%)	NA	NA	NA	NA
Spinal hematoma 2 days postoperative	No	26 (100.0%)	26 (100.0%)	26 (100.0%)	NA	NA	NA	NA

VAS: visual analog scale; PDPH: postdural puncture headache; Max: maximum; Min: minimum; n: number; NA: non-applicable; SD: standard deviation; *P*1: *P* value from the post hoc Tukey's test comparing groups A and B; *P*2: *P* value from the post hoc Tukey's test comparing group A and control group; *P*3: *P* value from the post hoc Tukey's test comparing group B and control group.

Discussion

Compared to general anesthesia, our results confirmed that PTED under epidural anesthesia or local anesthesia combined with dexmedetomidine could have better pain management and hemodynamic profile, with comparable rates of conversion to general anesthesia, patient satisfaction, and postoperative complications. Additionally, epidural anesthesia had superior intraoperative and postoperative analgesia.

Percutaneous surgery involves the blind process of puncturing and inserting a working channel. Back pain during PTED surgery is mainly caused by the insertion of the working channel, particularly during foraminoplasty. This procedure is necessary to access the desired area due to the presence of a prominent iliac crest, a large facet joint, and an inclined disc space.[20, 21] Therefore, it is crucial to maintain the patient's consciousness to prevent nerve injury, as the surgeon can receive vital information from the patient if nerve interference occurs. In the current study, there were no significant pain comparisons between general anesthesia and alternative anesthesia procedures, as patients are rendered unconscious, and pain was completely prevented during surgery.

Epidural anesthesia can effectively block sensation while preserving motor function in the lower limbs. This ensures that the patient remains comfortable throughout the surgical procedure and can actively participate in the surgery. Intraoperative observation can minimize or prevent neurological problems by preserving motor function.[22]

Similar to the current study, Wang et al.[23] found that epidural anesthesia was more effective than local anesthesia in reducing intraoperative pain for patients undergoing PTED for lumbar intervertebral disc herniation. The authors suggested that painless surgery could help reduce negative psychological impacts, such as postoperative anxiety. Fang et al.[22] reported that transforaminal lumbar surgery can be safely and effectively performed using epidural anesthesia. Additionally, there were no significant differences in neurological issues between the groups receiving epidural and local anesthesia. However, patients who received epidural anesthesia reported high levels of postoperative satisfaction.

Zhu et al.[16] found that both epidural and local anesthesia were equally effective in achieving positive clinical outcomes after PTED in elderly patients. However, epidural anesthesia was shown to be superior in pain control compared to local anesthetic. Nevertheless, this study mostly relied on electronic records, making it a retrospective study with inherent limitations. Zhu et al.[19] discovered that both epidural anesthesia and preemptive analgesia with morphine as an adjuvant to local anesthesia were more effective in managing pain than local anesthesia only.

For clinical practice, it is advisable to perform PTED under local anesthesia.[7] However, many patients are dissatisfied with the PTED procedure due to the unpleasant nature of the puncture, insertion of the working channel, and evacuation of the herniated disc.[17] Patients with large herniations may experience exacerbated nerve compression if a functioning channel is present. While the process of local anesthesia is straightforward, it is critical that the facet joint be anesthetized with great care. Excessive amounts of lidocaine can cause nerve root paralysis and increase the likelihood of nerve damage. Moreover, local anesthesia has certain drawbacks, including heightened operating anxiety and stress reactivity generated by anesthesia.[24]

Dexmedetomidine is a potent alpha-2 receptor agonist with sedative, analgesic, and anxiolytic effects.[25-27] It has a short duration of action and can effectively inhibit the sympathetic nervous system, resulting in a better control over the blood pressure and heart rate. When added to standard peripheral nerve blocks, it has been shown to prolong the duration of pain relief and reduce the need for morphine.[28, 29] According to Mantz et al.,[30] dexmedetomidine has favorable analgesic effects in the treatment of acute and chronic inflammatory pain, surgical pain, and chronic pain. In a randomized clinical trial on patients undergoing open lumbar fusion, Yi-Han et al.[31] reported that adding dexmedetomidine to ropivacaine, compared to using ropivacaine alone, resulted in a greater reduction in pain. Moreover, it did not result in any adverse reactions, increased mean arterial pressure, or changes in heart rate. In a prospective case series study, Gadjradj et al.[32] found that PTED performed under local anesthesia combined with dexmedetomidine was an efficient method for treating sciatica. This approach resulted in high levels of satisfaction among surgeons, anesthesiologists, and patients. Yang et al.[10] conducted a retrospective study to compare

the use of local anesthesia alone versus local anesthesia combined with sedation for PTED. They showed that dexmedetomidine plays a critical role in regulating blood pressure and heart rate, thereby reducing the stress response and promoting stability.

In the current study, we showed that neither epidural anesthesia nor local anesthesia combined with dexmedetomidine resulted in significant conversion to general anesthesia or postoperative complications. Similarly, earlier studies[22, 31, 32] reported safe methods for PTED. Contrary to our findings, Zhu et al.[19] reported a high incidence of urine retention associated with epidural anesthesia. It is important to note that the investigators attributed these complications to either bed rest or epidural anesthesia.

In the present study, the combination of local anesthesia and dexmedetomidine resulted in the highest satisfaction rate, although the difference between other approaches was not statistically significant. This could be due to the relatively small sample size. Ye et al.[17] compared the use of general anesthesia versus local anesthesia without sedation. Ye and his colleagues reported that half of the patients expressed apprehension about undergoing surgery with local anesthesia, while all patients were confident in their ability to tolerate the same surgery under general anesthesia. Differences in the intervention groups may explain the discrepancy between our findings and the study by Ye et al.[17]

Limitation

The current study had a short follow-up duration. Future clinical trials should consider longer follow-up periods. In addition, our study did not find a statistically significant improvement in postoperative satisfaction among patients who received local anesthesia with dexmedetomidine. Conducting multicenter trials with a larger sample size is recommended to determine whether there is a statistically significant difference in satisfaction.

Conclusion

In percutaneous endoscopic lumbar discectomy surgery, epidural anesthesia and local anesthesia combined with dexmedetomidine are effective and safe methods to achieve pain control and optimize hemodynamics. Epidural anesthesia is more effective than local anesthesia/dexmedetomidine combination for intraoperative and postoperative pain control.

Funding:

None

Conflict of interest:

The authors declare no competing interests.

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