Original Article

Retrolaminar block for opioid-free anaesthesia and enhanced recovery after posterior lumbar discectomy: A randomised controlled study

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ABSTRACT

Background and Aims: Intraoperative regional analgesia and enhanced recovery are standard care models aimed at reducing perioperative opioid use following spine surgeries. This study aimed to examine the analgesic effect of retrolaminar block in promoting recovery and pain relief after posterior lumbar discectomy. **Methods:** The patients undergoing elective posterior lumbar discectomy were randomised into the retrolaminar group (n = 36) (received an intra-operative bilateral retrolaminar block with 15 mL of bupivacaine 0.25%, 2 mL (8 mg) of dexamethasone, and 2 mL of magnesium sulphate 10% (200 mg) on each side) and control group (n = 36) (received standard general anaesthesia). Primary outcomes were recovery time (time from isoflurane discontinuation to the first response to verbal command) and time to discharge (time from admission to the post-anaesthesia care unit (PACU) to discharge from the PACU, when Aldrete score was ≥9). *P* values < 0.05 were considered statistically significant. **Results:** The extubation, recovery, and discharge times were significantly shorter in the retrolaminar group compared to the control group ($P < 0.001$). Postoperative pain scores were significantly lower in the retrolaminar group for up to 8 h compared to only 2 h in the control group ($P < 0.001$). The time to first administration of ketorolac post-operatively was significantly longer in the retrolaminar group compared to the control group ($P < 0.001$). The total consumption of ketorolac post-operatively was significantly reduced in the retrolaminar group compared to the control group ($P < 0.001$). **Conclusion:** Intra-operative retrolaminar block is an easy and effective opioid-free regional anaesthesia technique that improves recovery after posterior lumbar discectomy.

Keywords: Discectomy, enhanced recovery after surgery, nerve block, opioid, opioid-free anaesthesia, regional anaesthesia, retrolaminar block

INTRODUCTION

Lumbar discectomy is a common procedure for patients who experience leg and back pain due to disc problems. Managing pain after discectomy can be challenging, taking into consideration the increased occurrence of pre-existing chronic pain and pain from previous surgeries. Effective pain management is crucial for timely discharge and successful rehabilitation.[1]

The use of opioids in the perioperative period is often associated with various side effects, including nausea, respiratory depression, vomiting, itching, gastrointestinal issues, confusion, urinary retention, and an increased risk of developing opioid addiction. Therefore, substituting opioids with other pain relievers can improve recovery after surgery, enhance

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perioperative outcomes, and reduce the risk of opioid addiction. Opioid-free anaesthesia (OFA) is a technique that avoids the use of opioids during surgery.[2]

Enhanced recovery after surgery pathways are helpful strategies for incorporating opioid-free pain management techniques into clinical practice. These pathways typically involve a combination of acetaminophen, non-steroidal anti-inflammatory drugs, and regional anaesthesia methods during surgery.[3] Recently, the retrolaminar block has been studied as a method of providing analgesia and is a safe, effective, easy block with a lower risk of pleural injury than other truncal blocks.[4] During this procedure, the anaesthesiologist or the surgeon injects a local anaesthetic into the retrolaminar space.

This study aimed to investigate the opioid-free anaesthetic effects of intraoperative retrolaminar block on improving recovery and analgesia in patients undergoing posterior lumbar discectomy. The primary objective of the study was to assess the recovery time (time from isoflurane discontinuation to the first response to verbal command) and time to discharge (the time from admission to the post-anaesthesia care unit (PACU) to discharge from the PACU) in adult patients undergoing elective posterior lumbar discectomy under general anaesthesia. We hypothesised that using intra-operative retrolaminar block as a regional anaesthesia technique without opioids could enhance recovery after posterior lumbar discectomy.

METHODS

The current study was designed in accordance with the regulations and guidelines of the Helsinki Declaration, 2013. Ethical approval was obtained from the institutional review board (vide approval number IRB #9325-22-3-2022, dated 22 March 2022). The study was registered on clinicaltrials.gov (via registration number NCT05312866, dated 6 April 2022). This study was conducted from May 2022 to December 2022. Patients aged 21–65 years, American Society of Anesthesiologists (ASA) physical status of I and II and a body mass index (BMI) of 25–30 kg/m^2 undergoing an elective posterior lumbar discectomy under general anaesthesia were enroled in this randomised, double-blind study. Patients with disturbed mental status, allergies to the drugs used in the study, pain management therapy, respiratory, kidney, liver, or heart diseases, or coagulopathy were excluded from the study.

Written informed consent was obtained from all participants after they understood the concept of this research. The patient and outcome assessors (physician anaesthesiologists who collect the data) were blinded.

Our primary outcomes were the recovery time (time from isoflurane discontinuation to the first response to verbal command) and time to discharge (time from admission to the PACU to discharge from the PACU when the Aldrete score was ≥9). The secondary outcomes were the tracheal extubation time (time from isoflurane discontinuation to tracheal extubation), the pain intensity at rest and during movement assessed at 30 min, 2 h, 4 h, 8 h, 12 h, and 24 h post-operatively using a visual analogue scale (VAS), time until the first request for rescue analgesia (ketorolac), the total ketorolac consumption during the first 24 h of the postoperative period, and postoperative side effects such as nausea and vomiting in the first 24 h post-operatively.

Routine investigations, complete medical and surgical histories, and general and physical examinations were performed 1 day before the surgery. All patients were instructed to fast for 6 h for solid food and 2 h for clear liquids before the surgery. In the preparation room, the VAS was explained to the patient, ranging from 0 (no pain sensation) to 10 (worst pain sensation), on a 10-cm line scale to assess the intensity of postoperative pain. After transferring the patient to the operating room, an intravenous (IV) cannula was secured, and warmed IV fluid was infused. An IV bolus dose of 0.05 mg/kg midazolam was administered. The standard monitoring [five-lead electrocardiogram, pulse oximeter, temperature, non-invasive automated blood pressure, and end-tidal carbon dioxide ($EtCO_2$)] was attached to the patient, and a urinary catheter was inserted. Basal readings were recorded. 100% oxygen was administered for 3–5 min. Then, the patients were allocated into two groups by using computer-generated randomisation: the control group (number (n) =36) and retrolaminar group (n = 36). Sequentially numbered opaque-sealed envelopes were used for allocation concealment. In both groups, general anaesthesia was induced using IV propofol 2 mg/kg and 0.5 μg/kg dexmedetomidine over 10 min, and endotracheal intubation was facilitated with IV atracurium (0.5 mg/kg). In the retrolaminar group, anaesthesia was maintained using 1.5% isoflurane in a mixture of 50% oxygen (O_2) and 50% air and atracurium 0.1 mg/kg/h. However, in the control group, anaesthesia was maintained using 1.5% isoflurane in a mixture of 50% O_2 and 50% air, 1 μg/kg

fentanyl, and atracurium 0.1 mg/kg/h. In both groups, mechanical ventilation was adjusted to maintain the $EtCO_2$ at 30–35 mmHg. Before skin incision, patients in both groups received 15 mg/kg IV paracetamol.

In the prone position, after making a surgical wound incision and reaching the selected spinous process, an 18-G needle from a 20-mL syringe was inserted beside the spinous process and advanced until the needle tip made contact with the lamina. After ensuring no negative aspiration, the anaesthesiologist prepared a solution consisting of 15 mL of bupivacaine 0.25%, 2 mL (8 mg) of dexamethasone, and 2 mL (200 mg) of magnesium sulphate 10%. The neurosurgeon then injected the solution [Figure 1a]. The same steps were repeated on the other side [Figure 1b]. The depth of anaesthesia was guided by the Sedline monitor (Masimo Corporation, Irvine, CA, USA). In addition, the Patient State Index (PSI) was kept between 25 and 50 to ensure optimal analgesia and hypnosis. If the PSI value exceeded 50 in the retrolaminar group, the patient was treated with IV fentanyl 0.5 µg/kg, and the treatment was recorded. Any intra-operative complications, including hypotension and bradycardia (<20% from baseline), were recorded, and in such cases, 0.5 mg/kg ephedrine and 0.01 mg/kg atropine were administered. At the end of the surgery, the inhalational anaesthesia was stopped, and the residual neuromuscular blockade was antagonised using 0.05 mg/kg IV neostigmine and 0.01 mg/kg IV atropine. All patients were extubated, and the time from isoflurane discontinuation to extubation was recorded. The time from isoflurane discontinuation to the first response to a verbal command was also recorded, and then the patients were transferred to the PACU with standard monitors.

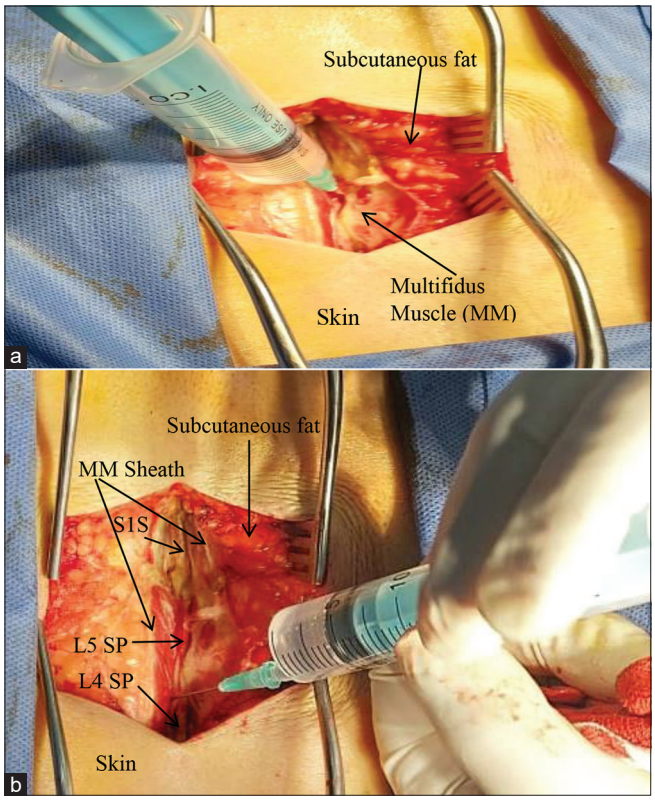

Figure 1: (a) Left retrolaminar block. (b) Right retrolaminar block. MM = Multifidus Muscle. SP = Spinous process

In the PACU, pain intensity at rest and during movement was assessed at 30 min, 2 h, 4 h, 8 h, 12 h, and 24 h post-operatively using VAS. The pain management protocol included IV paracetamol 1 g every 6 h. If the VAS was greater than or equal to 4, an IV bolus of 30 mg ketorolac (rescue analgesic) was given. The time until the first request for rescue analgesia (ketorolac) and the total amount of ketorolac given during the first 24 h of the postoperative period were recorded. The patients were ready for discharge from the PACU when they achieved an Aldrete score of ≥ 9 [Supplementary Table 1].[5] The discharge time was recorded, which refers to the time from arrival in the PACU to discharge to the ward. Any side effects, such as nausea and vomiting, were recorded and managed. Treatment for these side effects included 4 mg of ondansetron IV.

The sample size was calculated based on a previous study.[6] Assuming that the mean (standard deviation [SD]) of discharge time from the PACU was 54.9 (16.2) min in the retrolaminar block group and 67.1 (20.3) min in the local infiltration group, with an alpha error of 0.05 and a beta error of 0.2, the calculated sample size was 36 patients in each group.

All variables were collected, tabulated, and statistically analysed using Statistical Package for the Social Sciences (SPSS) statistics software version 21.0 (Armonk, NY: International Business Machines Corp, USA) statistical software. Continuous data were checked for normality by using the Shapiro–Wilk test. Quantitative variables (age, BMI, duration of surgery, postoperative recovery, and analgesic parameters) were represented as the mean (SD), and qualitative variables (gender, ASA physical status, type of operation, and intra-operative and postoperative complications) as numbers. A *t*-test was used to compare two groups of normally distributed variables (demographic characters, type and duration of operation, postoperative recovery, and analgesic parameters). The Mann–Whitney U test was used to compare two groups

of non-normally distributed variables [total dose of rescue analgesic (Ketorolac)]. When appropriate, the percentage of categorical variables such as intra-operative and postoperative complications was compared using the Chi-square or Fisher's exact test. All tests were two-sided. P values < 0.05 were considered statistically significant.

RESULTS

Seventy-two patients were enroled in this randomised study [Figure 2]. No statistically significant differences were detected in the demographic data (age, gender, BMI, ASA physical status), type, and duration of surgery in the current study [Table 1].

The extubation, recovery, and discharge times were significantly shorter in the retrolaminar group compared to the control group ($P < 0.001$, $P < 0.001$, and $P < 0.001$, respectively) [Table 2].

The mean (SD) postoperative pain scores obtained using VAS were significantly lower in the retrolaminar group at 30 min, 2 h, and 4 h post-operatively [0.64 (0.49), 1.5 (0.5), and 2.6 (0.5), respectively] compared to [2.6 (0.65), 4.3 (0.45), and 4.5 (0.51), respectively] in the control group, with degree of freedom (df) =70, 95% confidence interval (CI) of − 1.92 (−2.19, −1.65), −2.75 (−2.98, −2.52), and − 1.97 (−2.21, −1.73) ($P < 0.001$) at rest and were 1.7 (0.48), 2.5 (0.51), and 3.6 (0.5) in the retrolaminar group compared to [3.6 (0.65), 4.8 (0.5), and 5.53 (0.51)] in the control group at the same measured points times during movement, respectively, with df = 70, 95% CI of (−1.89 (−2.16, −1.62), −2.22 (−2.46, −1.98), and −1.97 (−2.21, −1.73); $P < 0.001$). However, at 8 h post-operatively, the retrolaminar group showed statistically significantly higher pain scores at rest [4.7 (0.67)] and [5.7 (0.69)] during movement compared to [3.7 (0.77)] at rest and [4.1 (0.75)] during movement in the control group, df = 70, 95% CI of (0.97 (0.63–1.31) at rest and (1.64 (1.3–1.98) during movement; $P < 0.001$. Otherwise, there was no statistically significant difference between the studied groups at 12 and 24 h post-operatively [Figure 3].

The time to the first call for rescue analgesic (ketorolac) was significantly longer in the retrolaminar group compared to the control group ($P < 0.001$). The total ketorolac consumption per mg for the postoperative 24 h was significantly decreased in the retrolaminar group compared to the control group ($P < 0.001$) [Table 2].

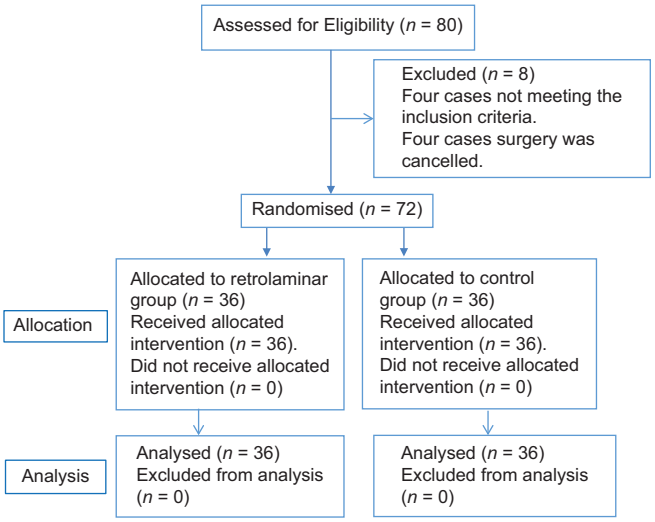

Figure 2: Flowchart showing inclusion, randomisation, and participation throughout the study

Table 1: Demographic characters, type, and duration of operation of the studied groups

Variables	Retrolaminar Group (*n*=36)	Control Group (*n*=36)
Age (years)	43.2 (11.2)	46.7 (11.4)
Gender: Females/Males	21/15	19/17
BMI (kg/m^2)	26.92 (1.96)	27.06 (1.67)
ASA Physical Status: I/II	22/14	15/21
Type of operation: L4–5/L5–S1 lumbar discectomy	19/17	22/14
Elective lumbar spine surgery duration (min)	98.1 (15.1)	100.7 (16.5)

Data expressed by either mean (standard deviation) or numbers. *n*=Number of patients, BMI=Body mass index, ASA=American Society of Anesthesiologists

Table 2: Postoperative recovery and analgesic parameters of studied groups

	Retrolaminar group (*n*=36)	Control group (*n*=36)	Mean difference (95% CI)	*P*
Extubation time (s)	170.8 (8.7)	325 (69.3)	−154.2 (−177.38, −130.95)	<0.001
Recovery time (s)	271.7 (24.6)	538.2 (47.1)	−266.5 (−284.19, −248.87)	<0.001
Discharge time (s)	446.9 (29.4)	773.9 (37.2)	−327 (−342.69, −311.19)	<0.001
Time to first call of rescue analgesic (Ketorolac) (h)	7.5 (0.81)	1.4 (0.45)	6.1 (5.83, 6.44)	<0.001
Total dose of rescue analgesic (Ketorolac) (mg)	47.5 (19.47)	92.5 (25.23)	−45 (−55.59, −34.41)	<0.001

Data expressed as mean (standard deviation). *n*=Number of patients, CI: Confidence interval

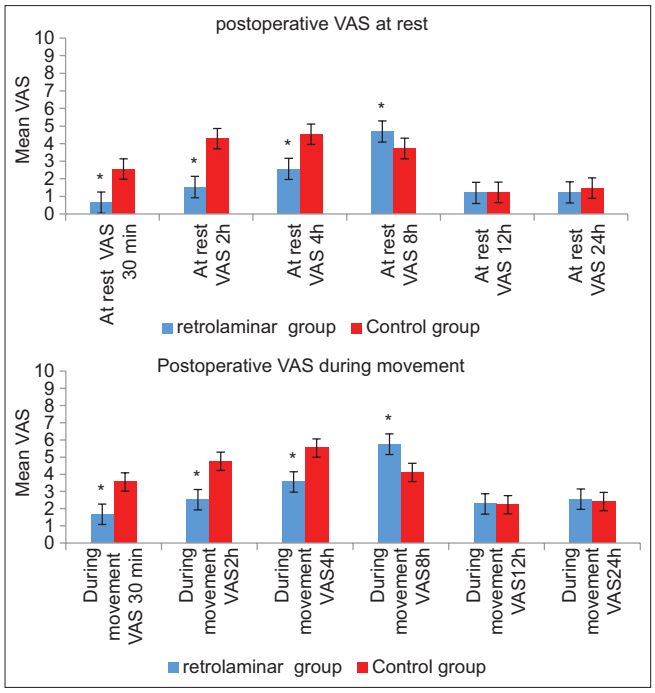

Figure 3: Mean of postoperative visual analogue scale score at rest and during movement. VAS = visual analogue scale, h = hour, * = significant

There was no statistically significant difference between the studied groups regarding intra-operative hypotension and bradycardia. No patients needed intraoperative fentanyl in the retrolaminar group. Only two patients suffered nausea in the retrolaminar group compared to eight patients in the control group, with a statistically significant difference [df = 1, 95% CI of 0.36 (0.1–1.28), P = 0.047]. However, no statistically significant difference in postoperative vomiting was detected between the studied groups.

DISCUSSION

We observed that the intra-operative retrolaminar block as an opioid-free regional anaesthesia technique enhanced recovery and reduced pain scores after lumbar spine discectomy under general anaesthesia.

Intra-operative regional anaesthesia has recently been incorporated into enhanced recovery protocols for lumbar spine surgeries.[7] The retrolaminar block has an anatomical basis similar to the erector spinae plane block, used for perioperative analgesia in patients undergoing lumbar spine surgeries.[8,9] Both methods offer several advantages, including ease of performance, safety, and a lower risk of complications than the paravertebral block.[10,11] However, Tao and Zhou[12] reported that the retrolaminar block was superior to the erector spinae block and the control group in providing effective perioperative analgesia for patients undergoing posterior lumbar spine surgery.

In line with the findings of this study, Abdelbaser *et al*.[13] reported that the median extubation time was significantly shorter in the retrolaminar group compared to the control group. In addition, the median time until the first request for analgesia was significantly longer (7 [5, 8] h) compared to the control group (2 [1, 2] h) after paediatric open-heart surgery. Several prospective randomised studies[14-16] have recently investigated the analgesic effects of ultrasound-guided retrolaminar block as postoperative analgesia. These studies revealed that retrolaminar block reduced pain scores and decreased the total consumption of analgesics, which is consistent with our results.

The analgesic effects of retrolaminar block were due to the spread of local anaesthetics to the epidural and paravertebral spaces, blocking the dorsal and ventral rami of the spinal nerves.[10] Adhikary *et al*.[17] revealed that a single injection of local anaesthetic in the retrolaminar space in cadavers produced neural foramina and epidural spread across several levels centred on the site of injection, explaining the clinical analgesic effect of retrolaminar block.

Moreover, in the present study, we added magnesium sulphate and dexamethasone to bupivacaine to intensify and prolong the analgesic effect of the retrolaminar block. Many previous studies have concurred with the analgesic effects of different regional blocks and OFA on enhanced recovery. Gupta *et al*.[18] discussed in their review article the effects of other non-opioid analgesic agents, including magnesium sulphate and dexamethasone, as OFA on enhanced recovery and to avoid the adverse effects of opioid use. Peng *et al*.[19] concluded that magnesium sulphate added to ropivacaine prolonged the duration of analgesia and reduced analgesic requirements in ultrasound-guided quadratus lumborum block.

The results of the present study revealed no complications associated with retrolaminar block, such as hypotension or toxicity from vascular or local anaesthetics. This can be explained by a study conducted by An *et al*.,[20] which reported that dexamethasone prevents neurotoxicity and rebound hyperalgesia induced by bupivacaine. In addition, the local anaesthetic was administered by the neurosurgeon under supervision safely and straightforwardly. As a result, no patients required intra-operative fentanyl for pain relief.

In the retrolaminar group, only two patients experienced significant nausea compared to eight patients in the control group. Furthermore, no patients in the retrolaminar group developed postoperative vomiting. This finding aligns with a study by Liu *et al*.,[15] which found that intestinal recovery was shorter in the retrolaminar group than in the erector spinae group in patients undergoing laparoscopic surgery.

A limitation of this study is the need for more research in the field as the sample size is small. Therefore, we recommend conducting further studies to compare the intra-operative retrolaminar block as a new opioid-free regional anaesthesia technique with other regional techniques in patients undergoing spine surgeries.

CONCLUSION

The intra-operative retrolaminar block is an easy and effective opioid-free regional anaesthesia technique that improves recovery after posterior lumbar discectomy under general anaesthesia.

Study data availability

De-identified data may be requested with reasonable justification from the authors (email to the corresponding authors) and shall be shared upon request.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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Supplementary Table 1: Modified Aldrete score[8]		
Parameter	**Description of patients**	**Score**
Activity level	Move all extremities voluntarily/on command	2
	Move 2 extremities	1
	Cannot move extremities	0
Respiration	Breathes deeply and cough freely	2
	Is dyspnoeic, with shallow, limited breathing	1
	Is apnoeic	0
Circulation (blood pressure)	Is 20 mmHg >preanaesthetic level	2
	Is 20-50mmHg >preanaesthetic level	1
	Is 50mmHg >preanaesthetic level	0
Consciousness	Is fully awake	2
	Is arousable on calling	1
	Is not responding	0
Oxygen saturation(As determined by pulse oximetry	Has level >90% when breathing room air	2
	Requires supplemental oxygen to maintain level >90%	1
	Has level <90% with oxygen supplementation	0

Patient who have a score of 9 or higher will be discharged