Effect of Dexmedetomidine Addition in Erector Spinae Plane Block on Opioid Consumption after Lumbar Spine Surgery

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ABSTRACT

Objective: To investigate the efficacy of adding 0.5 micrograms/kg of dexmedetomidine to 0.2% ropivacaine in erector spinae plane block in terms of 24-hour opioid consumption after lumbar spine surgeries.

Study Design: A randomised controlled trial.

Place and Duration of the Study: The Security Forces Hospital, Riyadh, Saudi Arabia, from 30th November 2022 to 30th March 2023.

Methodology: Patients aged between 18-70 years, ASA 1-3 who were booked to undergo lumbar spine surgeries under general anaesthesia were inducted. Patients in the intervention group received erector spinae plane block (ESPB). Exclusion criteria were patient refusal, inability to give consent, patients with contraindications to regional anaesthesia, known allergy to study medications, inability to use patient-controlled analgesia (PCA), psychiatric disorders or patients using any psychiatric medications. The primary outcome measure of the study was 24-hour opioid consumption.

Results: The numeric rating scale (NRS) pain scores were significantly decreased in the ESPB-D group at 30 minutes ($p = 0.042$), at 1 hour ($p = 0.018$), at 2 hours ($p = 0.044$), at 12 hours ($p = 0.039$), at 18 hours ($p = 0.011$), and at 24 hours ($p = 0.020$). Intraoperative use of remifentanil was also significantly lower in the ESPB-D group ($p < 0.01$). ESPB using dexmedetomidine also reduced opioid consumption over a period of 24 hours ($p < 0.01$). Median patient satisfaction score and median ease of mobility were also significantly better in the ESPB-D group.

Conclusion: Addition of dexmedetomidine in erector spinae plane block reduced pain scores and intraoperative and postoperative opioid consumption after lumbar spine surgery.

Key Words: *Dexmedetomidine, Erector spinae plane block, Lumbar spine surgery, Opioid consumption, Pain control.*

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INTRODUCTION

Regional anaesthesia technique is usually considered a better option for reducing opioid use in the postoperative period. Erector spinae plane block (ESPB) is a newer interfascial plane block that has been utilised with variable success in different surgeries.[1,2] This simple and relatively safer block involves injecting local anaesthesia between the erector spinae muscle and transverse process of adjacent vertebrae under guidance of ultrasound. ESPB targets the ventral and dorsal rami of spinal nerves and studies reported that a volume of 20 ml can spread up to 3-6 transverse processes cranially or caudally.[3]

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Therefore, ESPB at a higher level at T10 has been suggested to provide analgesia for lumbar spine surgeries.[3] Although, the studies showed that effective analgesia could last only 6-12 hours postoperatively,[4,5] there has been a quest for adjuvants that could improve the duration and quality of these nerve blocks. Several adjuvants have been utilised with local anaesthesia agents for this purpose.[6,7]

Dexmedetomidine is an alpha-2 receptor agonist that can increase the duration of anaesthetic and analgesic effects of a nerve block.[7] Mahmoudi *et al.* in their study reported significantly better pain control at the 6th, 12th, and 24th hours postoperatively in patients undergoing thoracotomy.[8] Vorobeichik *et al.* also demonstrated a significantly extended duration of block by using dexmedetomidine with local anaesthesia in brachial plexus blocks.[9] This beneficial effect of dexmedetomidine could sometimes be offset by its side effects as it can result in bradycardia and hypotension intraoperatively.[10] So, there is no general agreement regarding the correct dose of dexmedetomidine for peripheral nerve block. This study was planned to assess the effect of smaller dose of dexmedetomidine with local anaes-

thetic agents to rationalise its use with relatively lesser side effects. The aim of this randomised controlled trial was to investigate the efficacy of adding 0.5 micrograms/kg of dexmedetomidine to 0.2% ropivacaine in erector spinae plane block in terms of 24 hours opioid consumption after lumbar spine surgeries.

METHODOLOGY

This randomised controlled trial was conducted at the Security Forces Hospital, Riyadh, Kingdom of Saudi Arabia, between 30th November 2022 to 30th March 2023. The Institutional Ethical Review Committee approval was taken (Approval no. 22-623-59, Dated: 30th-November-2022). The trial was registered with ClinicalTrials.gov (NCT0566452). Written informed consent was taken from each patient. The patients aged between 18-70 years, ASA 1-3 who were scheduled to undergo lumbar spine surgeries under general anaesthesia were included. Exclusion criteria of the study were patients who refused enrollment or requested removal from the study later, inability to give consent, patients with contraindications to regional anaesthesia, known allergy to study medications, inability to use patient-controlled analgesia (PCA), and psychiatric disorders.

Upon admission to the ward, a random ID was allocated to each patient after meeting the inclusion criteria. Computer-generated random number table was used. Sealed opaque envelopes were used to determine the study groups once the patient arrived in the operation theatre. The envelope was then handed over to the primary anaesthetist of the patient. Patients were allocated to either of two groups, Group A – Control group and Group B – Erector spinae plane block (ESPB-D) group. Perioperative anaesthesia and surgical techniques were standardised in both groups.

On arrival to the room, patients were connected to standard ASA monitoring including pulse oximetry, ECG, and non-invasive blood pressure. After adequate pre-oxygenation, induction was performed using IV fentanyl 2 mcg/kg, IV propofol 2-2.5 mg/kg followed by IV rocuronium 0.6 mg/kg. After 2-3 minutes, tracheal intubation was done using a Macintosh laryngoscope. Anaesthesia maintenance was done using 0.8-1.2 MAC desflurane and IV remifentanil infusion at 0.05 to 0.15 mcg/kg/minute.

Patients in the control group did not receive any block. In the ESPB-D group, each patient was placed in a lateral position after induction of anaesthesia. Using all aseptic measures, a linear ultrasound probe (6-10 MHz) was placed in the cranio-caudal direction at the level of the L1 spinous process. After identifying the erector spinae muscle, a 21 gauge 100 mm ultrasound needle was inserted using an in-plane approach in the cranio-caudal direction. The needle was then progressed into the fascial plane on the anterior aspect of the erector spinae muscle. The location of the needle was confirmed using hydro-dissection. A total of 15 ml of 0.2% ropivacaine with 0.5 mcg/kg dexmedetomidine was injected on each side.

The dose of remifentanil infusion was adjusted according to haemodynamic response. Muscle relaxation was maintained using IV boluses of rocuronium at 0.2 mg/kg. At 20-30 minutes prior to the end of the surgery, 1 g IV paracetamol, 16 mg IV lornoxicam, 8 mg dexamethasone, and 1 mg granisetron were administered to all the patients. Muscle relaxation was reversed using IV sugamaddex at 2-4 mg/kg depending on the TOF (train of four) reading. After achieving TOF ratio of more than 0.9, the patients were extubated and shifted to the post-anaesthesia care unit (PACU).

The numeric rating scale (NRS) was utilised to evaluate postoperative pain. The NRS is a segmented version of VAS (visual analogue scale) in which a patient selects 0-10 to reflect the intensity of pain. All patients received a standardised postoperative analgesia protocol using IV morphine PCA (patient controlled analgesia). IV metoclopramide was administered if the patient complained of postoperative nausea and vomiting (PONV).

The primary outcome measure was 24-hour opioid consumption. The secondary outcome measures included NRS scores at 15 minutes, 30 minutes, and 1, 2, 6, 12, 18, and 24 hours after operation. Other secondary outcomes were ease of ambulation, ease of physiotherapy, patient satisfaction level, and the occurrence of adverse events including PONV and drowsiness/dizziness in 24 hours postoperatively. PONV and drowsiness were assessed on a 4-point scale (none, mild, moderate, and severe). All these postoperative observations were recorded in the first 24 hours postoperatively by an assigned staff member who was blinded to the group of the study.

The null hypothesis in the study was that there is no difference in postoperative 24 hours opioid consumption between ESPB-D and the control group in patients undergoing lumbar spine surgeries. For calculation of sample size, the authors utilised the study by Singh *et al.*[4] that showed the postoperative opioid consumption after lumbar surgery was 7.2 ± 2 mg. ClinCalc.com sample size calculator was used. Sample size came out as 38 in total with an expected 25% reduction in opioid consumption after using ESPB with ropivacaine and dexmedetomidine at 0.05 level of significance and 80% power. Keeping 10% dropout, it was decided to set sample size as 42 with 21 in each group.

SPSS 23.0 statistical package program (SPSS, Chicago, IL, USA) was used for statistical analysis in the study. Firstly, the normality of all data was checked using Kolmogorov-Smirnov test. Descriptive statistics were expressed as mean ± standard deviation or median ± interquartile range. Based on the normality of the data, continuous variables were compared using an independent t-test or Mann-Whitney U test. Categorical variables were expressed as numbers and percentages and compared using the Chi-square test and Fisher's exact test. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Fifty-six patients were considered for eligibility; however, 14 were excluded. Ten patients did not fulfill the inclusion criteria and 4 denied participating in the study. A total of 42 patients

were included in the study and randomised into two groups with 21 in each: Group A – Control group and Group B – Erector spinae plane block (ESPB-D) group. The CONSORT diagram is shown in Figure 1.

Twelve out of 21 in the control group were females *vs.* 13 in the ESPB-D group. There were twelve cases of laminectomies followed by 9 fixations in the control group *vs.* 13 laminectomies and 8 fixations in the ESPB group. In the control group, 4 patients had diabetes, 3 with hypertension, 3 with obesity while in the ESPB group, 4 had hypertension, 2 with obesity, 2 smokers, 1 with epilepsy, and 1 asthmatic. The median weight of patients in the ESPB-D group was 77 kg *vs.* 78 kg in the control group. The median duration of surgery was 156 minutes in the ESPB-D group *vs.* 170 minutes in the control group. There was no statistically significant difference between the baseline characteristics of the two groups ($p > 0.05$).

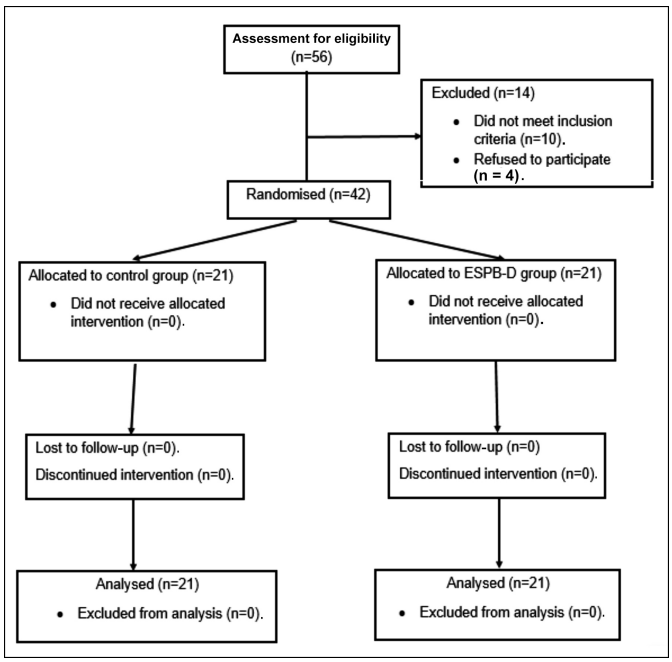

Figure 1: CONSORT flow diagram.

Mann-Whitney U test was used to compare median NRS pain scores between the two groups. NRS was significantly different at 30 minutes ($p = 0.042$), at 1 hour ($p = 0.018$), at 2 hours ($p = 0.044$), at 12 hours ($p=0.039$), at 18 hours ($p = 0.011$), and at 24 hours ($p = 0.020$) as shown in Table I. Median intraoperative remifentanil consumption was also found to be statistically significantly different between the two groups [Median (IQR), 1.7 (1.52-1.87) mg in the control group *vs.* 0.55 (0.47-0.65) mg in ESPB-D group ($p < 0.00$)] as shown in Table II. An independent t-test was used to compare the means of 24-hour opioid consumption and was found to be statistically higher in the control group 21.14 (12.014) mg *vs.* 12.62 (7.612) mg in the ESPB-D group ($p = 0.01$). The median satisfaction score in the control group was 8 (7-9) which was lower than 9 (8-9) in the ESPB-D group ($p = 0.014$). The median score for ease of mobility as assessed by the physiotherapist within 24 hours of operation was 7 (6-8) in the control group which was lower than 9 (8-9) in the ESPB-D group ($p = 0.003$). Fourteen patients received nonsteroidal anti-inflammatory drugs (NSAIDs) in the control *vs.* 9 in the ESPB-D group.

Only one patient in the control group *vs.* none in ESPB-D received rescue analgesia in the first 24 hours. Two patients in control *vs.* 1 in ESPB-D had PONV and needed anti-emetics. None of the patients in either group had postoperative dizziness.

Table I: Pain scores at different time points.

	Control group median (IQR)	ESPB group median (IQR)	p-value
NRS at 15 minutes postoperatively	2 (2-3.5)	2 (2-3)	0.366
NRS at 30 minutes postoperatively	3 (2-3)	2 (2-2)	0.042*
NRS at 1 hour postoperatively	2 (1.5-3)	1 (1-2)	0.018*
NRS at 2 hours postoperatively	2 (1-2)	1 (1-2)	0.044*
NRS at 6 hours postoperatively	2 (1-3)	2 (1-2)	0.10
NRS at 12 hours postoperatively	2 (1-3)	1 (0.5-2)	0.039*
NRS at 18 hours postoperatively	2 (1-2.5)	1 (1-2)	0.011*
NRS at 24 hours postoperatively	1 (1-2)	1 (0.5-1)	0.020*

**Indicates p-value less than 0.05 and statistically significant.*
Note: Mann-Whitney U test was used to compare NRS.

Table II: Outcome variables.

	Control group median (IQR)	ESPB group median (IQR)	p-value
Total intraoperative remifentanil use (mg)	1.7 (1.52-1.87)	0.55 (0.47-0.65)	0.00*
24-hour opioid consumption (mg) Mean ± SD†	21.14 ± 12.014	12.62 ± 7.612	0.01*
Satisfaction score	8 (7-9)	9 (8-9)	0.014*
Ease of physiotherapy	7 (6-8)	9 (8-9)	0.003*

*Indicates p-value less than 0.05 and statistically significant. † Standard deviation.
Note: Mann-Whitney U test was used to compare all variables except 24-hour opioid consumption which was compared using independent t-test.

DISCUSSION

This study compared conventional opioid-based multimodal analgesia with a combination of ESPB and opioid-based analgesia for lumbar spine surgery. The results demonstrated that ESPB using ropivacaine with dexmedetomidine in lumbar spine surgeries significantly decreased opioid consumption for a period of 24 hours postoperatively. The block ensued better pain scores up to 24 hours postoperatively. The study also demonstrated better patient satisfaction scores in the ESPB-D group. The ease of mobility and physiotherapy after 24 hours of surgery was also improved with the use of ESPB in lumbar spine surgeries.

The use of dexmedetomidine with ropivacaine in ESPB in this study resulted in significantly reduced NRS pain scores up to 24 hours postoperatively. Yayik *et al.* and Singh *et al.* compared ESPB using local anaesthetic agent only with no block group in lumbar spine surgeries and found lesser pain scores.[3,4] Although Singh *et al.* found significantly lesser pain scores immediately after surgery and at six hours only.[4] Sifaki *et al.*

also found lesser pain scores in patients receiving ESPB with ropivacaine and dexmedetomidine in patients undergoing laparoscopic cholecystectomy.[11]

In this study, 24-hour opioid consumption was decreased by 40.30% with the use of dexmedetomidine plus ropivacaine in ESPB for lumbar spine surgeries. This reduction was relatively greater than the percentage reduction of opioid consumption in other studies[4,12,13] although they used local anaesthetic agent only in their ESPB block compared to the control group. Yayik *et al.*, Zhang *et al.*, and El Ghamry *et al.* reported a significant reduction in 24-hour opioid consumption by 27.5%, 32.9%, and 14.5%, respectively.[3,12,13] Nashibi *et al.* demonstrated a 60% reduction in 24-hour opioid consumption by using ESPB with bupivacaine only in patients undergoing lumbar spine surgery.[14] On the other hand, Zhang *et al.* in their study compared ESPB using ropivacaine only with the control (no-block) group and found no reduction in 24-hour opioid consumption in patients undergoing lumbar spine surgery.[15] Zha *et al.* compared ESPB using ropivacaine and dexmedetomidine with a control (no-block) group in patients undergoing video-assisted thoracic lobectomy and demonstrated a 45% reduction in 24 hours of opioid consumption.[16] Sifaki *et al.* in their study on laparoscopic cholecystectomy reported a 96.2% reduction in opioid consumption in the group using ESPB with ropivacaine and dexmedetomidine compared to the no-block group.[11]

Intraoperative remifentanil consumption in this study was 67% lesser in the ESPB-D group compared to the control group. Zhang *et al.* on the other hand found only a 20% reduction in intraoperative opioid consumption with ESPB using ropivacaine only in their study.[15] Jin *et al.* in their study demonstrated a 46.7% reduction in intraoperative consumption by using ESPB with ropivacaine.[17] While El Ghamry *et al.* reported a 74.6% reduction in intraoperative consumption in ESPB with the ropivacaine-only group.[13] These comparisons suggest that ESPB using local anaesthetic agent along with dexmedetomidine results in a much lesser requirement of intraoperative analgesics. Although in the study by Yi-Han *et al.*, the results showed that intraoperative opioid consumption was nearly similar in patients who received ESPB with ropivacaine *vs.* ESPB with ropivacaine along with dexmedetomidine.[18]

This study's results demonstrated better patient satisfaction in the group who received ESPB with ropivacaine and dexmedetomidine. This is inconsistent with the findings in a meta-analysis by Xiao *et al.* that included studies comparing ESPB with ropivacaine only *vs.* control (no-block) group in patients undergoing lumbar spine surgery.[19] Yi-Han *et al.* also found significantly better patient satisfaction in patients receiving ESPB with ropivacaine and dexmedetomidine compared to ESPB with ropivacaine.[18] Sifaki *et al.* also demonstrated better patient satisfaction by using ESPB with ropivacaine and dexmedetomidine compared to the no-block group in patients undergoing laparoscopic cholecystectomy.[11] Vorobeichik *et al.* showed better satisfaction in patients receiving local anaesthetic agents with dexmedetomidine in their brachial plexus block compared to local anaesthetic agents only.[9]

The ease of physiotherapy was found to be better with the use of ESPB with ropivacaine and dexmedetomidine in this study. Zhang *et al.* also found a significantly shorter time to ambulate postsurgery in patients who received ESPB using ropivacaine and dexmedetomidine.[15]

There was an insignificant difference in the occurrence of adverse events like PONV and dizziness. This was consistent with findings in the study by Yi-Han *et al.*, who compared ESPB using ropivacaine with dexmedetomidine and ropivacaine-only in patients undergoing lumbar surgery and did not find any difference in the incidence of adverse events.[18] Although the meta-analysis by Liu *et al.* that included studies comparing ESPB *vs.* no-block in lumbar spine surgery found a lesser incidence of PONV in the ESPB group. However, they did not find any difference in the occurrence of other adverse events.[20]

The authors used 0.5 mcg/kg dose of dexmedetomidine in ESPB for this study. Yi-Han *et al.* used 1 mcg/kg dose in ESPB for lumbar spine surgery.[18] Zha *et al.* used 1 mcg/kg in their ESPB for video-assisted thoracoscopy.[16] Sifaki *et al.* also used 1 mcg/kg dexmedetomidine in ESPB for laparoscopic cholecystectomy.[11] Mahmoudi *et al.* used a similar dose as this study in their intercostal nerve block for thoracotomy.[8]

There are a few limitations in this study. The main limitation is that the authors did not document the sensory block in the ESPB-D group. The assessment for loss of sensation could not be done in this study as the block was performed after anaesthesia induction to maintain patient blinding in the study. So, any associated systemic effect of local anaesthetic agents could not be ruled out. The time to block performance was also not measured in the study. The study was inadequately powered to identify block-related complications. Also, this was a single-centric study. The number of participants enrolled was small, so the results could not be generalised.

CONCLUSION

ESPB using ropivacaine and dexmedetomidine reduces intraoperative and 24 hours opioid consumption and pain scores in lumbar spine surgery. It also results in better ease of mobility postoperatively. Patient satisfaction is improved in patients who received ESPB for lumbar spine surgery.

ETHICAL APPROVAL:

Ethical approval was taken from the Institutional Review Board (IRB) of Security Forces Hospital, Saudi Arabia (Approval no. 22-623-59, Dated: 30-November-2022).

PATIENTS' CONSENT:

Informed written consent was taken from each patient for participation in the study, and publication of study results.

COMPETING INTEREST:
The authors declared no conflict of interest.

AUTHORS' CONTRIBUTION:
AUH: Concept, literature search, conduct of the study, data analysis, and manuscript writing and editing.
MY: Literature search, data collection, and manuscript editing.
MFS: Data collection, conduct of the study, and manuscript editing.
MZM, AA: Data collection and manuscript editing.
All authors approved the final version of the manuscript to be published.

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