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Effect of Ultrasound Guided Erector Spinae Plane Block on Postoperative Pain in Patients Undergoing Lumbar Spine Surgery

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Abstract

Background: *Spine surgeries are associated with moderate to severe pain and its management is critical for early recovery and reduced complications following lumbar spine surgery.*

Aim: *This research aimed to evaluate the effect of ultrasound-guided erector spinae plane (ESP) block on postoperative 24-hr morphine consumption in patients undergoing lumbar spine surgeries.*

Patients and methods: *This was a randomized, controlled, double-blind clinical trial performed on 30 cases undergoing elective lumbar spine surgery at Suez Canal University Hospitals. Patients have been randomized into 2 equal groups: Group C; Control group: they received a sham block with normal saline combined with general anesthesia and Group E; erector spinae plane: they received ESP block with local anesthetic combined with general anesthesia.*

Results: *Patients in Group E had lower 24-hr morphine consumption after surgery, enhanced hemodynamic stability, earlier mobilization, and higher patient satisfaction compared to Group C (p-value less than 0.05). Additionally, Group E reported significantly reduced VAS scores at all postoperative time points except at 48 hours ($p<0.05$) and delayed 1st analgesic request.*

Conclusion: *Ultrasound-guided ESP blocks significantly reduce postoperative pain, morphine requirements, and hemodynamic fluctuations while enhancing early mobilization and patient satisfaction in lumbar spine surgery cases. It presents a promising analgesic option for improving postoperative outcomes.*

Key words: *Erector spinae plane block, lumbar spine surgery, postoperative pain.*

Introduction

Multiple regimens have been used to decrease acute post-operative pain in lumbar spine surgeries, including conventional intravenous analgesics, neuraxial blocks, local anesthetic infusion and regional techniques (1). Regional techniques have a lot of benefits, including more stable hemodynamics, opioid sparing effect and prolonged post-operative analgesia (2). In addition to the benefits of using

ultrasound guidance including, direct visualization of anatomical structures and nerves, real-time control of needle advancement, and assessment of local anesthetic (LA) spread (3).

The Erector spinae plane (ESP) block is an interfascial plane block which was first described in 2016. The ESP block has increasing clinical academic and clinical interest because of its relative simplicity, safety, and efficacy in a wide range of surgeries (4). It has been used in breast surgeries (5), hernia repair (6), thoracic spine surgeries (7), rib fractures (8), major abdominal surgeries (9), thoracoscopic surgeries (10), and lumbar spine surgeries (1).

This study aimed to evaluate the effectiveness of ultrasound-guided erector spinae plane block in diminishing pain following the operation, consumption of opioid, and hemodynamic fluctuations in cases undergoing lumbar spine surgery.

Patients and methods

This is a randomized, controlled, double-blinded clinical trial that has been performed on 30 patients at elective operating theaters in Suez Canal University Hospitals.

Patients were randomized into 2 equal groups: Group C: Control group which received a sham block with normal saline combined with general anesthesia and Group E; erector spinae plane which received ESP block with local anesthetic combined with general anesthesia.

Randomization was done using a computer-randomizing website (www.randoma.com) and randomization sequence was concealed in closed numbered envelopes. On the day of surgery, one of the anesthesia team members, not involved in the study, opened the patient's envelope to know the group assignment and prepared the local anesthetic solution or sham solution and gave it to the investigator to perform the block.

Inclusion criteria: adult patients aged 18 to 70 years, ASA I, II, scheduled for elective lumbar spine surgery of one or two levels, and Body Mass Index (BMI) between 18 and 35.

Exclusion criteria: any known allergies to the study medications, anatomical abnormalities or infections in the back, bleeding disorders (e.g., thrombocytopenia, elevated INR, high PT), impaired kidney function, patients on regular hemodialysis, patients on chronic pain medications frequently receiving analgesics, alcoholics, or opioid dependents, those with a previous history of back surgery, patients suffering from any neurological disease, and patients with psychiatric disease that interferes with postoperative pain assessment.

The sample size has been determined by utilizing the following formula:

$$n = 2\left[\frac{\left(Z_{\alpha/2} + Z_{\beta}\right) * \sigma}{\mu_1 - \mu_2}\right]^2 \quad \textbf{(11)}$$

Where n = sample size.

Zα/2 = 2.576 (the critical value that divides the central ninety-nine percent of the Z distribution from the one percent in the tail).

Zβ = 1.24 (the critical value that separates the lower ten percent of the Z distribution from the upper 90%).
σ = the estimate of the standard deviation = 6.31 mg morphine (12).
μ1 = mean of morphine consumption in the study group = 24.95 mg (12).
μ2 = mean of morphine consumption in the control group = 29.2 mg (12).
The calculated sample size will be fifteen per group, accounting for a ten percent dropout rate, resulting in a total sample size of thirty subjects.

Upon arrival to the operating room, standard intraoperative monitors; ECG, pulse oximeter, non-invasive blood pressure were attached. Two wide-pore peripheral venous lines were established. Vital signs of the patient including (mean arterial blood pressure and heart rate) were recorded at; preoperative (baseline), 5 minutes after giving the block, with surgical incision and throughout the operation every 15 minutes. General anesthesia was administered with propofol 2 mg/kg and fentanyl 2 microgram/kg, followed by cisatracurium 0.15 mg/kg intravenously (I.V) to facilitate endotracheal intubation. Anesthesia was maintained with isoflurane at end tidal of 1.15 MAC in 50% oxygen/air, 2 Liters fresh gas flow by controlled mechanical ventilation keeping the end tidal CO2 between 35-40 mmHg using Avance CS anesthesia machine. Patients were placed in the prone position while padding the pressure areas e.g. wrists, elbows, knees and ankles. Also, protection of the eyes, genitalia, and breasts from pressure.

Patients in ESP group received Erector Spinae Plane Block: Ultrasound was used in all patients (SonoSite, FUJIFILM), with a curved ultrasound transducer of 5-8 MHz frequency. After skin disinfection, the ultrasound transducer was placed in a parasagittal orientation over the tips of the transverse process at T10. A spinal needle of 22-gauge was inserted in-plane to the ultrasound probe in a Cranial-to-caudal direction. The transverse process was contacted gently with the needle tip and 15 ml of local anesthetic solution was injected and seen spreading in both cranial and caudal directions that separates and lifts the erector spinae muscle off the transverse process. The technique was repeated on the other side. The local anesthetic solution consists of 15 mL of 0.25% bupivacaine on each side. Surgery was allowed after 15 minutes of giving the block.

Patients in Control group also received Erector Spinae Block by the same technique except for the injectate was 15 mL of normal saline (sham block) on each side. All patients were given 8 mg dexamethasone, 10 mg metoclopramide to prevent postoperative nausea and vomiting, and 1 gm tranexamic acid before skin incision. Mean arterial blood pressure (MAP) and heart rate were maintained within 20% of the preoperative baseline values (Incremental boluses of 1 microgram/kg fentanyl was given if MAP or HR increased more than 20% of baseline and ephedrine was used in cases of hypotension). Inhalational anesthetic consumption was obtained from the anesthesia machine, and intraoperative analgesics consumption was recorded. After the end of operation, the patients were turned back to supine position; waiting for their recovery from anesthetics and muscle relaxation then extubation was done.

Pain management after surgery included patient-controlled analgesia (PCA), which gave 1 milligram of morphine on demand with a 10-minute lockout interval. If pain persisted for 30 minutes after PCA doses and 1 gm paracetamol I.V every 6 hrs. If that didn't help, 75 mg of diclofenac was given

intramuscularly. The time of the 1st analgesic request, total 24-hour morphine consumption, and pain intensity utilizing the Visual Analogue Scale (VAS) have been documented at 0, 1, 2, 4, 6, 8, 12, 18, 24, 36, and 48 hours postoperatively. Vital signs were recorded at the same intervals, and mobilization ability was assessed using the Timed-Up-and-Go (TUG) test on postoperative days 1 and 2, with scores categorized as ≤10 seconds (normal), 11-20 seconds (normal for frail/disabled cases), or >20 seconds (requiring assistance). Active maximum spine flexion was also evaluated on days 1 and 2. Postoperative complications like vomiting, nausea, hypotension, pruritus, and bleeding were documented, and patients were encouraged for early oral intake and mobilization.

Statistical analysis

Statistical analysis has been carried out utilizing IBM statistics version 26 (IBM Inc., Armonk, NY, the United States of America); the Shapiro-Wilk test and histograms have been utilized to evaluate the normality of the data distribution. Quantitative parametric data have been expressed as mean and standard deviation (SD) and evaluated utilizing an unpaired Student's t-test. Quantitative non-parametric data have been expressed as median and interquartile range (IQR) then evaluated using the Mann-Whitney test. Qualitative data have been expressed as percentages and frequencies and evaluated utilizing the Fisher's exact test or chi-square test as applicable. A two-tailed P value under 0.05 has been considered statistically significant.

Results

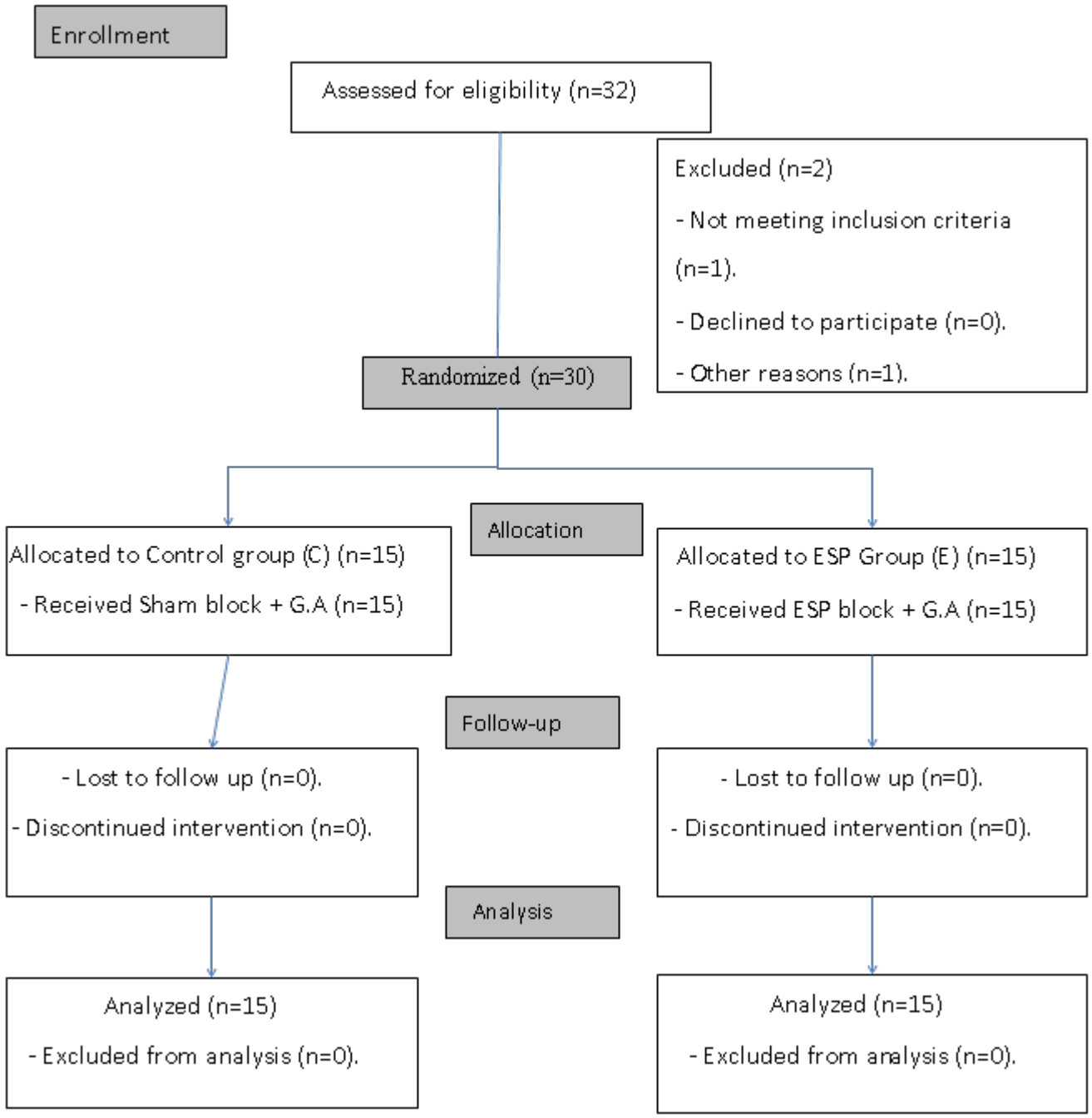


Figure 1: CONSORT Study Flow Chart

Table 1: Patients characteristics

		Group C (n=15)	Group E (n=15)	P value
Age (years)	**Mean ± SD**	44.8 ± 14.24	44.2 ± 8.85	0.891
	Range	18 - 70	33 - 60	
Sex	**Male**	8 (53.33%)	8 (53.33%)	1.000
	Female	7 (46.67%)	7 (46.67%)	
Comorbidities	**HTN**	5 (33.33%)	2 (13.33%)	0.390
	DM	4 (26.67%)	3 (20%)	1.000
	Asthma	0 (0%)	1 (6.67%)	1.000
	IHD	2 (13.33%)	0 (0%)	0.483
Duration of surgery (min.)	**Mean ± SD**	126 ± 29.89	127 ± 35.35	0.934
	Range	75 - 180	60 - 180	
Type of Surgery	**Discectomy**	5 (33.33%)	4 (26.67%)	0.295
	Laminectomy	4 (26.67%)	8 (53.33%)	
	Fixation	6 (40%)	3 (20%)	

DM: diabetes mellitus, HTN: hypertension, IHD: ischemic heart disease

Table 2: Total (24 hr) Morphine Consumption of the studied groups

		Group C (n=15)	Group E (n=15)	P value
Total (24 h) morphine consumption (mg)	**Mean ± SD**	7.64 ± 2.87	2.32 ± 1.67	<0.001*
	Range	3 - 14	1 - 6	

*: significant as P value ≤ 0.05

Total (24 h) morphine consumption was significantly lower in group E ’2.32 ± 1.67 mg’’ than group C ‘7.64 ± 2.87mg’’ (P value <0.001). (Table 2)

Table 3: First Analgesic request of the studied groups

		Group C (n=15)	Group E (n=15)	P value
First analgesic request (h)	**Mean ± SD**	2.44 ± 3.01	6.95 ± 4.29	**<0.001***
	Range	0- 12	4 - 18	

*: significant as P value ≤ 0.05

The first analgesic request was significantly delayed in group E “6.95 ± 4.29 hrs” than group C “2.44 ± 3.01 hrs” (P value <0.001). (Table 3)

Table 4: Intraoperative Observations of the studied groups

		Group C (n=15)	Group E (n=15)	P value
Total blood loss (ml)	**Median**	400	200	0.061
	IQR	200 - 770	150 - 300	
Inhalational anesthetics consumption (ml)	**Mean ± SD**	41.73 ± 15.97	20.27 ± 5.93	**<0.001***
	Range	20 - 80	10 - 30	
Number of patients who received fentanyl		12 (80%)	0 (0%)	**<0.001***
Intraoperative fentanyl consumption (mcg)	**Mean ± SD**	116.67 ± 49.24	Nill	**---**
	Range	50 - 200		

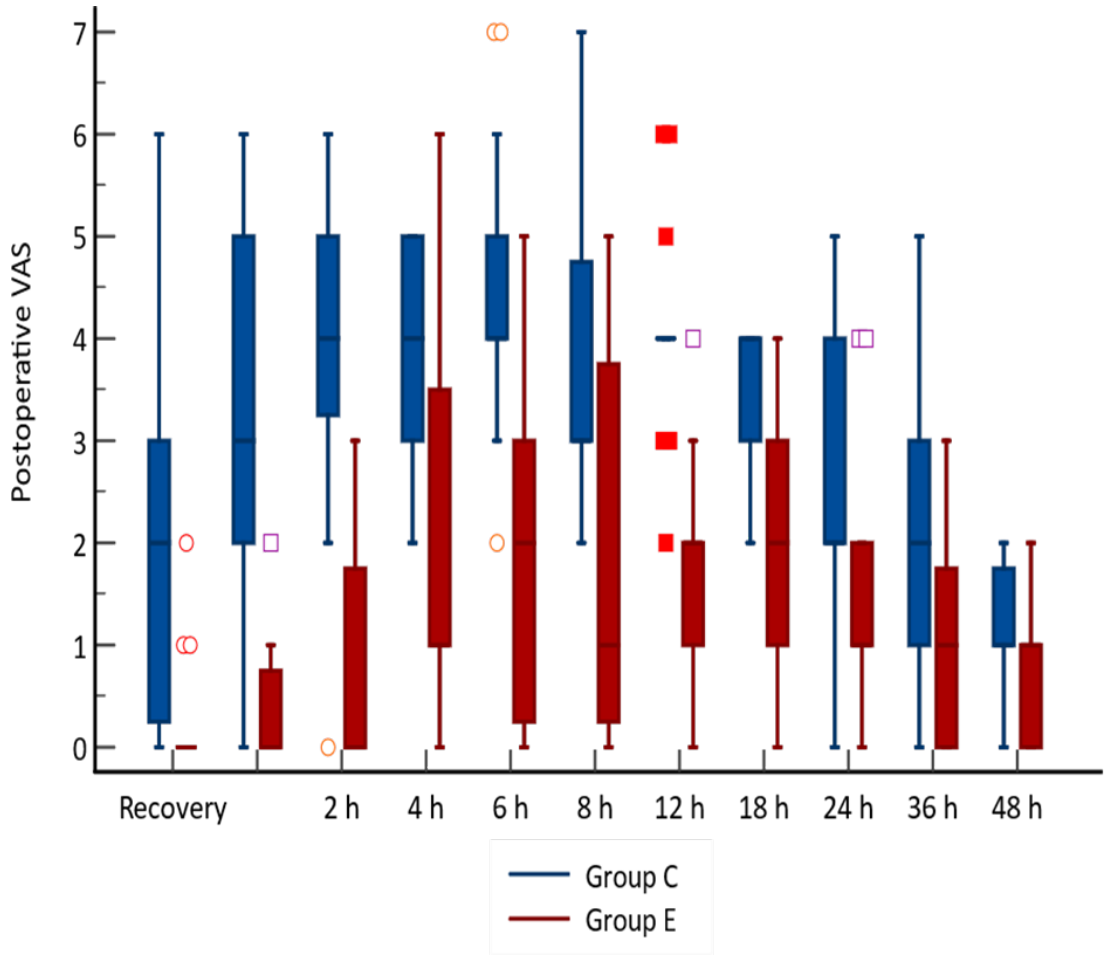
*: significant as P value ≤ 0.05

Inhalational anesthetics consumption was significantly decreased in group E than group C (P value <0.001).

In group E, there was no need for intraoperative fentanyl while in group C; 12 (80%) patients received fentanyl with a significant difference between the two groups (P value <0.001) as its consumption in group C ranged from 50 to 200 mcg with a mean ± SD of 116.67 ± 49.24 mcg.

(Table 4)

Figure 2: Postoperative VAS of the studied groups



Postoperative VAS was lower in group E than group C at all times of observation except at 48 hrs postoperatively ($p<0.05$). (Figure 2)

Regarding Intraoperative hemodynamics, there's a statistically significant difference in MABP as group E was lower than group C at skin incision and at 75 and 150 min (P value =0.009, 0.020, and 0.009 respectively). Otherwise, there was no statistically significant difference between two groups at other times of observation. Intraoperative HR was also decreased in group E than group C at skin incision and at 15, 60 and 75 min (P value =0.001, 0.025, 0.049, and 0.014 respectively).

On the other hand, regarding the postoperative hemodynamics, MABP was only lower in group E than group C at 1hr (88.2 ± 9.49 vs. 98.07 ± 10.85), 2hr (84.8 ± 10.3 vs. 99.4 ± 9.2), 4hr (87.93 ± 9.79 vs. 97.13 ± 9.88), 6hr (87.4 ± 9.63 vs. 101.27 ± 10.31), and 12 h (83.93 ± 10.15 vs. 98.8 ± 10.82) (P value =0.013, <0.001, 0.016, <0.001, and <0.001 respectively).

Postoperative HR was also lower in group E in comparison with group C only at 1, 2, 6, 8,12, and 18 h (P values equal 0.015, 0.001, 0.001, 0.008, <0.001, and 0.003 correspondingly).

Table 5: Mobilization time of the studied groups

		Group C (n=15)	Group E (n=15)	P value
Mobilization time (h)	**Median**	8	3	**<0.001***
	IQR	6 - 9	2 - 4	

*: significant as P value ≤ 0.05

Mobilization time was significantly delayed in group C than group E (P value <0.001) (table 5).

Table 6: Mobilization assessment of the examined groups

		Group C (n=15)	Group E (n=15)	P value
Day-1 TUG score test	**1**	3 (20%)	12 (80%)	**0.004***
	2	11 (73.33%)	3 (20%)	
	3	1 (6.67%)	0 (0%)	
Day-2 TUG score test	**1**	12 (80%)	15 (100%)	0.224
	2	3 (20%)	0 (0%)	

TUG: Timed-Up-and-Go

Group C had delayed Day 1 TUG test compared to Group E (P value equal 0.004). There was no statistically significant difference between examined groups in Day-2 TUG. (Table 6)

Table 7: Postoperative complications of the examined groups

	Group C (n =15)	Group E (n=15)	P value
Nausea	5 (33.33%)	1 (6.67%)	0.169
Vomiting	3 (20%)	0 (0%)	0.224
Dizziness	8 (53.33%)	1 (6.67%)	**0.014***
Itching	1 (6.67%)	0 (0%)	1.000

Dizziness was significantly raised in group C in comparison to group E (P value = 0.014). There was a statistically insignificant difference between examined groups regarding nausea, vomiting, and itching (p-value above 0.05). (Table 7)

Table 8: Patients and surgeons' satisfaction of the studied groups

	Patients' satisfaction		P value	Surgeons' satisfaction		P value
	Group C (n=15)	Group E (n=15)		Group C (n=15)	Group E (n=15)	
Very satisfied	7 (46.67%)	13 (86.67%)	**0.048***	11 (73.33%)	14 (93.33%)	0.330
Satisfied	5 (33.33%)	2 (13.33%)		4 (26.67%)	1 (6.67%)	

Neutral	3 (20%)	0 (0%)		0 (0%)	0 (0%)	

Patients' satisfaction was significantly better in group E than group C (P value = 0.048). There was a statistically insignificant difference between examined groups according to surgeons' satisfaction (p-value< 0.05). (Table 8)

Discussion

We aimed in this study to assess the efficacy of Erector spinae plane block in reducing the 24-hr postoperative morphine consumption, VAS score, and intraoperative analgesic requirements. It was done on 30 patients undergoing elective lumbar spine surgery of one or two levels.

We found that there was a significant reduction in the total 24-hr morphine consumption in ESP group compared to control group (2.32 ± 1.67 mg versus 7.64 ± 2.87 mg) (P value <0.001).

Our findings were in line with those of Singh et al., 2020, Wahdan et al., 2021, and Asar et al., 2022 agreed with our results that the total postoperative morphine consumption in ESP group was lower than control group; (6.21±3.28 mg vs. 10.12±3.29 mg), (7.2 ± 2.0 mg vs. 1.4 ± 1.5 mg), and (8.9 ± 1.2 vs. 21.3 ± 0.9) respectively. (13:15)

On the other hand, Yörükoğlu et al., 2021 consumed more postoperative morphine (11.3±9.5) mg in ESP group vs (27±16.7) mg in Control group. It might be because of their different modality of pain control. Unlike us, they administered Tramadol (100 mg) and paracetamol (1 g) only once at the end of the surgery and their rescue analgesia was tenoxicam 20 mg IV. While we gave 1 gm of paracetamol regularly every 6 hrs in 1st 24 postoperative period. (16)

El Ghamry et al. (12) conducted a randomized clinical trial including 60 cases who underwent lumbar interbody fusion operation. They were randomized into two equal groups. Group I (control group) had GA only, and group II had bilateral ESPB with 20 milliliters of 0.25% bupivacaine following the operation. They illustrated that the 1st request of rescue analgesia was significantly extended in the ESP group as compared with the control group (178.33 ±45.26) mins. and (461.33 ±58.82) mins., respectively. This was in line with our results as we found that 1st analgesic request was significantly delayed in group E in comparison to group C 6 (4-8) hrs vs. 1(1-2) hrs, respectively (P value under 0.001).

ESP reduced the usage of intraoperative opioids significantly as 12 patients in group C received fentanyl, while no patients in group E received it. Intraoperative fentanyl consumption ranged from 50 to 200 mcg with a mean ± SD of 116.67 ± 49.24 mcg in group C. Wang et al. (17) indicated that intraoperative sufentanil consumption was less in ESP group (28.72 ± 3.99 microgram) compared with control group (42.85 ± 7.84 microgram)(P < 0.001). Also, Zhu et al. (18), El Ghamry et al. (12), and Zhang et al. (19) stated that the intraoperative remifentanil, fentanyl, and sufintanil consumption respectively was significantly lower in the ESP group compared with the control group.

Mahmoud et al. (20) didn't agree with our study results as they found that there was no statistically significant difference between ESP group and Intrathecal morphine group regarding intraoperative consumption of fentanyl and this is ought to their different methodology.

The postoperative VAS was significantly less in group E in comparison with group C at all times of observation postoperatively except at 48 hrs postoperatively. Jin et al. (21) demonstrated significant differences in VAS scores over time among the ESP group and the Control group throughout the early interval following the operation. The VAS values for the control group and the ESP group reached their maximum at 1 hour and 12 hours, correspondingly, with Group G exhibiting a significantly elevated peak pain level compared to Group E (P=0.002).

Asar et al. (15), highlighted that NRS scores following the operation were reduced in the ESP group.

ESP affected the intraoperative hemodynamics at certain time points. We found that there was no statistically significant difference between two groups regarding intraoperative MABP except at skin incision, 75, and 150 min (P value =0.009, 0.020, and 0.009 respectively) as they were lower in group E. HR was significantly decreased in group E than group C at skin incision and at 15, 60 and 75 min (P value =0.001, 0.025, 0.049, and 0.014 respectively).

In line with our results, Jin et al. (21) reported that diastolic blood pressure change (▵ DBP) in control group were significantly higher than that of ESP group (P ▵ DBP=0.000) (Jin et al., 2021). Heart rate change (▵ HR) in control group were significantly higher than that of case group E (P ▵ HR=0.003).

Mahmoud et al. (20) stated that non-significant difference was found considering the intraoperative mean arterial blood pressure measurement except at 120 minutes. They also highlighted that the heart rate was significantly lower in the (ITM) group compared to the (ESPB) group in all study postoperative time points except 24 hours (P = 0.04).

Regarding postoperative hemodynamics, it was found that postoperative MABP was statistically significantly lower in group E compared to group C only at 1, 2, 4, 6, and 12 hours. Postoperative HR was statistically significantly lower in group E in comparison with group C only at 1, 2, 6, 8, 12, and 18 h.

Gamal et al. (22) showed that postoperative mean arterial blood pressure was comparable and revealed that there was a statistically insignificant difference among both groups.

ESP also affected the inhalational anesthetic consumption, which was lower in group E in comparison with group C (P value under 0.001) and that was also concluded by Jin et al. (21).

There was no statistically significant difference regarding total blood loss between the groups studied. Zhang et al. (19), who randomized 59 patients in their study; 30 in the ESPB group and 29 in the control group—and Goel et al. (23), who compared the control group, which received G.A. and multimodal analgesia, with the ESP group, agreed with our results at this point.

Regarding the postoperative complications, it has been found that dizziness was significantly elevated in group C in comparison with group E (P value = 0.014). Both groups showed a statistically insignificant difference in nausea, vomiting, itching, and migraine.

Yörükoğlu et al. (16) observed that the frequency of nausea following the operation was significantly reduced in the ESP group compared to in the control group.

We also found that mobilization time was significantly delayed in group C in comparison with group E, represented by median and (IQR) in hours: 8 (6-9) and 3 (2-4), respectively. (P value <0.001) which was aloso concluded by Zhang et al. (19). Although Asar et al. (15) highlighted that postoperative

mobilization wasn't observed to be statistically significant in the two groups (p-value equal to 0.38 & p-value equal to 0.52, correspondingly).

In the current research, it has been found that patients' satisfaction was significantly better in group E in comparison with group C. Goel et al. (23) and Singh et al. (13) agreed with this outcome.

Conclusion

Postoperative pain management is crucial, and the erector spinae plane block (ESPB) showed significant benefits, including delayed analgesic requests, reduced pain scores, decreased hemodynamic fluctuations, and lower inhalational anesthetic consumption. ESPB also reduces dizziness resulting from high opioid intake, allows for earlier mobilization, and increases patient satisfaction, highlighting its efficacy in improving postoperative outcomes and recovery.

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