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# Comparative Study between Erector Spinae Plane Block versus Intravenous Morphine as Postoperative Analgesia after Spine Surgeries

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## ABSTRACT

**Background:** Postoperative pain is defined as acute pain present at the surgical site or related to it after procedure.
**Objective:** This work was aimed at performing a comparison between the erector spinae plane block (ESPB) impact in comparison with Intravenous morphine for postoperative analgesia following spine surgeries.
**Patients and Methods:** This prospective randomized double-blind research included sixty individuals with ASA physical status class I and class II going through an uncomplicated spine surgery with general anesthesia. All participants went through a categorization into two equal groups; 30 in each. The first group patients were administered bilateral ultrasound guided ESPB utilizing plain bupivacaine at a dosage of 100 mg diluted to volume with saline, thus obtaining 50% concentration (50 mg plain bupivacaine in each side), The second group: received a dosage of 0.1 mg /kg of IV morphine diluted with saline to 10 ml volume when the surgical procedure is completed.
**Results:** Postoperative heart rate (HR), mean arterial pressure (MAP), respiratory rate (RR), and visual analogue measurements (VAS) were significantly lower at 6h,12h and 24h within the first group as opposed to the second one (P value<0.05). Duration till the first analgesic need was significantly longer within group 1. Total paracetamol dosages within initial twenty-four hours postoperatively were significantly lower in group 1. PONV, hypotension and bradycardia were insignificantly varied among both groups.
**Conclusions:** Using ESPB in spine surgeries is associated with better analgesic outcomes through pain score, duration till the first analgesia need and total paracetamol administration with no difference regarding complications compared to intravenous morphine.
**Keywords:** Erector Spinae Plane Block, Intravenous Morphine, Postoperative Analgesia, Spine Surgeries

## INTRODUCTION

Postoperative pain refers to acute pain present at the surgical site or related to it after procedure. The WHO and international association for the study of pain have stated pain alleviation as a fundamental human right [1]. The postoperative pain management aims at decreasing anxiety, stress and discomfort. It has significant physiological and psychological effects. It helps in early mobility, good rehabilitation, less complication of prolonged bed ridden and shortened hospital stays [2].

Postoperative pain management has various routes (oral, intravenous, neuraxial and regional) and various agents (Opioid or nonopioid) [3]. One of the most annoying complications of insufficient post-operative pain management is chronic pain for years [4].

The Postoperative pain occurrence could be severe for those going through lumbar surgeries. As a result, they become unable to leave bed during the initial stage, impacting their recovery [5].

ESPB was introduced as a novel trunk fascia block approach in 2016, arousing many nerve block experts curiosity. The ESPB efficiency has not been explained yet. The technique's mechanism of action remains controversial. It is often obtained through the local anesthetic solution injection (with other substances) between erector spinae muscles (iliocostalis, longissimus, spinalis/ from lateral to medial) and the transverse process [6].

This approach is conducted utilizing ultrasound guidance. A high frequency linear probe is positioned on a sagittal orientation to scan and locate the transverse process at the desired column level. The needle is inserted in an "in plane" direction; its tip slightly touches the transverse process posterior surface. The local anesthetic solution administration should form an anechoic space between the transverse process and the erector spinae muscles [7].

LA diffuses through a caudal and cephalic direction. It probably crosses the internal intercostal membrane, thus inhibiting signals transmission from dorsal and ventral rami of spinal nerves. In addition, it blocks both somatic and sympathetic nerves [8].

The work was aimed at comparing ESPB effects as opposed to Intravenous morphine as postoperative analgesia following spine surgical procedures.

## PATIENTS AND METHODS

This prospective randomized double-blind study included a total of 60 patients with ASA physical status class I and class II going through an uncomplicated spine surgical procedure (lumbar discectomy or single level fixation) under general anesthesia. Patients attended at Sohag University Hospital.

**Exclusion criteria:** Individuals who refused to participate, or having drug abuse, significant neurological, psychiatric, and neuromuscular disorders, chronic pain in medicine, prior allergy or



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hypersensitivity regarding the study drugs, infiltration site infection, bleeding tendency.

Participants were divided equally using opaque sealed envelopes into two groups; 30 each: The first one involves those who administered bilateral ultrasound guided ESPB using plain bupivacaine at dosage of 100 mg diluted with saline, thus obtaining 50% concentration (50 mg plain bupivacaine in both sides), while the second one involves those administered a dosage of 0.1 mg /kg of IV morphine diluted to 10 ml volume with saline when the surgical procedure is completed.

The study was double blinded in which the patients, and anesthesiologist involved were blinded to the technique. A non-participating anesthesiologist produced the drug solutions. In addition, he observed the patients who were blinded to the treatment group. Anesthesiologist unaware of the group allocation done data collection.

**Preoperative preparation:**

All participants underwent a comprehensive medical history, clinical assessment and routine laboratory testing. During the preanesthetic assessment, all patients were familiarized with VAS, from 0 to 10. Zero exhibits pain absence while 10 exhibits severe intolerable pain.

**Intraoperative:**

Pre-anesthesia: Fentanyl at a dosage of 1 microgram/kg was intravenously administered just prior to anesthesia induction, which then occurred with propofol 2 mg/kg and atracurium 0.5 mg/kg, anesthesia maintenance with inhalational anesthetic (isoflurane) and atracurium 0.1 mg/kg on demand.

**Group I:**

ESPB was conducted on both sides while patient was lying face down. A high-frequency ultrasound transducer was positioned in a longitudinal orientation three cm lateral to midline. For ribs counting identification using ultrasound, 3 muscles were detected as superficial to hyperechoic transverse process shadow as follows: trapezius, rhomboid major, and erector spinae. However, when rhomboid major muscle disappears this indicates that we are at the seventh thoracic vertebra level then counting down to the level of spine intervention. 18-gauge needle was positioned in craniocaudal direction towards transverse process in-plane to the US transducer until needle came in contact with the transverse processes passing through all the muscles. The accuracy of needle positioning was verified using hydro-dissection with 2-3 ml saline.

Plain bupivacaine at a dosage of 100 mg diluted with saline, thus obtaining 50% concentration (50 mg plain bupivacaine in both sides) were injected.

**Group II:**

Participant received at a dosage of 0.1 mg /kg of IV morphine diluted with saline to 10 ml volume when the surgical procedure is completed.

**Postoperative pain evaluation**

It was measured using VAS at zero, 1,2,4 6,9,12, 18 and 24 hours after surgery where zero to three is mild, four to six is moderates, while seven to ten is severe pain. Time interval, first need of analgesia and overall dose of analgesia used in both groups were recorded.

Analgesic requirement: If the VAS is >4 (presence of pain), the participant is administered supplementary paracetamol (iv) injection at a dosage of fifteen mg/Kg and ketorolac with maximum dose 60 mg per day. Postoperative hemodynamics were recorded every 2 hours up to 24 hours [heart rate (HR), (MAP), (RR)].

Any adverse effects in recovery room were monitored: Bradycardia (if HR is <20% of baseline) was treated by atropine (IV) 0.01 mg/kg, hypotension (if MAP is <20% of baseline) was treated with (IV) fluid and an incremental (IV) at dosage of ephedrine 0.2- 0.3 mg/kg, respiratory depression, apnea, as well as hypoxemia (SpO2 < 92%) needed O2 supplementation as well as disturbed conscious level, hallucinations, abnormal movement, nausea, and vomiting.

**Ethical approval:**

**Sohag Medical Ethics Committee of the Sohag Faculty of Medicine gave its approval to this study [Approval No.: Soh-Med-22-03-10]. All participants gave written consent after receiving all information. The Helsinki Declaration was followed throughout the study's conduct.**

***Statistical analysis***

Data went through a statistical analysis utilizing SPSS V. 26.0. The Shapiro-Wilks test and histograms were utilized for assessing the normality of the distribution of data. Quantitative parametric variables were displayed as mean and standard deviation. A comparison among both groups were applied utilizing unpaired Student's t- test. Quantitative non-parametric data were displayed as median and interquartile range (IQR), then analyzed utilizing the Mann Whitney-test. Qualitative variables were displayed as frequency and percentage then analyzed utilizing the Chi-square test or Fisher's exact test when appropriate. A two tailed P value < 0.05 deemed to be statistically significant.

**RESULTS**

In our research, 84 individuals went through an assessment for eligibility, 18 were excluded since they didn't match our requirements while six individuals refused to take part in the research. The remaining individuals went through a random categorization into two equal groups (30 individuals in each). All of them were followed-up and underwent a statistical analysis. Figure 1

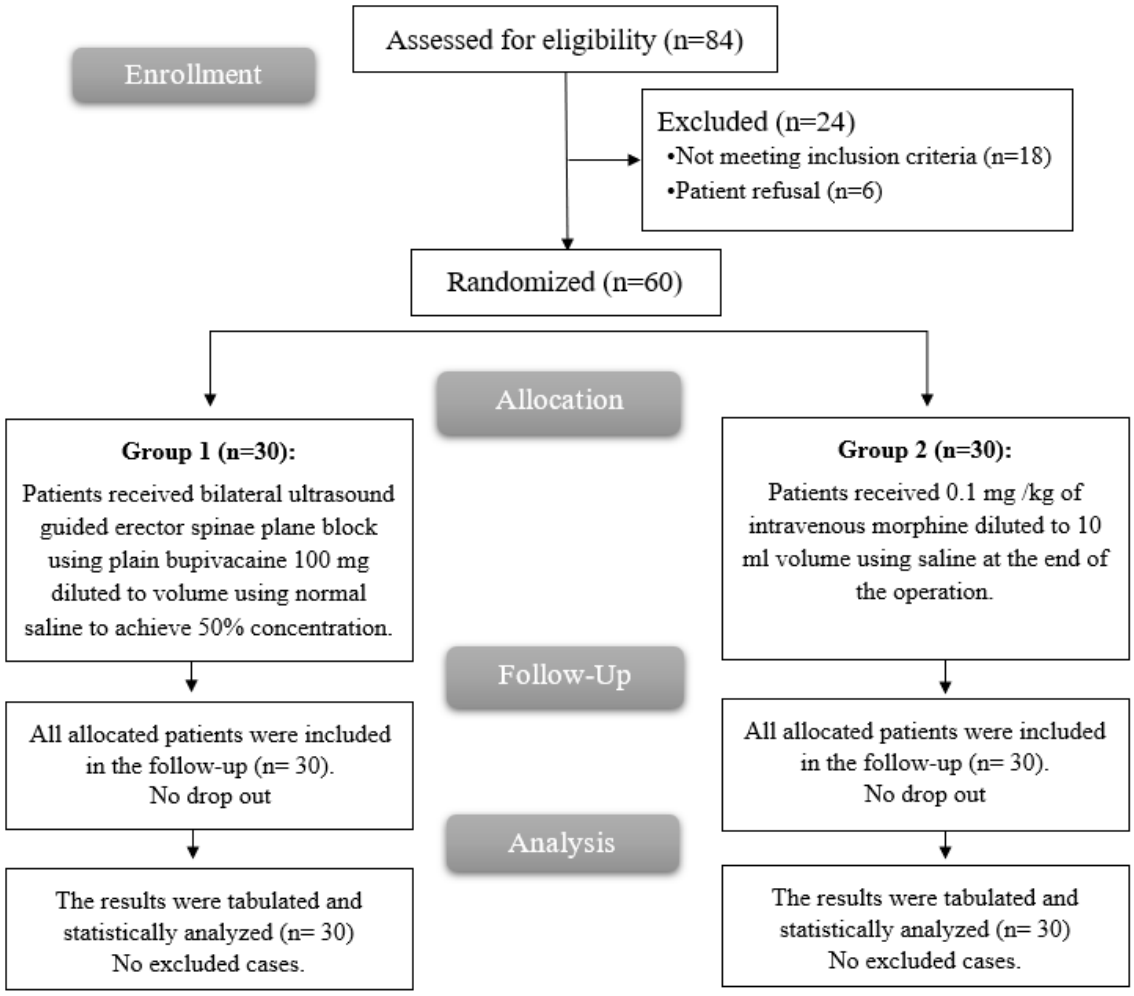


**Figure (1): CONSORT flow diagram of the participants through each stage of the trial.**

Patient characteristics and surgery duration were insignificantly varied among two groups (Table 1).

**Table (1): Patient characteristics and duration of surgery of the studied group**

| Parameters | | Group 1 (n=30) | Group 2 (n=30) | P value |
|---|---|---|---|---|
| **Age (years)** | | 34.5 ± 8.19 | 36.8 ± 9.3 | 0.314 |
| **Sex** | **Male** | 20 (66.67%) | 21 (70%) | 0.781 |
| | **Female** | 10 (33.33%) | 9 (30%) | |
| **Weight (kg)** | | 72.5 ± 8.53 | 74.6 ± 8.68 | 0.348 |
| **Height (m)** | | 1.66 ± 0.07 | 1.64 ± 0.07 | 0.236 |
| **BMI (kg/m$^2$)** | | 26.47 ± 3.88 | 28.06 ± 4.65 | 0.156 |
| **ASA physical status** | **ASA I** | 11 (36.67%) | 7 (23.33%) | 0.260 |
| | **ASA II** | 19 (63.33%) | 23 (76.67%) | |
| **Duration of surgery (min)** | | 233.33 ± 38.27 | 237.5 ± 37.85 | 0.673 |

Data exhibited as mean ±SD or frequency (%) BMI: body mass index. ASA: American society of anesthesiologists

Postoperative HR as well as MAP measurements were insignificantly different at zero, 2h, 4h, 8h, 10h, 14h, 16h, 18h, 20h and 22h and were significantly lower at 6h, 12h and 24h in the first group as opposed to the second one (P value<0.05) (Table 2).

**Table (2): Postoperative HR and MAP measurements of the studied group**

| | Group 1 (n=30) | Group 2 (n=30) | P value |
|---|---|---|---|
| **HR measurements** | | | |
| **At zero** | 77.8±9.14 | 79.23±9.89 | 0.562 |
| **2 hours** | 80.87±9.07 | 82.8±9.71 | 0.429 |
| **4 hours** | 79.07±9.14 | 83.4±14.09 | 0.163 |
| **6 hours** | 80.4±9.25 | 87.97±12.86 | **0.011*** |
| **8 hours** | 85.43±11.45 | 88.4±14.04 | 0.373 |
| **10 hours** | 84.47±13.82 | 81.97±10.89 | 0.440 |
| **12 hours** | 86.97±14.31 | 95.2±14.46 | **0.031*** |
| **14 hours** | 85.57±15.48 | 90.07±13.62 | 0.237 |
| **16 hours** | 85.23±14.35 | 88.57±15.44 | 0.390 |
| **18 hours** | 87.7±11.22 | 93.07±15.11 | 0.124 |
| **20 hours** | 83.7±8.81 | 88.63±14.03 | 0.108 |
| **22 hours** | 82.13±8.92 | 87.5±14.46 | 0.089 |
| **24 hours** | 86.33±14.11 | 94.4±15.17 | **0.037*** |
| **MAP measurements** | | | |
| **At zero** | 88.33±10.97 | 87.73±10.18 | 0.827 |
| **2 hours** | 91.73±11.56 | 89.67±11.48 | 0.490 |
| **4 hours** | 91.13±11.28 | 93.57±13.98 | 0.461 |
| **6 hours** | 89.37±11.18 | 97.67±13.87 | **0.013*** |
| **8 hours** | 94.83±13.82 | 95.3±17.04 | 0.908 |
| **10 hours** | 94.5±12.51 | 88.83±12.66 | 0.086 |
| **12 hours** | 93.93±16.39 | 102.73±15.97 | **0.039*** |
| **14 hours** | 98.13±15.92 | 102.2±15.48 | 0.320 |
| **16 hours** | 97.23±16.13 | 101.33±15.83 | 0.324 |
| **18 hours** | 104.97±14.3 | 101.17±16.13 | 0.338 |
| **20 hours** | 95.8±13.66 | 101.47±12.31 | 0.097 |
| **22 hours** | 94.3±13.76 | 100.03±12.12 | 0.092 |
| **24 hours** | 92.73±16.95 | 101.2±12.47 | **0.032*** |

Data exhibited as mean ±SD, * Significant as P value≤0.05, HR: Heart rate, MAP: Mean arterial blood pressure.

Postoperative RR and VAS score measurements were insignificantly different at zero, 2h, 4h, 8h, 10h, 14h, 16h, 18h, 20h and 22h and were significantly lower at 6h, 12h and 24h in the first group as opposed to the second one (P value<0.05) (Table 3).

**Table (3): Postoperative RR measurements and VAS score measurements of the studied groups**

| | Group 1 (n=30) | Group 2 (n=30) | P value |
|---|---|---|---|
| **RR measurements** | | | |
| **At zero** | 11.73±1.39 | 11.47±1.33 | 0.451 |
| **2 hours** | 12.2±1.37 | 11.9±1.45 | 0.414 |
| **4 hours** | 13.67±1.54 | 13.83±1.42 | 0.664 |
| **6 hours** | 13.17±1.32 | 14.17±2.28 | **0.042*** |
| **8 hours** | 14.93±1.91 | 14.67±2.04 | 0.603 |
| **10 hours** | 15.13±2.21 | 14.33±1.45 | 0.102 |
| **12 hours** | 14.63±2.14 | 16.27±2.41 | **0.007*** |
| **14 hours** | 14.67±2.22 | 15.7±2.51 | 0.096 |
| **16 hours** | 13.7±2.25 | 14.57±2.65 | 0.177 |
| **18 hours** | 16.83±2.79 | 16.07±2.42 | 0.260 |
| **20 hours** | 15.57±2.7 | 16.67±3.57 | 0.183 |
| **22 hours** | 14.1±2.68 | 15.2±3.7 | 0.193 |
| **24 hours** | 14.6±2.39 | 16.2±3.16 | **0.031*** |
| **VAS score measurements** | | | |
| **At zero** | 1 (0 - 1) | 0 (0 - 1) | 0.200 |
| **1 hour** | 0 (0 - 1) | 1 (0 - 1) | 0.306 |
| **2 hours** | 1 (1 - 2) | 1 (1 - 2) | 0.363 |
| **4 hours** | 2 (2 - 3) | 2 (2 - 3) | 0.411 |
| **6 hours** | 3 (2 - 3) | 3 (2 - 5) | **0.033*** |
| **9 hours** | 2.5 (1.25 - 4) | 3 (2 - 3.75) | 0.490 |
| **12 hours** | 3 (2 - 5) | 5 (4.25 - 6) | **0.003*** |
| **18 hours** | 5 (4.25 - 5.75) | 5 (2.25 - 5) | 0.317 |
| **24 hours** | 3 (2 - 5) | 5 (2.25 - 6) | **0.011*** |

Data exhibited as mean ±SD or median (IQR), * Significant as P value≤0. 05, VAS: visual analog score, RR: respiratory rate.

Duration till first analgesic need was significantly longer within the first group as opposed to the second one (P value <0.001). Total paracetamol dose in 1st 24 hours postoperative, rescue diclofenac amount, patients required dancit and patients required morphine were significantly lower within the first group as opposed to the second one (P value <0.05) (Table 4).

**Table (4): Time to first analgesic request and total paracetamol administration in 1st 24h of the studied groups**

| | Group 1 (n=30) | Group 2 (n=30) | P value |
|---|---|---|---|
| **Time to first analgesic request (h)** | 10.2 ± 1.63 | 6.3 ± 1.44 | **<0.001*** |
| **Total paracetamol consumption in 1st 24h (g)** | 2.17 ± 0.59 | 3.47 ± 0.73 | **<0.001*** |
| **Rescue diclofenac amount (mg)** | 7.33 ± 2.77 | 23.3 ± 6.68 | **<0.001*** |
| **Patients required dancit** | 8 (26.67%) | 17 (56.67 %) | **0.018*** |
| **Patients required morphine** | 11 (36.67%) | 21 (70%) | **0.01*** |

Data exhibited as mean ±SD, or frequency (%) *: Significant as P value≤0.05.

PONV, hypotension and bradycardia were insignificantly varied among both groups. Respiratory depression wasn't documented in any participants in both groups (Table 5).

**Table (5): Adverse events of the studied groups**

| | Group 1 (n=30) | Group 2 (n=30) | P value |
|---|---|---|---|
| **Postoperative nausea and vomiting** | 4 (13.33%) | 10 (33.33%) | 0.067 |
| **Hypotension** | 1 (3.33%) | 3 (10%) | 0.301 |
| **Bradycardia** | 3 (10%) | 4 (13.33%) | 0.688 |
| **Respiratory depression** | 0 (0%) | 0 (0%) | --- |

Data exhibited as mean ±SD, * Significant as P value≤0. 05.

## DISCUSSION

The ESPB which was first demonstrated in 2016 [9], is one of postoperative pain management.

The participants of this study went through a categorization into two equal groups; 30 in each The first group patients were administered bilateral ultrasound guided ESPB utilizing plain bupivacaine at a dosage of 100 mg diluted to volume with saline, thus obtaining 50% concentration (50 mg plain bupivacaine in each side), The second group: received a dosage of 0.1 mg /kg of IV morphine diluted with saline to 10 ml volume when the surgical procedure is completed.

Our study addressed a significant difference among both two groups regarding baseline characteristics as well as that postoperative HR, MAP, RR and VAS measurements were insignificantly different at zero, 2h, 4h, 8h, 10h, 14h, 16h, 18h, 20h, 22h and 24h. In addition, they were significantly lower at 6h,12h and 24h within the first group as opposed to the second one (P value<0.05).

Aligned with our results, Rasmy *et al.* [10] addressed, HR assessed at 15, ½ h, 1h 2,6,12 and 24 hours following the surgical procedure, was statistically significant lower in the ESP group as opposed to the other one. Also reported that measuring MAP at15, 30 and 60 minutes, 2, 12 and 24 hours was applied following the surgical procedure. The ESP and morphine groups didn't have any statistically significant variations. In addition, there was no significant difference at 6h which is not in line with our results, also VAS score measured at fifteen, thirty and sixty minutes, 2,6,12 and 24 hours following the surgical procedure, was markedly less in the ESP group as opposed to the IV morphine one.

Different to our findings, **Mahmoud *et al.*** [11] reported that HR was significantly less within ITM group as opposed to the ESPB one in all study postoperative time points except 24 hours . The difference between these findings and ours could be shown through the difference in the morphine administration route among the two studies.

Aligned with our study, **Hussain *et al.*** [12] showed that pain score was statistically significant lower within ESP group as opposed to intravenous opioids one.

Our results were agreed with **Zhang *et al.*** [13] who found that the ESPB group reported lower pain scores as opposed to the GA one in the four time periods (1, 6, 12 and 24 h following the surgical procedure.

Different from our findings, **Mahmoud *et al.*** [11] reported that the postoperative VAS scores were significantly lower within ITM group as opposed to the ESPB one throughout all documented postoperative study time points till forty-eight h postoperative. During the entire postoperative period, VAS scores were greater within the ESPB group as opposed to the ITM one; the estimate (95% CI) equals 1.989 (1.664 - 2.314), t = 12.198, P < 0.001.

The present study reported that the mean time for rescue analgesia was 10.2 ± 1.63 h in group 1 and 6.17 ± 1.56 h in group 2. The mean of total paracetamol consumption in 1st 24h was 2.37 ± 0.72 g in group 1 and 3.47 ± 0.73 g in group 2.

Duration till first analgesic need was significantly prolonged in group 1 than group 2. Total paracetamol dose in 1st 24 hours postoperative was significantly lower within the first group as opposed to the second one.

Aligned with our results, **Rasmy *et al.*** [10] addressed, morphine administration during the first

twenty-four h following the surgical procedure was significantly less within ESP group as opposed to intravenous morphine group, while analgesia duration in hours was more in the ESP one.

Similar to our results, **Hussain *et al.* [12]** reported that in comparison with parenteral opioids, ESPB resulted in a decrease in cumulative 24-hour oral morphine equivalent intake by −17.60 mg (−24.27 to −10.93).

Similar to our results, **Zhang *et al.* [13]** reported that as opposed to GA group, the ESPB one addressed a significant decrease in morphine intake during initial 24 h following the surgical procedure. ESPB group significantly decreases the fentanyl intraoperative administration, as well as requiring rescue analgesia following the surgical procedure.

Different from our findings, **Hussain *et al.* [12]** reported that as opposed to parenteral opioids, ESPB intervention hadn't extended time for rescue analgesia.

Different to our results, **Mahmoud *et al.* [11]** reported that the time for rescue analgesic was significantly longer within ITM group as opposed to the ESPB one. Also, total 48-hour postoperative pethidine administration was significantly less within the ITM group was 87.5 (44) mg compared to the ESPB group 112 (13) mg. This is attributed to the difference in administration route between this study and intravenous administration route in the present study.

The current study addressed, PONV, hypotension as well as bradycardia were insignificantly varied among the two groups. Respiratory depression occurrence wasn't documented in any patient in both groups. Aligned with our study, **Rasmy *et al.* [10]** addressed the complications incidence: no patients developed any complication within ESP and controlled groups.

Different from our findings, **Mahmoud *et al.* [11]** addressed a significant difference concerning the complications incidence with no complications found in the ESPB group; there were 33 individuals (80%) within ITM group that had at least one complication.

Different from our findings, **Hussain *et al.* [12]** reported that as opposed to parenteral opioids, ESPB decreased the OR (95% CI) of PONV occurrence by 0.43 (0.28 to 0.66) (p=0.0002, I2=0%). Different from the present findings, ESPB is associated with statistically lower incidence of PONV.

**Limitations:** a single-centered study, placebo group wasn't included, short follow up period and no investigation of different drug doses.

## CONCLUSIONS

Using ESPB in spine surgeries is associated with better analgesic outcomes through VAS score, duration till first analgesia as well as total paracetamol intake with no difference in complications compared to intravenous morphine. However, it is associated with lower HR, MAP and RR at 6h, 12h and 24h postoperatively.

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**Conflict of Interest:** Nil

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