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Effect of Preoperative Fluoroscopic Guided Single Shot Erector Spinae Block for Posterior Lumbar Spine Surgery: A Surgeon and Patient Prospective

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ABSTRACT

Background: Posterior spinal surgery is considered one of the most painful surgeries. Erector Spinae Block is likely to produce effective pain management as it causes blockade of the dorsal rami **.**

Objective: This study was conducted to assess the efficacy of ESPB in controlling intraoperative and POP and surgical field during lumbar spine fixation.

Patients and methods: A total of 70 cases were enrolled, and they were haphazardly divided into two groups; ESPB group which comprised 35 cases who underwent the blockade technique, and the control group which included the remaining 35 cases that underwent surgery without blockade. The primary outcome was POP, while secondary outcomes involved intraoperative bleeding, and surgeon satisfaction.

Results: No significant differences were detected among both groups concerning patient demographic features. Operative bed bleeding was significantly decreased in the ESPB group. Also, ESPB group expressed lower pain scores during the initial 6 hours after surgery with no difference detected between both studied groups on subsequent assessment. Surgeon satisfaction was significantly better in the ESPB group.

Conclusion: ESPB appears to be safe and efficacious technique not only in decreasing POP, but also in improving operative bed bleeding, and surgeon satisfaction.

Keywords: Erector Spinae Plane Block, Fluoroscopy, Spine Surgery, Surgeon satisfaction.

INTRODUCTION

The ESPB is a new regional anesthetic approach which could be utilized to offer pain relief after numerous surgical interventions. It can be also used to treat acute or chronic painful conditions. This approach includes introduction of the blocking agent into the paraspinal fascial plane located between erector spinae muscle and the thoracic transverse processes [(1)].

This leads to blockade of both dorsal and ventral rami of thoracic and abdominal spinal nerves, which in turn causes multilevel sensory blockade of anterior, lateral, and posterior thoracic and abdominal walls. This multi-level block could be explained by both cranial and caudal spread of the blocking agent that is aided by thoracolumbar fascia extending over the posterior thoracic and abdominal walls [(2)].

Its efficacy was first reported in 2016 when it was utilized to manage neuropathic thoracic pain in cases with metastatic rib tumor or rib fractures [(3)]. After that, its use became widely accepted as efficacy was also proved in multiple operations including thoracotomy, nephrolithotomy, lumbar fixation, along with ventral hernia repair [(2, 4-7)].

It could be carried out whether via a single-injection technique, or via continuous infusion through catheter. Moreover, the technique could be carried out either via ultrasound or fluoroscopy [(8)].

Posterior spinal surgery is considered a painful surgical intervention, with a median pain score ranging between 5 and 7 on the 1st postoperative day on numerical pain scale [(9)].

Although opioid therapy plays an important role in managing pain after surgery, it has multiple side effects including dependence [(10)].

Hence, the application of regional anesthetic techniques should be considered [(11, 12)].

In cases with spine diseases requiring instrumentation, ESPB is likely to produce effective pain management as it causes blockade of the dorsal rami [(13)].

Herein, we assess ESPB effect on blood loss, POP, and surgeon satisfaction in patients undergoing spinal instrumentation for degenerative causes.

PATIENTS AND METHODS

This prospective randomized study was carried out at Neurosurgery Department, Mansoura University Hospitals.

Inclusion criteria: age more than 18 years who were prepared for spinal fixation due to degenerative causes with lumbar involvement.

Exclusion criteria: patients with uncontrolled systemic comorbidities, and refusal to contribute to the study were causes of exclusion.

The sample size was calculated by utilizing PASS version 15.0.5 for windows (2017) based on data acquired from **li *et al.*** study with the efficacy of ESPB in controlling POP after spine surgery at six hours as the primary outcome.

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Reported VAS score at six hours after spine surgery was 2.767 ± 0.679 in ES group and 3.656 ± 1.066 in general anesthesia group [14].

A sample size of 28 cases in each group was needed to achieve 95% power in the suggested study by utilizing a two-sided two-sample unequal-variance t-test with a significance level of 5%. Seven patients drop-out was expected in both groups, as a result 35 cases were enrolled to each group.

This study was carried out on two groups:
ESPB group: comprised 35 cases who underwent the blockade technique

Control group comprised 35 cases who underwent surgery without blockade.

Entire cases were subjected to detailed history taking, complete neurological examination, and preoperative laboratory investigations. Plain X-ray along with spinal CT or MRI was ordered to assess the site and extent of disease.

All cases were carried out under general anesthesia. The patient was initially positioned at supine position. Intravenous cannula was inserted. ECG, noninvasive BP monitoring, pulse oximetry, and temperature were monitored. Induction of anesthesia was carried out using propofol (0.5 – 2 mg/kg), fentanyl (1–2 ug/kg), and atracurium (0.05 mg/kg).

The patient was turned to the prone position on operating table to enable access to the patients back. Skin disinfection was carried out with 2% chlorhexidine in 70% alcohol. 22G spinal needle was inserted 3 cm lateral to the spinous process, one vertebral level beyond the predetermined marked surgical site directed toward transverse process "TP" under fluoroscopic guidance.

The needle was directed in a shallow trajectory (10-20°) in a cephalic to caudal direction, after contacting the TP needle was slightly retracted, until its tip sits in the interfacial plane below the muscle. The correct position was confirmed by injecting 1 ml of iohexol (Omnipaque-300®) mixed with one ml saline under anteroposterior and lateral view fluoroscopic guidance, aspiration test was done first to avoid intravascular injection.

A smooth cephalic–caudal spread was noticed of the injected mixture included; 8 cm isobaric bupivacaine 0.5%, 3 cm 1/10000 adrenaline with saline and 1 cm contrast dye for each side. Adequacy of spread was established via anterior–posterior and lateral views. Double level fixation; six screws were inserted in all cases in the current study (Figure 1).

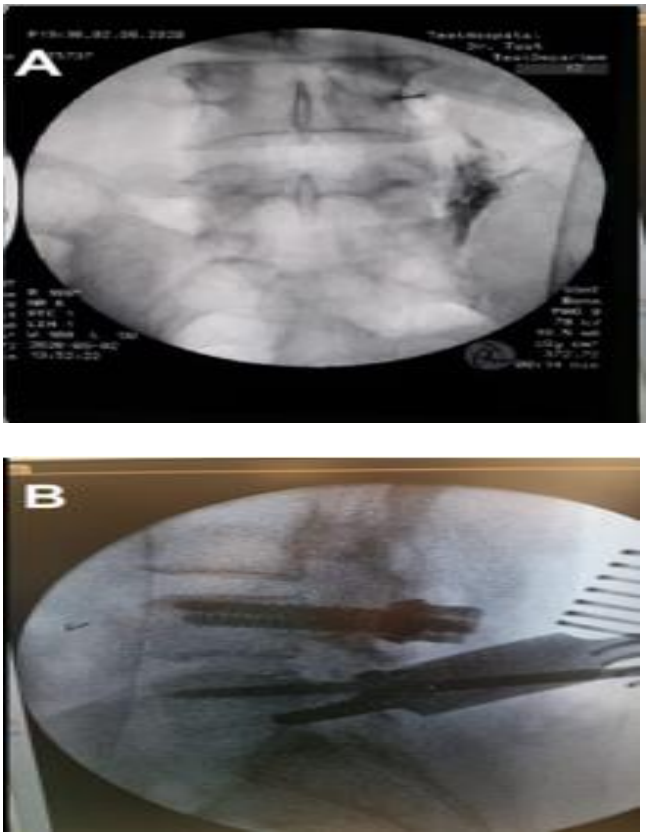

Figure (1): Anteroposterior view of dye reaching posterior superior iliac spine (PSIS), B lateral view of dye distribution covering 3 levels

Through the surgery, systolic blood pressure (SBP) was maintained at 25% below basal value (80–90 mmHg in normal cases) via firstly increasing the dose of volatile anesthetics by 10% minimum alveolar concentration (MAC) after 5 min if the desired level not reached 0,5 μg/kg of fentanyl was given, it can be repeated after 5 min if necessary. Meanwhile, if heart rate was above 80 beat/min 1 mg of propranolol was used, a second dosage could be given after 120 seconds if heart rate (HR) not yet controlled, and finally glyceryl trinitrate continuous infusion (1–10 μg/kg/min) was initiated to achieve systolic pressure desired level.

If the mean arterial blood pressure (MAP) dropped below 50 mmHg, first we intervene through reduction depth of anesthesia MAC by 10%, after 5 min if not getting desired response, fluid resuscitation via 500 ml normal saline 0.9% was infused over 10 min, if not corrected 5 mg of ephedrine was administered as incremental intravenous boluses to max 20 mg. in case of bradycardia (HR ‹ 50/ min) IV of 0.5 mg atropine was given. MAP was to return to the basal value prior to the termination of the surgery, reversal of muscle relaxation with 0.04 mg/kg neostigmine and 0.02 mg/kg atropine. Regaining consciousness, spontaneous breathing, and response to verbal command were extubation criteria. Figure (2) shows surgical field during dissection and surgical field at end of surgery.

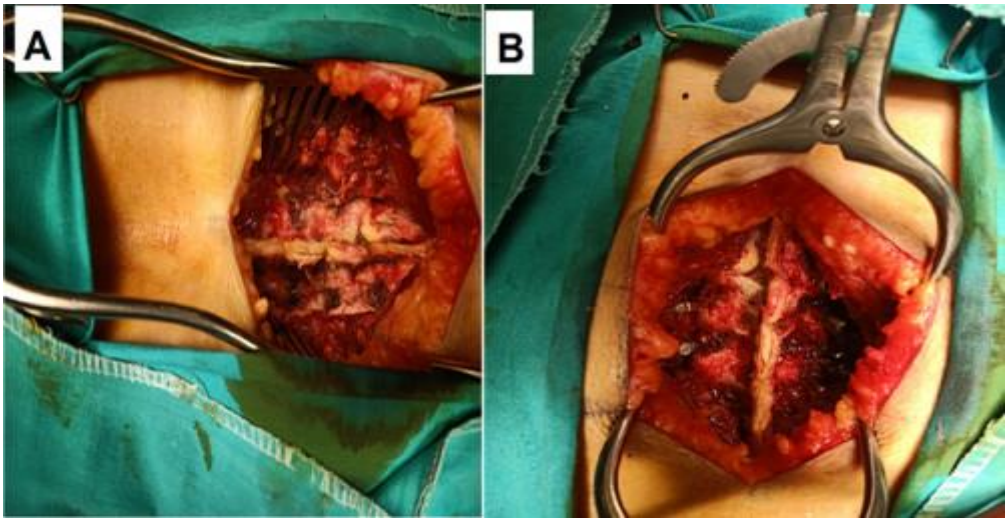

Figure (2): A surgical field during dissection, B surgical field at end of surgery

- During surgery, both MAP and HR were continuously monitored. Intraoperative blood loss, isoflurane consumption was measured using the next calculation [15]; fluid volatile agent = mean fresh gas flow (FGF) (ml/min) · mean agent concentration (Vol%) · anesthetic duration(min)/saturated gas volume (ml) · 100 (Vol%) = ml, and total fentanyl dose were recorded.
- 15 mg/kg i.v. paracetamol was given at the termination of surgery and repeated every 6 h in the 1st postoperative day.

After surgery, all cases were transferred to the recovery room. Postoperative agitation was assessed via Richmond Agitation-Sedation Scale (RASS) [16]. Surgeon satisfaction was classified into; poor, fair, good, or excellent. The pain was assessed via visual analogue scale (VAS), with 0 for no pain, and 10 for the worst pain ever at time intervals 1, 3, 6 ,12, and 24 h postoperatively [17]. All patients with VAS score (VAS > or = 4) received rescue analgesia in the form of i.v. 15 mg ketolac, after 30 min pain was assessed again if VAS score still above >4 a rescue analgesia in the form of 2 mg i.v. morphine boluses with a maximum 10 mg in 24 hours (h); time of the first analgesic request was reported.

Ethical consent:

The approval of the study was got from the Institutional Research Board (IRB) of Faculty of Medicine, Mansoura University prior to beginning the research and an informed written consent was taken from each participant in the study. Number of ethical approval is R.20.08.972. This work was conducted in agreement with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for researches comprising human beings.

Statistical analysis

IBM's SPSS statistics for Windows (version 25, 2017) was utilized for statistical analysis of the gathered information. Shapiro-Wilk test was used to check the normality of the data distribution. Entire tests were carried out with a 95% confidence interval (CI). P<0.05 was considered significant. using median (minimum and maximum) and mean, standard deviation for parametric data after testing normality using Kolmogrov-Smirnov test. Significance of the obtained results was judged at the (0.05) level. whereas categorical variables were expressed as frequency and percent. Independent sample T and Mann Whitney tests were utilized for intergroup (among individuals) comparison of parametric and non-parametric continuous data respectively. Fisher exact and Chi square tests were utilized for intergroup comparison of nominal data by utilizing the crosstabs functions.

RESULTS

No significant difference was detected between both studied groups in terms of the sociodemographic data (Table 1).

Table (1): Sociodemographic characteristics among both groups

		ESPB group (n= 35)	Control group (n= 35)	p
Age (Years) Mean±SD		53.97 ± 8.926	53.17 ± 8.880	0.708
Gender	**Male**	45.7% (16)	60.0% (21)	0.231
	Female	54.3% (19)	40.0% (14)	
Height (m) Mean±SD		173.06 ± 5.450	173.54 ± 4.943	0.697
Weight (kg) Mean±SD		92.51 ± 8.462	93.63 ± 9.365	0.603
BMI (kg\m^2)Mean±SD		30.99 ± 3.495	31.06 ± 2.500	0.925
ASA	**I**	54.3% (19)	65.7% (23)	0.329
	II	45.7% (16)	34.3% (12)	

***BMI: Body mass index* , ASA:** American Society of Anesthesiologists

The duration of operation was significantly prolonged in the control group. Isoflurane consumption and blood loss were significantly decreased in ESPB group. Intraoperative consumption of fentanyl, beta-blockers, and nitroglycerine was significantly reduced in the ESPB group. Also, morphine consumption was markedly decreased in the same group. Postoperative agitation was significantly decreased in the same group as well (Table 2).

Table (2): Surgical details and postoperative profile among both groups

		ES group (n= 35)	Control group (n= 35)		p
operated segments	**1**	37.1% (13)	20.0% (7)		0.155
	2	48.6% (17)	71.4% (25)		
	3	14.3% (5)	8.6% (3)		
Duration (minutes) Mean+SD		177.43 ± 34.987	195.86 ± 30.857		**0.022**
Isoflurane consumption (ml) Mean+SD		51.71 ± 11.754	96.57 ± 17.140		**< 0.001**
Intraoperative fentanyl (µg) Mean+SD		30.00 ± 21.828	52.57 ± 29.639	**z=7.06**	**0.001**
Intraoperative beta-blockers		0% (0)	100% (35)		**< 0.001**
Intraoperative nitroglycerine		0% (0)	74.3% (26)		**< 0.001**
Blood loss (ml) Mean+SD		292.86 ± 80.570	464.29 ± 122.217	**z=8.59**	**< 0.001**
RASS score at 30 minutes postoperative median (range)		0 (0, 0)	1 (1, 2)		**< 0.001**
Postoperative Morphine consumption (mg) Mean+SD		2.34 ± 1.056	3.63 ± 1.395	**z=3.89**	**< 0.001**

As shown in figure (3), although heart rate didn't significantly vary among both studied groups before operation, the control group showed significantly higher heart rates compared to ESPB group during and after operation ($p < 0.05$).

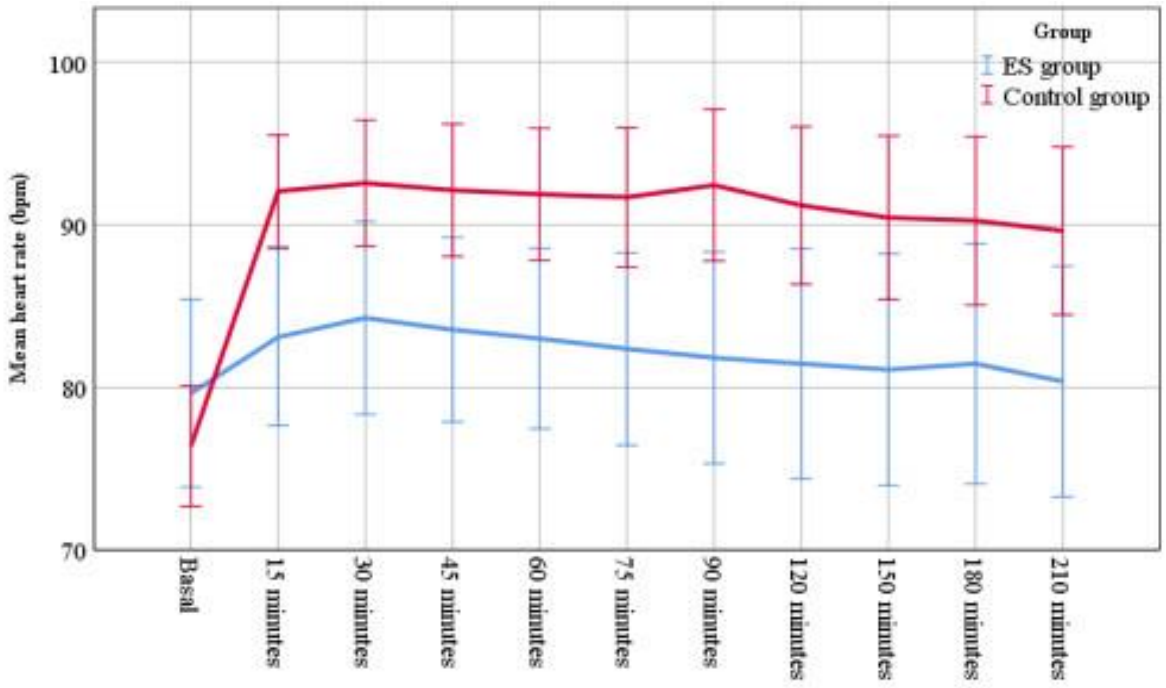

Figure (3): Basal and follow-up heart rate values in the studied groups

As regard MAP, it didn't vary among both groups before operation. Nevertheless, the ESPB group showed higher MAPs throughout the operation ($p < 0.05$) compared to controls (Figure 4).

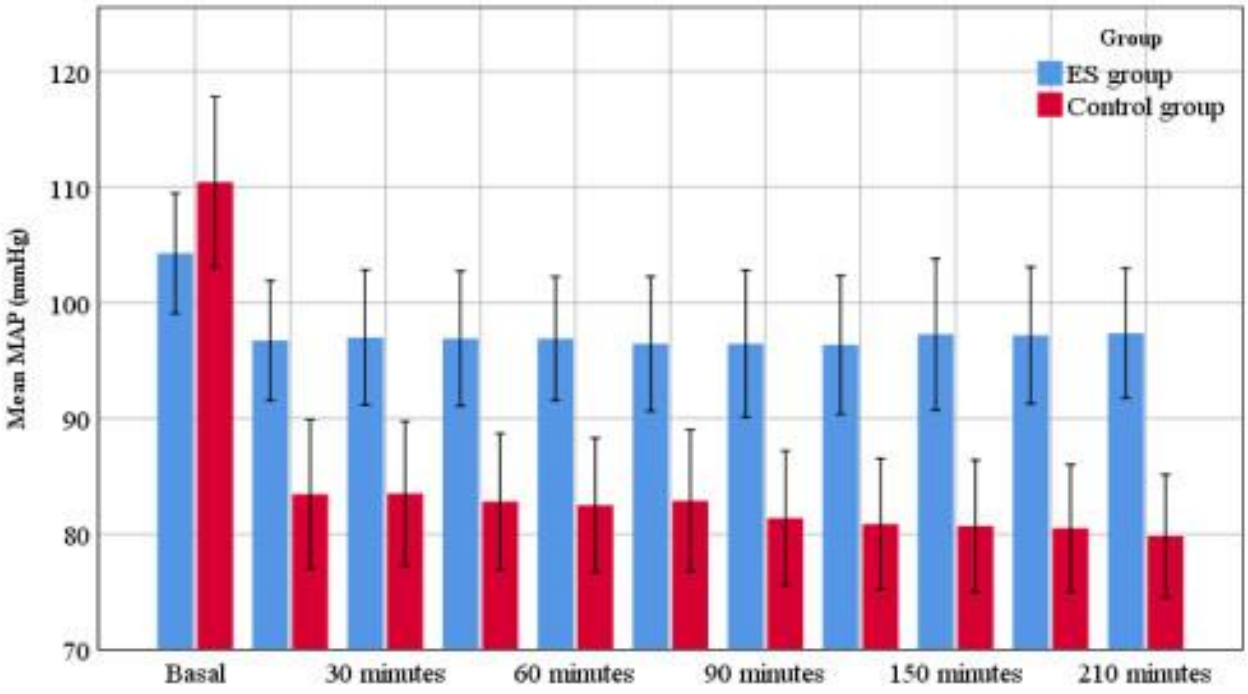

Figure (4): Basal and follow-up mean arterial pressure (MAP) values in the studied groups

Patients in the ESPB group expressed lower VAS during the initial 6 hours following operation. However, no difference was detected among both groups on subsequent assessment.

Table (3): Postoperative VAS score among both groups (Data are presented as mean±standard deviation (SD)

VAS	ESPB group (n= 35)	Control group (n= 35)	z=	p
One hour	1.91 ± 0.818	4.43 ± 1.243	**6.64**	**< 0.001**
Three hours	2.11 ± 0.963	4.11 ± 1.301	**5.61**	**< 0.001**
Six hours	2.34 ± 1.056	3.69 ± 1.345	**4.09**	**< 0.001**
12 hours	2.83 ± 1.124	3.34 ± 1.349	1.56	0.118
24 hours	2.83 ± 1.200	2.77 ± 1.682	0.433	0.665

Z: ***Mann-Whitney test***

Surgeon satisfaction was significantly improved in the ESPB group in comparison with the control group (Table 4).

Table (4): Surgeon satisfaction with regard to intraoperative bleeding and surgical field state in the studied groups

Satisfaction	ESPB group (n= 35)	Control group (n= 35)	p
Poor	0.0% (0)	11.4% (4)	**0.001**
Fair	8.6% (3)	37.1% (13)	
Good	37.1% (13)	28.6% (10)	
Excellent	54.3% (19)	22.9% (8)	

DISCUSSION

This study was conducted at Mansoura University Hospitals aiming to evaluate the safety and feasibility of ESPB in patients undergoing spinal fixation as regard operative hemodynamics, intraoperative bleeding, POP, and surgeon satisfaction. Of note, there is a limited number of researches that handle the efficiency of such blockade technique in spine surgery in the existing literature [13].

Although some of studies discussing ESPB carried out the blockade under ultrasound guidance [13, 18], we carried out this study with fluoroscopy as it was already available in the neurosurgical operative theater. Furthermore, we used the fluoroscopic guided procedure to easily identify the vertebral transverse process, which is the primary landmark for injection. Identification of that landmark is easier to identify by fluoroscopy compared to musculoskeletal ultrasound, which may compromise the block accuracy. Nevertheless, it spares the patient from radiation produced from the fluoroscopy device [19].

In the current study, we noted only caudal diffusion of the dye during injection. The patient was also in the prone position, which excludes the role of gravity. Evidence to date indicates that spread with 12 mL of injectate extends three – four vertebral levels or more from the site of injection in a caudal direction [3, 20]. **Chin and his associates** in their cadaveric study reported that the injected agent had spread from the injection site to 3 or 4 segments in both caudal and cranial directions [2]. Another study has used MRI to evaluate the ways of spread of the blocking agent in ESPB. Epidural and transforaminal spread were confirmed. Authors concluded that ESPB is more advantageous than other thoracic fascial blocks as these ways of spread also provide abdominal visceral analgesia [21].

The findings of our study and prior researches may be attributed to the anatomical fact that, at lower lumbar area, the paraspinal muscles are totally encircled by the erector spinae aponeurosis which spreads to the inferior margin of L3 laterally, while it spreads cranially into the thoracic region medially. Beginning at approximately L5 and below, the erector spinae aponeurosis and the overlying superficial layers fuse tightly making one very thick aponeurotic structure that has an attachment in the lateral aspect with iliac crest at PSIS, joins the gluteus maximus inferolaterally, and ends covering the sacrotuberous ligament that can explain the caudal distribution of the injectate along this fascial plane [22]

In the current study, there was a significant decrease in operative bleeding in the ESPB group (292.86 versus 464.29 ml in controls). Despite, higher MAP was significantly in the ESPB group. The actual explanation may be clarified by two facts; firstly, addition of adrenaline to the injected mixture which causes vasoconstriction, and injection of fluid into the right plane causes more separation making it easier for the surgeon to dissect through the exact anatomical planes which also resulted in a significant decrease in the operative time. Secondly our results showed that intraoperative inhalational anesthetics consumption and, fentanyl dosage were markedly decreased in the ESPB group. Also, heart rate was significantly decreased in the ESPB group indicating better analgesia during operation.

In concomitance to our results, **Li *et al.*** detected more stable hemodynamic parameters with no usage of hypotensive agents with significant difference; the diastolic blood pressure (DBP) and HR were significantly decreased with the ESP group instead of the controls (PDBP<0.001, PHR=0.003) **[14].** Also, **Brandao and his colleagues** have recorded in lumbar spine surgery case received a preoperative bilateral one-shot ESP; the sympathetic stimulation blunting was enough to exclude the need for hypotensive techniques [23] **.**

Moreover, reduction of MAP below 70 mm Hg using hypotensive agents paradoxically resulted in increased intraoperative bleeding because of local vasodilation. Another possible explanation could be an increase in cardiac output (COP) throughout controlled hypotension, which could be induced by reflex tachycardia, in particular when a pure vasodilator (such as sodium nitroprusside) is utilized. Such theoretical concerns are reinforced by clinical observations recorded by **Jacobi and his colleagues** who have displayed that; surgical situations in terms of endoscopic sinus surgeries weren't improved by moderate controlled hypotension (MAP=65–75 mmHg) induced by sodium nitroprusside. Bleeding was greater in the hypotensive group (245 ml versus 278 ml) with no significant differences owing to the major alteration in measurements[24].

So, in the control group in attempt to improve operative bed bleeding during surgery the need for increased isoflurane concentration, and usage of hypotensive agents (nitroglycerine and propranolol) was significantly more than ESPB group, as operative bed bleeding was accepted. Therefore, the need for increasing depth of anesthesia and use of hypotensive agents was markedly decreased. As a result of isoflurane usage in higher concentrations for inducing hypotension sometimes tachycardia is encountered, which necessitated the usage of beta-blockers **[25].** In concurrence with these results **Aujla *et al***. compared use of inhalational anesthetic isoflurane for induction of controlled hypotension with the usage of total intravenous anesthesia (TIVA). Esmolol was studied as a rescue drug for HR control and achieve the MAP desired. They found that isoflurane group received more esmolol in comparison with the TIVA group in the form of more cases **[26].**

This encountered reflex tachycardia to both ; the use of hypotensive agents and increase the concentration of inhalational anesthetic to reach the

desired blood pressure level, also the use of beta-blockers was used as rescue drug to reflex tachycardia explain why the heart rate was greater in the control group in comparison with ESPB group.

Asregard patient recovery, we noticed that RASS was significantly elevated in controls in comparison with the ESPB group, and that could be explained by the reduction of isoflurane consumption [27]. In another study conducted by **Forero and his colleagues** utilizing ESP block associated with general anesthesia, the anesthesia was maintained with minimal anesthetic requirements 0.4–0.7 MAC desflurane **[28].**

After surgery, cases in the ESPB group expressed lower VAS throughout the initial 6 hours after surgery, which resulted in a marked reduction in opioid requirements. However, no difference was found among both studied groups on subsequent assessment.

A previous study has assessed the efficacy of fluoroscopic guided ESPB in fractured ribs. One case showed a significant reduction of pain during breathing and cough. The same patient also expressed a change of sensation extending from T1 to T8 segments. Single-injection had provided a total of 10 hours of analgesia [8].

In a previous retrospective study, authors retrospectively analyzed the data of 41 patients undergoing lumbar spinal surgery. Twenty-three cases received only general anesthesia, while the remaining 18 cases received the ESPB along with general anesthesia (E group). There was a significant reduction in pain scores and fentanyl consumption in the group that received blockade in comparison with the other group [18]. Additionally, another study assessed the efficacy of ESPB at the T10 or T12 level in 6 cases undergoing lumbosacral spine surgery. All cases expressed mild POP and decreased postoperative opioid demands. There was no apparent motor or sensory blockade in all patients and no interference with intraoperative somatosensory evoked potential monitoring utilized in two of the included patients [29]. The previous studies confirmed our findings with regard to pain management.

The distribution of local anesthetic agents along thoracolumbar fascia provides a rational explanation for the effective pain relief as this fascia encompasses the dorsal rami of the spinal nerves [3]. The density of nerves fibers in the posterior layer of the fascia appears to be even greater than that of the underlying muscle **[22].** An additional explanation to our findings, the study conducted by **Tulgar *et al.*** using computerized tomography imaging to demonstrate the spread of local anesthetic to the lumbar plexus, inducing an effect comparable to lumbar plexus blockade [30]. In the same line, **Ahiskalioglu and his colleagues** carried out ESP as the primary anesthesia in the context of hip surgeries, contrast MRI demonstrated local anesthetic distribution to ventral rami of the lumbar and higher roots of the sacral plexuses **[31].**

Surgeon satisfactions were significantly improved in the ESPB group compared to controls. This could be explained by decreased intraoperative bleeding, clear and dry surgical field, better recovery and early assessment of sensory and motor power, lastly decreased postoperative calls for rescue analgesics.

With regard to complications of ESPB, no complications were encountered in our study. A previous study has also reported that there was no complications encountered after application of ESPB [8]. Similar to other fascial plane blocks, ESPB has low risk of complications that may include infection, nerve injury, pneumothorax, or hematoma [1].

Despite the promising outcomes of the current study the following limitations have to be taken into consideration; it is a single-center research, and the comprised number of cases is to some extent small. As a result, additional researches comprising more number of patients from various centers have to be carried out. The range of the blocked nerves should have been assessed as well. Also, the efficacy of other guidance techniques like ultrasound should be compared to fluoroscopy to determine the optimum method for plane blockade guidance.

CONCLUSION

Based on our findings, ESPB appears to be safe and efficacious technique not only in decreasing POP, but also in improving intraoperative hemodynamics, operative bed bleeding, and surgeon satisfaction.

Conflict of Interest: Nil.
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REFERENCES

1. **Hamilton D, Manickam B (2017):** Erector spinae plane block for pain relief in rib fractures. *British Journal of Anaesthesia*, 118(3): 474-5.
2. **Chin K, Adhikary S, Sarwani N *et al.* (2017):** The analgesic efficacy of pre-operative bilateral erector spinae plane (ESP) blocks in patients having ventral hernia repair. *Anaesthesia*, 72(4): 452-60.
3. **Forero M, Adhikary S, Lopez H *et al.* (2016):** The erector spinae plane block: a novel analgesic technique in thoracic neuropathic pain. *Regional Anesthesia and Pain Medicine*, 41(5): 621-7.
4. **Yoshizaki M, Murata H, Ogami T *et al.* (2019):** Bilateral erector spinae plane block using a programmed intermittent bolus technique for pain management after Nuss procedure. *Journal of clinical anesthesia*, 57: 51-2.
5. **Raft J, Chin K, Belanger M *et al.* (2019):** Continuous Erector Spinae Plane Block for thoracotomy analgesia after epidural failure. *Journal of clinical anesthesia*, 54: 132-3.
6. **Kim E, Kwon W, Oh S *et al.* (2018):** The erector spinae plane block for postoperative analgesia after percutaneous nephrolithotomy. *Chinese medical journal*, 131(15): 1877.

7. **Chin K, Lewis S (2019):** Opioid-free analgesia for posterior spinal fusion surgery using erector spinae plane (ESP) blocks in a multimodal anesthetic regimen. *Spine*, 44(6): E379-E83.
8. **Jadon A, Swarupa C, Amir M (2018):** Fluoroscopic-guided erector spinae plane block: A feasible option. *Indian journal of anaesthesia*, 62(10): 806-8.
9. **Gerbershagen H, Aduckathil S, van Wijck A *et al.* (2013):** Pain Intensity on the first day after surgerya prospective cohort study comparing 179 surgical procedures. *Anesthesiology: The Journal of the American Society of Anesthesiologists*, 118(4): 934-44.
10. **Savarese J, Tabler Jr N (2017):** Multimodal analgesia as an alternative to the risks of opioid monotherapy in surgical pain management. *Journal of Healthcare Risk Management*, 37(1): 24-30.
11. **Carli F, Kehlet H, Baldini G *et al.* (2011):** Evidence basis for regional anesthesia in multidisciplinary fast-track surgical care pathways. *Regional Anesthesia and Pain Medicine*, 36(1): 63-72-63-72.
12. **Lenart M, Wong K, Gupta R *et al.* (2012):** The impact of peripheral nerve techniques on hospital stay following major orthopedic surgery. *Pain Medicine*, 13(6): 828-34.
13. **Klesius L, Schroeder K (2019):** Effective analgesia with bilateral erector spinae plane catheters for a patient with traumatic rib and spine fractures. *Case reports in anesthesiology*, 2019: 9159878.
- **14. Li J, Jin Y, Zhao S *et al.* (2020):** Efficacy of ultrasound-guided erector spinae plane block for perioperative pain control and short-term outcomes in lumbar laminoplasty. *DOI:10.1101/2020.01.30.20019745*
15. **Biro P (2014):** Calculation of volatile anaesthetics consumption from agent concentration and fresh gas flow. *Acta anaesthesiologica Scandinavica*, 58(8): 968-72.
16. **Sessler C, Gosnell M, Grap M *et al.* (2002):** The Richmond Agitation–Sedation Scale: validity and reliability in adult intensive care unit patients. *American journal of respiratory and critical care medicine*, 166(10): 1338-44.
17. **Crichton N (2001):** Visual analogue scale (VAS). *Journal of Clinical Nursing*, 10(5): 706-6.
18. **Ueshima H, Inagaki M, Toyone T *et al.* (2019):** Efficacy of the erector spinae plane block for lumbar spinal surgery: a retrospective study. *Asian spine journal*, 13(2): 254-7.
19. **El-Boghdadly K, Pawa A (2017):** The erector spinae plane block: plane and simple. *Anaesthesia*, 72(4): 434-8.
20. **Muñoz F, Cubillos J, Bonilla A *et al.* (2017):** Erector spinae plane block for postoperative analgesia in pediatric oncological thoracic surgery. *Canadian Journal of Anesthesia*, 64(8): 880-2.
21. **Schwartzmann A, Peng P, Maciel M *et al.* (2018):** Mechanism of the erector spinae plane block: insights from a magnetic resonance imaging study. *Canadian Journal of Anesthesia*, 65(10): 1165-6.
22. **Tesarz J, Hoheisel U, Wiedenhöfer B *et al.* (2011):** Sensory innervation of the thoracolumbar fascia in rats and humans. *Neuroscience*, 194: 302-8.
23. **Brandão J, Graça R, Sá M *et al.* (2019):** Lumbar erector spinae plane block: successful control of acute pain after lumbar spine surgery–a clinical report. *Revista Española de Anestesiología y Reanimación (English Edition)*, 66(3): 167-71.
24. **Jacobi K, Böhm B, Rickauer A *et al.* (2000):** Moderate controlled hypotension with sodium nitroprusside does not improve surgical conditions or decrease blood loss in endoscopic sinus surgery. *Journal of clinical anesthesia*, 12(3): 202-7.
25. **Luis J, DeLaCallel A, Forero M (2020):** Multimodal anesthesia via opioid-free analgesia and erector spinae plane block. *Case reports in anesthesiology*, 2020: 5.
26. **Aujla K, Kaur M, Gupta R *et al.* (2017):** A study to compare the quality of surgical field using total intravenous anesthesia (with propofol) versus inhalational anesthesia (with isoflurane) for functional endoscopic sinus surgeries. *Anesthesia, essays and researches*, 11(3): 606.
27. **Meyer R, Muenster P, Werner C *et al.* (2007):** Isoflurane is associated with a similar incidence of emergence agitation/delirium as sevoflurane in young children–a randomized controlled study. *Pediatric Anesthesia*, 17(1): 56-60.
28. **Forero M, Rajarathinam M, Adhikary S *et al.* (2017):** Continuous erector spinae plane block for rescue analgesia in thoracotomy after epidural failure: a case report. *A&A Practice*, 8(10): 254-6.
29. **Melvin J, Schrot R, Chu G *et al.* (2018):** Low thoracic erector spinae plane block for perioperative analgesia in lumbosacral spine surgery: a case series. *Canadian Journal of Anesthesia/Journal canadien d'anesthésie*, 65(9): 1057-65.
30. **Tulgar S, Selvi O, Senturk O *et al.* (2018):** Clinical experiences of ultrasound-guided lumbar erector spinae plane block for hip joint and proximal femur surgeries. *Journal of Clinical Anesthesia*, 47: 5-6.
31. **Ahiskalioglu A, Tulgar S, Celik M *et al.* (2020):** Lumbar erector spinae plane block as a main anesthetic method for hip surgery in high risk elderly patients: initial experience with a magnetic resonance imaging. *The Eurasian journal of medicine*, 52(1): 16-20.