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ANALGESIC EFFICACY OF BILATERAL ULTRASOUND GUIDED ERECTOR SPINAE PLANE BLOCK IN LUMBAR SPINE SURGERIES

By

Abd El-Rahman Mohammed Abd El-Fattah El-Maghraby, Ayman Hussein Fahmy Mohammed Kahla and Othman Saad El-Deen Yahia Mousa

Department of Anesthesiology and Intensive Care, Faculty of Medicine, Al-Azhar University

Corresponding author: Abd El-Rahman M. A. Maghraby;

Mobile: 01121153132; **E-mail:** drabdelrahmanelmaghraby@gmail.com

ABSTRACT

Background: Pain after lumbar spine surgery is often difficult to control in the postoperative period. Traditionally, opioids have been the mainstay of treatment but are associated with many unwanted side effects and prolonged hospital stay. The ultrasound-guided erector spinae plane block (ESPB) is a relatively safe, simple technique. However, there are few controlled studies evaluating its efficacy.

Objective: To evaluate the analgesic efficacy of bilateral ultrasound-guided erector spinae plane block in lumbar spine surgeries.

Patients and Methods: This study included 50 patients of both sexes admitted for lumbar surgery at the Al-Hussein University Hospital from December 2019 to August 2020. They were randomly allocated into two groups: Control group (general anesthesia without ESPBP), and ESPB Group: included general anesthesia and bilateral ultrasound-guided erector spinae plane block. The following parameters were assessed in the two studied groups: Heart rate, mean arterial blood pressure, arterial oxygen saturation, end-tidal CO2, recovery profile, time of patient ambulation, visual analog score pain scores (VAS), Ramsay Sedation Scale scores, first request for postoperative analgesia, adverse events, the level of the patient satisfaction, and total dose of postoperative nalbuphine consumption.

Results: This study showed a significant statistical difference regarding the postoperative VAS pain scores between the two groups. Patients who received ESPB had improved post-operative analgesia, better patients' satisfaction, and earlier patient ambulation.

Conclusion: Bilateral ultrasound-guided erector spinae plane block in lumbar spine surgeries is one of the most advantageous adjuvant blocks for improving post-operative pain relief and reducing opioid use and subsequently side effects.

Keywords: Erector Spinae, Postoperative Nalbuphine Consumption, Lumbar Surgery.

INTRODUCTION

Postoperative pain management is a significant problem following spinal surgery. Post-operative pain that cannot be well controlled may lead to delayed mobilization, pulmonary and thromboembolic complications, prolonged hospital stays, and chronic pain syndromes. Effective post-operative pain management can also contribute to better surgical outcomes *(Devin and McGirt, 2015).*

Opioid-based analgesia plays a significant role in the control of postsurgical pain after lumbar surgery; however, use of opioid may lead to significant side effects (e.g., nausea and vomiting) and adverse events (e.g. respiratory depression), which may be associated with significantly longer hospital stays and higher hospital costs in the postsurgical setting *(Calandese and Adduci, 2019).*

Since these adverse events occur more often in patients receiving higher doses of opioids, it is important to find ways to reduce opioid use in the post-operative period after lumbar spine surgery. Bilateral Ultrasound-Guided Erector Spinae Plane Block in Lumbar Spine Surgeries is a way to improve post-operative pain control and reduce opioid use *(Ding et al., 2014).*

Erector spinae plane block (ESPB) is an interfacial plane block first described by *Forero et al. (2016)* as an effective treatment method for treating thoracic neuropathic pain. Currently, the ESP block is performed as one of the pain management procedures for patients of all generations undergoing abdominal and thoracic surgeries with minimal complications compared to opioid consumption *(Ueshima and Otake, 2017).*

The aim of this study was to evaluate the analgesic efficacy of bilateral ultrasound-guided erector spinae plane block in lumbar spine surgery.

PATIENTS AND METHODS

This study was a prospective, double-blinded, and controlled randomized study conducted at the Al-Hussein University Hospital, following approval from the department and institution ethics committee. Following patients informed consent, 50 patients undergoing lumbar spine surgery of the following criteria were conducted for this study.

Inclusion criteria:

1. Both genders.
2. Aged 21-60 years.
3. With American Society of Anesthesiologists' (ASA) physical status I or II.
4. BMI less than or equal to 30.
5. The patients have no renal, lung, heart, or liver disorders found on clinical and biochemical tests.

Exclusion criteria:

1. Patient refusal.
2. Pregnant females.
3. Communication difficulties which might prevent a reliable postoperative assessment.
4. Contraindication to regional anesthesia (bleeding disorder, use of any anticoagulants, local infection, etc.).
5. Known allergy to local anesthetics.

Duration of Study: From December 2019 to August 2020.

Primary outcome was the total nalbuphine consumption during the first 24 hours after surgery.

Secondary outcome was to evaluate of pain scores, the incidence of opioid-related side effects, post-operative nausea and vomiting (PONV), patient satisfaction, and the incidence of complications such as nerve injury,

hematoma formation, and local anesthetic toxicity.

Patients were randomly allocated into two equal groups:

- ESPB Group received bilateral ultrasound-guided ESPB following standard general anesthesia technique.
- Control Group received general anesthesia without ESPB.

All patients were screened for suitability by history, American anesthesiologists' physical status assessment, physical examination of heart and chest, and complete investigations (CBC, coagulation profile, liver function, kidney function, and electrocardiogram). Standard patient monitoring was applied by pulse oximetry, ECG, Non-invasive blood pressure monitoring, and capnography.

Preoxygenation with 100% oxygen was done for three minutes. General anesthesia was induced with an injection of nalbuphine (0.1 mg/kg), and propofol (2 mg/kg), followed by atracurium (0.5 mg/kg) to facilitate orotracheal intubation. Anesthesia was maintained using isoflurane in an air/oxygen mixture. Intermittent bolus of atracurium was given to achieve muscle relaxation. Minute ventilation was adjusted to maintain normocapnia (end-tidal carbon dioxide; EtCO2, between 34 - 38 mmHg).

In ESPB Group, a high-frequency linear ultrasound transducer was sagittally placed against the vertebral target level in the prone position and moved in approximately 3 cm lateral to the spinous process. The erector spinae muscle and transverse muscle were then identified, and a needle was advanced through the interfacial plane between the erector spinae and the underlying transverse process. After that, the local anesthetic was administered into space 2 ml of saline solution was injected to confirm the erector spinae muscle plane. The bilateral ESP blocks was performed by injecting 40 ml of 0.25% bupivacaine (20 mL into each side) into the fascial plane between the deep surface of the erector spinae muscle, and the lumbar transverse processes vertebrae for pain management after lumbar spinal surgery.

At the end of the surgery, anesthesia discontinued, and residual neuromuscular blockade was antagonized with neostigmine (0.08 mg/kg) and atropine (0.02 mg/kg), followed by extubation. When the patients became fully awake, patients transferred to the post anesthesia care unit (PACU). All patients in the study were subjected to paracetamol (1g) infusion intravenously every 8 hours. Patients were allowed to receive incremental doses of nalbuphine 2 mg intravenously if VAS pain score was ≥4.

Measured parameters:

1. Noninvasive mean arterial pressure (MAP).
2. Heart rate (HR).
3. SpO2.
4. End-tidal CO2.
5. Intraoperative blood loss.
6. Recovery profile assesses by measuring tracheal extubation time, time to eye-opening, time to follow verbal commands; starting from the end of surgery and discontinuation of inhalational anesthetics.
7. Time of ambulation.

8. Total nalbuphine need in the first 24 hours.
9. Post-operative pain assessment using VAS scores.
10. Level of postoperative sedation: is assessed by the Ramsay Sedation Scale.
11. Postoperative nausea and vomiting.
12. Patients' satisfaction was assessed 24 and 48 hours postoperatively.
13. Incidence of complications: such as nerve injury, hematoma formation, local anesthetic toxicity, and intravascular injection.

All parameters were postoperatively recorded at 2 hr, 4 hr, 8 hr, 12 hr, 16 hr, 20 hr and 24 hours by an independent anesthesiologist, who was unaware of the group allocation.

Statistical method:

Recorded data were analyzed using the statistical package for the social sciences version. 23.0 (SPSS Inc., Chicago, USA). Quantitative data were expressed as mean ± standard deviation (SD). Qualitative data were expressed as frequency and percentage. The confidence interval was set to 95% and the margin of error accepted was set to 5%. Comparison between the two groups was performed using unpaired Student's t-tests for parametric data and Mann–Whitney test for nonparametric ordinal data. For data collected as proportions, $\chi 2$-test was performed. A P-value less than 0.05 was considered statistically significant.

RESULTS

No statistically significant differences between the two studied groups regarding patients' and operative characteristics in the form of age, gender, weight, height, BMI, ASA classification and surgical time (P value >0.05) **(Table 1)**.

Table (1): Patients and operative characteristics in both studied groups

Groups / Variables	ESPB Group (n=25)	Control Group (n=25)	P Value
Age (years)	33.20 ± 8.93	32.60 ± 8.48	> 0.05
Gender (Male/Female)	11 (44 %)	13 (52.0%)	> 0.05
	14 (56%)	12 (48%)	
Weight (Kg)	75.64 ± 9.34	81.52 ± 13.44	> 0.05
Height (cm)	174.56 ± 6.98	177.24 ± 8.73	> 0.05
BMI (kg/m2)	22.48 ± 2.01	22.60 ± 2.10	> 0.05
ASA (I/II)	17 (68 %)	17 (68 %)	> 0.05
	8 (32 %)	8 (32 %)	
Surgical Time (min.)	136.40 ± 34.23	131.20 ± 39.03	> 0.05
Anesthesia Time (min.)	149.40 ± 36.23	136.20 ± 40.03	> 0.05

Data were represented as mean ±SD or number (Proportion).
ASA; American Society of Anesthesiologists. Unpaired t-test, Chi-Square test.

The heart rate was found significantly lower in ESPB group than control group at 30 min, 45, 60, 75, 90, 105, 120 and 135 min (P value <0.05); while no statistically significant difference at 150 min and at end of surgery with P value >0.05 **(Table 2)**.

Table (2): Intraoperative heart rate changes in both studied groups

Groups / Variables	ESPB Group (n=25)	Control Group (n=25)	P Value
Baseline	92.80 ± 9.93	91.72 ± 5.71	> 0.05
15 min	87.60 ± 5.20	90.80 ± 8.57	> 0.05
30 min	81.20 ± 5.61	86.92 ± 8.48	0.007
45 min	77.76 ± 4.96	84.00 ± 8.13	0.002
60 min	75.80 ± 6.47	82.88 ± 8.07	0.001
75 min	73.00 ± 6.46	81.72 ± 12.35	0.003
90 min	69.52 ± 5.33	80.88 ± 15.28	0.001
105 min	69.32 ± 6.95	78.04 ± 13.20	0.005
120 min	66.08 ± 6.67	75.20 ± 13.60	0.004
135 min	66.40 ± 6.87	73.04 ± 13.65	0.035
150 min	68.60 ± 8.63	74.16 ± 12.90	> 0.05
End of Surgery	69.24 ± 6.97	74.56 ± 14.08	> 0.05
Data are represented as mean ±SD Unpaired t-test.			

In respect to comparing intraoperative MAP measurements between study groups, it observed statistically significant differences at 45, 60, 75, 90, 105, 120, 135, 150 min and at end of surgery with P value <0.001 **(Table 3)**.

Table (3): Intraoperative mean arterial pressure changes in both studied groups.

Groups / Variables	ESPB Group (n=25)	Control Group (n=25)	P Value
Baseline	97.49 ± 9.63	96.27 ± 8.43	> 0.05
15 min	93.27 ± 8.89	90.89 ± 9.37	> 0.05
30 min	85.93 ± 7.75	88.93 ± 10.06	> 0.05
45 min	77.47 ± 5.27	86.19 ± 10.19	< 0.001
60 min	72.71 ± 4.16	82.31 ± 10.87	< 0.001
75 min	68.49 ± 4.93	77.35 ± 9.91	< 0.001
90 min	63.25 ± 3.62	76.00 ± 9.65	< 0.001
105 min	59.33 ± 0.76	74.48 ± 10.17	< 0.001
120 min	59.68 ± 0.44	76.27 ± 7.76	< 0.001
135 min	59.24 ± 0.57	74.48 ± 10.17	< 0.001
150 min	59.61 ± 0.48	75.60 ± 9.69	< 0.001
End of Surgery	62.77 ± 0.51	75.60 ± 9.69	< 0.001
Data were represented as mean ±SD. Unpaired t-test.			

On comparing the recovery profile of the two studied groups, there was highly a significant difference with P value <0.01 **(Table 4)**.

Table (4): Recovery profile characteristics in both studied groups

Variables \ Groups	ESPB Group (n=25)	Control Group (n=25)	P Value
Time of Recovery (min)	10.24 ± 3.35	17.72 ± 5.10	< 0.01
Time to eye opening (min)	6.36 ± 2.86	10.52 ± 3.77	< 0.01
Time to verbal command (min)	7.96 ± 3.27	14.12 ± 4.50	< 0.01
Time of extubation (min)	10.24 ± 3.35	17.72 ± 5.10	< 0.01
Data are represented as mean ±SD. Unpaired t-test.			

There was a statistically significant difference between the two studied groups regarding VAS pain scores at 12th hour post-operative with p-value < 0.01. Thereafter, there was no statistically significant difference between the two studied groups till the end of the study with p-value >0.05 **(Table 5)**.

Table (5): Postoperative Visual analogue score pain scores evaluation in both studied groups

Variables \ Groups	ESPB Group (n=25)	Control Group (n=25)	P Value
PACU	2 (2 - 2)	3 (1 - 3)	>0.05
2 hr	2 (1 - 2)	5 (3 - 5)	< 0.01
4 hr	2 (1 - 2)	5 (3 - 5)	< 0.01
8 hr	3 (3 - 3)	5 (3 - 5)	< 0.01
12 hr	4 (3 - 4)	5 (4 - 6)	>0.05
16 hr	4 (4 - 5)	5 (3 - 5)	>0.05
20 hr	4 (4 - 5)	5 (3 - 5)	>0.05
24 hr	4 (4 - 5)	4 (4 - 5)	>0.05
Data were represented as median (interquartile range). Mann Whitney test.			

There was a statistically significant difference between the two studied groups regarding number of patients requested nalbuphine postoperative at the different time intervals of the first postoperative day (P value <0.05) **(Table 6)**.

Table (6): Rescue analgesic requirement in both studied groups

Variables \ Groups	ESPB Group (n=25)	Control Group (n=25)	P Value
PACU	0 (0%)	4 (16%)	0.037
2 hr	0 (0%)	13 (52%)	< 0.01
4 hr	0 (0%)	15 (60%)	< 0.01
8 hr	0 (0%)	17 (68%)	0.001
12 hr	6 (24%)	13 (52%)	0.041
16 hr	8 (23%)	19 (76%)	0.002
20 hr	6 (24%)	13 (52%)	0.041
24 hr	9 (36%)	17 (52%)	0.024
Data were represented as number (Percentage). Chi-square test.			

There was statistically significant difference between the two studied groups regarding the total consumption of nalbuphine use in the first 24 hrs. in mg, duration of pain relief in an hour, and time of ambulation per hour (P value <0.01) **(Table 7)**.

Table (7): Postoperative analgesia and ambulation characteristics in both studied groups

Variables \ Groups	ESPB Group (n=25)	Control Group (n=25)	P Value
Nalbuphine Consumption (mg)	4.80 ± 1.26	9.48 ± 5.70	< 0.01
Analgesic Duration (hr)	15.20 ± 4.55	3.84 ± 3.90	< 0.01
Ambulation Time (hr)	2.65 ± 0.66	5.24 ± 2.16	< 0.01
Data were represented as mean ±SD. Unpaired t-test			

Moreover, patients' satisfaction scores in the first 24 hours was significantly better versus the control group (P value <0.01), whereas, no significant difference in the second day (P value >0.05). Furthermore, there were no significant complications reported in the two studied groups. This study did not reveal significant difference between the two studied groups as regard intraoperative blood loss (P value > 0.05) **(Table 8)**.

Table (8): Evaluation of patients' satisfaction score in both studied groups

Variables \ Groups		ESPB Group (n=25)		Control Group (n=25)		P-Value
		No.	%	No.	%	
24 hr	**Poor**	0	0 %	2	8 %	< 0.01
	Fair	0	0 %	23	92 %	
	Good	21	84 %	0	0 %	
	Excellent	4	16 %	0	0 %	
48 hr	**Poor**	3	12 %	6	24 %	>0.05
	Fair	18	72 %	19	76 %	
	Good	4	16 %	0	0 %	
	Excellent	0	0 %	0	0 %	
Data were represented as number (Proportion). Chi-square test						

DISCUSSION

The current study revealed a reduction in post-operative pain incidence and severity, which was demonstrated by comparing the visual analog scale (VAS) measurements among the two study groups. VAS pain scores in ESPB Group were lower than in the control group in the first 12 hours. Also, it showed that the time needed to give the first dose of systemic opioid analgesia after the operation was longer in ESPB group than in control group. The patients' number who required analgesic in ESPB group was less than in control group and the total consumption of required opioid analgesic in ESPB group was less than in control group.

Moreover, the present study showed statistically significant differences

regarding intraoperative hemodynamics in the two study groups (heart rate and MAP). Meanwhile, there were no significant differences in SPO2, ETCO2 and intraoperative blood loss. Patient's satisfaction scores were significantly higher in ESPB group versus control group. There were non-significant reported postoperative complications as respiratory depression, nausea, vomiting, and pruritis.

These results were in agreement with a previous study done by *Altiparmak et al. (2019)* that prove the efficacy of ultrasound-guided erector spinae plane block for analgesia after laparoscopic cholecystectomy and noted significant variations in heart rates overtime, the patients' MAP values differed significantly at different time points.

The current results were in consistence with the retrospective results of *Ueshima et al. (2019)* ESP block provides effective postoperative analgesic effect for 24 hours in patients undergoing lumbar spinal surgery.

A similar previous study published by *Singh et al. (2020)* showed that post-operative pain score, number of patients requiring rescue analgesia, and total morphine consumption during the first 24 Post-operative hours were recorded. Patient satisfaction was assessed 24 hours after surgery. Results showed post-operative morphine consumption was significantly lower in patients in the ESPB group compared with those in the control group. Pain scores were lower in the ESPB group compared with the control group. Patient satisfaction scores were more favorable in the block group. They concluded that US-guided ESP block reduces post-operative opioid requirement and improves patient satisfaction compared with standard analgesia in lumbar spine surgery patients.

These results were comparable to the results of *Karaca and Pınar (2020)* who reported efficacy of Ultrasound-Guided Erector Spinae Plane Block for postoperative Analgesia in laparoscopic cholecystectomy. The control group who received only intravenous patient-controlled analgesia (PCA) and the ESPB group who received bilateral ESPB (bupivacaine 0.25, 50 mL) and IV PCA found that Numeric rating scores in Group ESPB were lower in the post anesthesia care unit at 1st, 2nd, 4th, 6th hours, and 8th hour. The fentanyl consumption during postoperative period was lower in ESPB Group. PACU and hospital stay was shorter in ESPB group. Intraoperative fentanyl requirement was lower in Group E. Unassisted walking time was shorter in ESPB Group and no block related complications were encountered.

Another study done by *Aksu et al. (2019)* who investigated the effect of Erector Spinae Plane Block on postoperative pain following laparoscopic cholecystectomy showed postoperative morphine consumption was significantly lower in patients in the ESP block group compared with those in the control group. All patients in the control group required supplemental morphine compared with the ESP block group. Pain scores were lower in the ESP block group than the control.

CONCLUSION

Use of ultrasound-guided erector spinae plane block significantly reduced postoperative nalbuphine consumption and pain scores in the first 24h after

lumbar spine surgeries and thus it represented a reliable safe method for postoperative pain relief.

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فاعليه تسكين الألم للإحصار ذو الجانبين لمستوي عضلات ناصبة الفقار الموجه بالموجات فوق الصوتية في جراحات الفقرات القطنية

عبد الرحمن محمد عبد الفتاح المغربي، أيمن حسين فهمي محمد كحله، عثمان سعد الدين يحيى موسي

قسم التخدير والرعاية المركزة، كلية الطب، جامعة الازهر

E-mail: drabdelrahmanelmaghraby@gmail.com

خلفيــة البحــث: تعتبــر جراحــات الفقــرات القطنيــة مــن الجراحــات الشــائعة والتــي تكــون مقرونــة بحــدوث آلام حــادة قــد تــؤثر علــى حركــة المرضــى وتطيــل فتــرة الإقامــة بالمستشفى وتزيد من إحتمالية حدوث بعض المضاعفات المرضية.

الهــدف مــن البحــث: تهـدف هـذه الدراسـة إلـى مقارنـة مـدي كفـاءة وفاعليـة تسـكين الألـم للإحصـار ذو الجـانبين لمسـتوي عضـلات ناصـبة الفقـار الموجـه بالموجـات الفـوق صوتية في جراحات الفقرات القطنية.

المرضــي وطــرق البحــث: أجريـت هـذه الدراسـة فـي مستشـفى الحسـين الجـامعي، بعـد موافقـة لجنـة الأخلاقيـات الطبيـة فـي قسـم التخـدير والرعايـة المركـزة وجامعـة الأزهـر، وبعـد موافقـة المرضـى علـى الخضـوع للدراسـة، وشـملت هـذه الدراسـة 50 مريضـاً بالغـاً حسـب الجمعيـة الأمريكيـة لأطبـاء التخـدير مـن الوضـع البـدني الأول والثـاني مـن كـلا الجنسـين الـذين تتـراوح اعمـارهم بـين 21 الـي 60 سـنة، أثنـاء الفتـرة مـن ديسـمبر2019 حتـى أغسـطس 2020، مـع مؤشـر كتلـة الجسـم أقـل مـن أو يسـاوي 30 لجراحـات الفقـرات القطنيـة، حيـث تـم تقسـيم المرضـي عشـوائياً إلـي مجمـوعتين متساويتين.

- **المجموعــة الاولــي:** شـملت إحصـار ذو الجـانبين لمسـتوي عضـلات ناصـبة الفقـار الموجـه بالموجـات الفـوق صـوتية بعـد إجـراء التخـدير الكلـي حيـث تـم حقـن 20 مليليتـر مـن عقـار بيوبيفـاكين (0.25 %) علـى جـانبي مسـتوى الفقـرة القطنية المستهدفة.

- **المجموعة الثانية الضابطة:** شملت إجراء التخدير الكلي دون اجراء إحصار لمستوي عضلات ناصبة الفقار.

نتائج البحث: قدمت تقنية الإحصار ذو الجانبين لعضلات ناصبة الفقار الموجه بالموجات فوق الصوتية تسكينًا مطولاً ملحوظاً للألم بعد العملية الجراحية، وقللت من متطلبات المسكنات المخدرة للمرضى بعد العملية، وكذلك أدت إلى تحسين معدل رضاء المرضى.

الاستنتاج: تشكل تقنية إحصار عضلات ناصبة الفقار ذو الجانبين بالموجات الفوق صوتية في جراحات الفقرات القطنية طريقة آمنة وفعالة لتسكين الألم بعد جراحات الفقرات القطنية وتقليل الاستهلاك الكلى للمسكنات المخدرة دون حدوث أية مضاعفات أو اثار جانبية غير مرغوبة.

الكلمات الدالة : جراحات الفقرات القطنية، عضلات ناصبة الفقار.