Unleashing the Power of the Erector Spinae Plane Block: Enhancing Post-Operative Analgesia in Lumbar Spine Surgery

Original Article

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ABSTRACT

Introduction: The emerging role of Bilateral Ultrasound-Guided Erector Spinae Plane (ESP) Block as a novel and promising technique for Effective postoperative pain management needs to be evaluated after lumbar spine surgery.

Materials and Methods: Prospective, randomized single blinded study. ASA I and II patients in age group of 18-65 years posted for lumbar spine surgery. Patients were randomised in two groups of 30 each.

Group A received ultra sound guided ESP block with 0.2% ropivacaine postoperatively before extubation.

Group B did not receive block and analgesic was given once VAS >4. Postoperative vital parameters and VAS scores were assessed at regular intervals up to 24 hours.

Results: In the ESPB group, prolonged duration of analgesia (10.01±1.89 hours VS 2.11±0.82 hours) was noted when compared with non-ESPB group (p value <0.05). The Visual Analog Scale (VAS) scores in ESPB group were significantly lower than non-ESPB group (p value <0.05). Hemodynamic parameters were significantly stable in ESPB group than non ESPB group (p<0.05)

Conclusion: To conclude, bilateral US-guided ESP block is an effective way of providing prolonged postoperative analgesia after lumbar spine surgery with reduced requirement of rescue analgesics in the first 24 hours without any complications.

Key Words: Multimodal analgesia, postoperative pain, ropivacaine, spine surgery.

Received: 29 July 2024**, Accepted:** 23 August 2024

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ISSN: 2090-925X, Vol.17, No.1, 2025

INTRODUCTION

Spine surgery, encompassing a spectrum of procedures from degenerative interventions to trauma-related surgeries, holds *a* pivotal place in contemporary surgical practice. The success of these interventions not only relies on surgical precision but is equally dependent upon the meticulous orchestration of postoperative care. Thus, it is of paramount importance to manage post operative pain effectively, in order to facilitate early patient recovery thus reducing postoperative complications.

Historically, the correlation between postoperative pain control and early mobilization has been well-established. The benefits of early ambulation after spine surgery are multifaceted, encompassing enhanced respiratory function, reduced risk of thromboembolic events and accelerated restoration of physical functionality. A fundamental prerequisite for achieving early mobilization lies in the successful alleviation of postoperative pain, prompting a continuous exploration for novel and efficacious analgesic techniques.

In recent years, regional anaesthesia has emerged as an important modality of refined pain management. One such innovative approach gaining importance is the Erector Spinae Plane (ESP) block. First introduced by Forero *et al.*, in 2016 the ESP block involves the deposition of local anaesthetic in the plane deep to the erector spinae muscle[1]. This technique has since shown promise in providing targeted analgesia for a variety of surgical procedures, owing to its simplicity, safety, and potential for widespread application.

As we delve into the application of bilateral ultrasound (USG)-guided ESP blocks for postoperative analgesia in lumbar spine surgery, our exploration builds upon the foundational work of prior studies stating the ease of administration and feasibility[2,3].

Our hypothesis posits that the ESP block will emerge as a superior modality for postoperative analgesia through its well-defined anatomical targeting and reported efficacy in other surgical domains. The outcomes of this investigation are anticipated to augment the evolving discourse on pain management strategies in spine surgery.

DOI: 10.21608/ASJA.2024.282235.1091

The primary aim of this study was to assess the duration of post-operative analgesia in patients undergoing lumbar spine surgery receiving ESP block postoperatively.

The Secondary objectives included assessment of the total requirement of rescue analgesic dosages in the first 24 hours after surgery, haemodynamic changes in response to pain during the first 24 hours after surgery and Postoperative complications if any.

MATERIALS AND METHODS

This study was conducted in a tertiary care hospital after the institutional Ethical committee clearance. Ours was a prospective, randomized single blinded study conducted from March 2022 to October 2023 in complete accordance with Declaration of Helsinki. Both male and female patients aged between 18-65 years scheduled for elective surgical procedures of spine (prolapsed lumbar intervertebral disc, lumbar stenosis, laminectomy), under General Anaesthesia, belonging to ASA physical status I & II, with valid informed consent were enrolled for the study.

The subjects were selected by computer generated random number table and divided in 2 groups of 30 each.

Patients with Local skin infections at the site of block, deranged coagulation profile or on anti-coagulant therapy and BMI >30 were excluded from the study.

A detailed preanesthetic examination was conducted assessing: general condition of the patient, Airway assessment, Mallampati grading (to assess the ease of intubation), Body weight of the patient (to calculate drug doses as per body weight) and detailed systemic examination. Routine laboratory investigations including haemoglobin estimation, Urine examination for albumin, sugar and microscopy, Blood sugar, Liver Function Test, Renal Function Test, Prothrombin Time/International Normalized Ratio, electroencephalogram, chest *X*-Ray. All patients included in the study were kept nil per oral 8 hours prior to surgery. In the preoperative room, the baseline vital parameters including systolic blood pressure, diastolic blood pressure, mean arterial pressure and heart rate were recorded. In the Operation Theatre multiparameter monitor was connected for continuous monitoring of heart rate, Systolic, Diastolic and Mean Arterial blood Pressure, End Tidal Co_2, Electrocardiogram and oxygen saturation. After recording the baseline readings, all patients were premedicated with intravenous (IV) glycopyrrolate (4mcg/kg), midazolam 0.03mg/kg, IV fentanyl (2µg/kg). The patients were pre-oxygenated for 3 minutes via face mask. Induction of anaesthesia was done with Inj. Propofol (2mg/kg) till loss of verbal response. Endotracheal intubation was facilitated with Inj. Vecuronium 0.1mg/kg IV. Laryngoscopy and orotracheal intubation were performed using appropriately sized Macintosh blade and after confirmation of bilateral equal air entry, the endotracheal tube was fixed. Anaesthesia was maintained using 50% each of nitrous oxide and oxygen with sevoflurane. Inj. Vecuronium was used intermittently to maintain the muscle relaxation. Intra-operative analgesia was maintained with Inj. Paracetamol 1gm IV.

After completion of the surgery, under all aseptic precautions Ultrasound guided Erector Spinae Block was given with Inj. Ropivacaine 0.2% 20ml on each side of target vertebral level using 22 gauge spinal needle in the prone position, to all patients in group A. The transducer was placed in a transverse position on the target spinous process laterally. The transducer was then turned into a sagittal position, and the landmarks (trapezius muscle, erector spinae muscle, and transverse process) were identified. The needle was inserted in a cephalad to caudad orientation, and an in-plane technique was used in order to identify its correct position. The needle was advanced slowly until its tip reached the fascia between the transverse process and the erector spinae muscle. The same procedure was repeated on opposite side. Group B patients did not receive the block. The procedure was performed by the experienced anaesthesiologist.

At the end of the procedure neuromuscular block was reversed with Inj. neostigmine 0.05mg/kg body weight and Inj. glycopyrrolate 8mcg/kg. All patients were extubated as per extubation guidelines. All the patients were monitored postoperatively for pain using Visual Analogue Score (VAS) which was assessed every 30mins until 2 hours and later at 2, 4, 6, 8, 12, 24 hours. The anaesthesiologist observing the pain scores post operatively was blinded to the patient's group and the intervention done. If VAS score was 4 or >4 then inj. tramadol 2mg/kg IV was administered as the rescue analgesic.

Parameters observed

Total duration of post-operative analgesi (Time interval between study procedure to first requirement of rescue analgesia in hours), Heart Rate, Mean Arterial Blood Pressure, No. of Rescue Analgesic Dosages Required in 24 Hours After Surgery.

Any Complications like muscle weakness, local anaesthetic systemic toxicity or pneumothorax were noted[4].

Hemodynamic parameters of patients including systolic BP (SBP), diastolic BP (DBP), mean arterial pressure (MAP), and heart rate (HR), were recorded At T_0 (Baseline), T_1 immediately before Extubation, T_2 (immediately after extubation) and later at 30min, 2, 4, 6, 8, 12, 24 hours postoperatively.

Hypotension was defined as reduction in SBP ≥20% of baseline value. Tachycardia was defined as increase in HR ≥25% of baseline value. Bradycardia was defined as reduction in HR ≥20% of baseline value.

Statistical analysis

Based on the previous study by Singh *et al.*,[5] and taking the alpha error of 80%, considering a 50% reduction in postoperative pain scores the minimum number of patients required were 20 in each group. We enrolled 60 patients to consider any dropouts from the study.

Differences between 2 groups were calculated using Mann Whitney *U* test for normally distributed continuous and non-continuous data. Categorical data were analysed using Fisher Exact test. A *p* value <0.05 was considered statistically significant.

RESULTS

Both the groups under study were comparable to each other with respect to age, weight, sex and ASA physical status (Table1).

Table 1: Comparison of Demographic Data:

Variable	Group A (*N*=30)	Group B (*N*=30)	*p* value
age (years)	53.30±13.67	47.43±13.74	0.13
weight (kg)	64.60±12.17	69.72±16.32	0.12
sex (m/f)	15/15	15/15	-
asa physical status (i/ii)	14/16	15/15	-

Mean±Std deviation.

Heart rate was measured at baseline and multiple time points up to 24 hours post-surgery. At baseline, there was no statistically significant difference in heart rate between Group A (87.6 bpm) and Group B (82.6 bpm) with a *p*-value of 0.15. After 30 minutes, heart rate became statistically significantly lower in Group A compared to Group B. This statistically significant difference persisted at all subsequent time points through 24 hours (Table 2, Figure1).

Table 2: Comparison of Heart Rate in two groups at different time points:

Time (Hrs)	Group A (*N*=30)	Group B (*N*=30)	*P* value
Baseline	87.6±9.25	82.6±5.24	0.15
Before	85.6±6.26	87.26±4.91	0.24
0	78±8.64	83.4±4.82	0.16
0.5	73.46±10.06	80±8.07	0.01
1	75.33±5.42	82.53±7.04	0.0002
1.5	72.66±5.42	85.86±7.5	<0.05
2	72.6±4.62	88.13±6.30	<0.05
4	78.26±5.62	89.53±6.16	<0.05
8	83.46±8.57	87.93±7.92	<0.04
12	84.53±10.0	91.8±5.96	<0.04
24	67.53±3.08	72.86±11.79	<0.02

Mean±Std deviation.

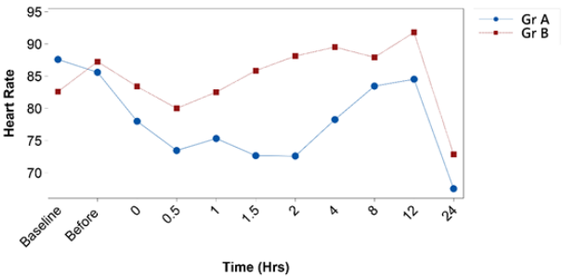

Fig. 1: Comparison of Heart Rate in two groups at different time points. Overall, heart rate was significantly lower at all time points after 30 minutes in the group A compared to the control group B. This suggests better pain relief after ESP block.

Mean arterial Blood pressure (MABP) was compared between the two groups at baseline, before surgery, and at several timepoints after surgery up to 24 hours. MABP was similar between the two groups at baseline and before surgery. However, MABP was significantly lower in Group A compared to Group B after 30 minutes of administration of Block and continuing through all subsequent measurements up to 24 hours. The difference in MABP between the two groups was statistically significant ($p<0.05$) at all timepoints after 30 minutes (Table 3, Figure 2).

Table 3: Comparison of Mean Arterial Blood Pressure among the two groups at different time points:

Time (Hrs)	Group A (*N*=30)	Group B (*N*=30)	*P* value
Baseline	82.56±4.57	83.06±2.83	0.4
Before	87.83±2.57	88.23±1.87	0.5
0	84.2±4.88	84.66±2.08	0.6
0.5	81.16±2.39	87.33±3.53	<0.05
1	79.3±1.75	91.7±5.36	<0.05
1.5	79.16±2.17	95.63±5.68	<0.05
2	80.3±2.45	95.1±5.50	<0.05
4	84.33±2.32	92.8±5.50	<0.05
8	82.93±11.53	88.7±8.6	<0.04
12	85.13±9.42	89.1±3.75	<0.03
24	85.73±7.73	89.7±5.29	<0.03

Mean±Std deviation.

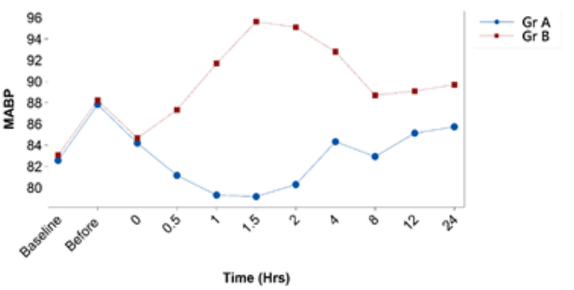

Fig. 2: Mean arterial blood pressure.

This indicates that patients in group A had significantly better pain control in the immediate postoperative period.

The mean arterial blood pressure (MBAP) was also significantly lower in Group A compared to Group B at starting 30 minutes after surgery (Table 2). The p-value was less than 0.05 (5% significance) for all timepoints from 30 minutes through 24 hours, indicating a statistically significant difference in MABP between the two groups.

The VAS score was used to assess pain levels at various time points after surgery. VAS scores between the two groups were statistically different significantly lower in group A, at each time point measured, with $p<0.05$ (Table 4, Figure 3).

Table 4: Comparison of VAS Score among the two groups at different time points:

Time (Hrs)	Group A (*N*=30)	Group B (*N*=30)	*P* value
0.5	0	0.73±0.51	<0.05
1	0	1.9±1.24	<0.05
1.5	0.06±0.24	3±1.34	<0.05
2	0.26±0.51	4.16±1.26	<0.05
4	1.96±0.79	5.13±0.92	<0.05
8	3.53±0.95	5.86±0.8	<0.05
12	5.23±0.5	6.33±0.7	<0.05
24	6.4±0.75	7.03±0.7	<0.05

Mean±Std deviation.

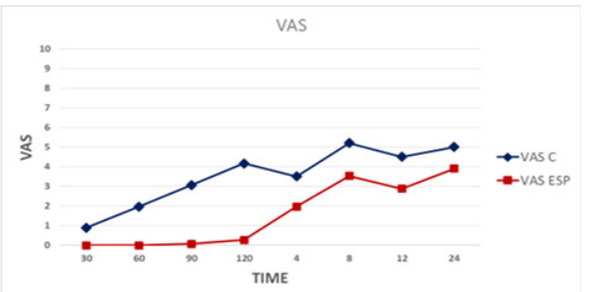

Fig. 3: VAS score: Overall, the patients of Group A reported significantly lower pain levels based on their VAS scores.

The total duration of postoperative analgesia was significantly longer in group A compared to the control B group. Patients who received Block had a mean duration of post operative analgesia of 10.01±1.89 hours. In contrast, the group B had a much shorter mean duration of analgesia of 2.11±0.82 hours. This difference between the two groups was statistically significant ($p<0.05$) (Table 5, Figure 4).

Table 5: Comparison of Duration of Post-Operative Analgesia among the two groups at different time points:

Variable	Group A (*N*=30)	Group B (*N*=30)	*P* value
Total duration of Post-operative Analgesia	10.01±1.89	2.11±0.82	<0.05

Mean±Std deviation.

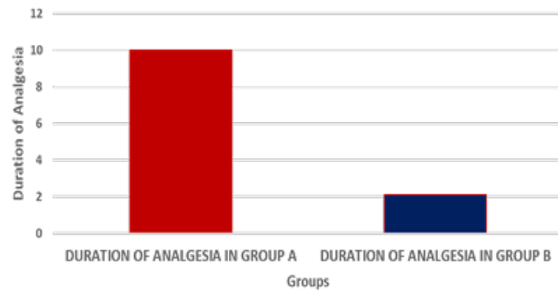

Fig. 4: Duration of Post Operative Analgesia.

The number of rescue analgesic dosages required in the first 24 hours following surgery were compared between the two groups. Patients in Group A required significantly fewer rescue analgesic dosages (2.2±0.4) compared to patients in Group B (4.33±1.04) ($p<0.05$) (Table 6, Figure 5).

No side effects like prolonged muscle weakness, local anaesthetic systemic toxicity and pneumothorax were observed in any of the patients.

Table 6: Comparison of Rescue Analgesic Requirement among the two groups at different time points:

Variable	Group A (*N*=30)	Group B (*N*=30)	*P* value
No. of Rescue Analgesic Dosages Required in 1st 24 Hours After Surgery	2.2±0.4	4.33±1.04	<0.05

Mean±Std deviation.

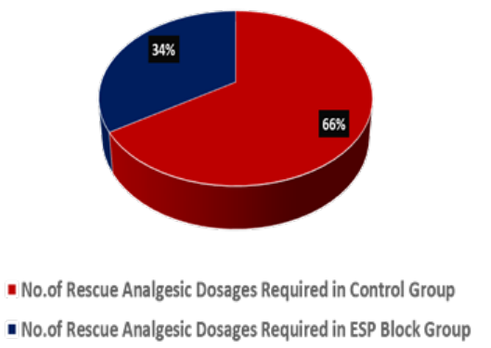

Fig. 5: Number of Rescue Analgesia.

DISCUSSION

Early ambulation after spine surgery is crucial for rapid recovery and to achieve this an effective postoperative analgesia is essential. In our study, we administered ESP block as a fascial plane block modality for postoperative analgesia after lumbar spine surgery. The intervention involved administering bilateral ultrasound-guided ESP block postoperatively. We decided to administer block post operatively as few authors have reported that the local anaesthetic may get washed away if block is given before incision[6].

Our findings align with those of Singh *et al*., who performed Bilateral Ultrasound-guided ESP block for Postoperative Analgesia in Lumbar Spine Surgery. They observed that patients were more satisfied in the ESPB group compared to the non ESPB group and the opioid requirement as well as post-operative analgesic requirement was significantly reduced in the ESPB group[5].

Adhikary *et al*., reported ESP block as an alternative modality to epidural analgesia for post-operative pain relief following video-assisted thoracoscopic surgery in a 16 years female patient and observed adequate analgesia along with minimal opioid requirements, early ambulation and short post-operative length of hospital stay[7].

Ueshima *et al.,* performed retrospective study related to ESP block on patients who underwent thoracotomy in 2017. At the end of study; they observed that ESP block could not provide effective analgesia for the first 24 hours post-surgery period but in our study, we had included lumbar spine surgery and found adequate post-operative analgesia[8].

Singh *et al*., conducted ESP block on series of 5 cases of either left or right modified radical mastectomy (MRM). US-ESP block was able to block the ventral rami of required thoracic spinal nerves providing good pain relief[9].

Chin *et al*., performed pre-operative bilateral ESP blocks in four patients undergoing laparoscopic ventral hernia repair. They observed that ESP block is a promising regional analgesic technique for laparoscopic ventral hernia repair as well as other abdominal surgeries. Its advantages are the ability to block both supra and infra-umbilical dermatomes with a single-level injection[10], similarly Tulgar *et al.,* performed ESP block in three different cases of laparoscopic abdominal surgeries for postoperative pain and concluded that ESP block can be successfully used in lower and upper abdominal surgical procedures for effective pain control[11].

ESP block has been administered in cases of bariatric surgery by few authors and the block effectively provided both visceral and somatic abdominal analgesia as per the report[12]. however we have excluded the patients whose BMI >30 from our study and hence the role of block in obese patients cannot be commented in our study.

There are no clear guidelines for the volume of drug to be administered in ESP block, but the volume has to be cautiously calculated to prevent LAST. We used 20 ml of 0.2% ropivacaine on both sides of block making a total volume of 40ml 0.2% Ropivacaine. Sifaki *et al*., used 0.375% of Ropivacaine for laparoscopic cholecystectomy and reported similar pain free period as ours[13]. Hence lower concentrations are sufficient in providing equivalent analgesia and hence we recommend low concentrations for postoperative pain relief.

Intra-operative as well as post-operative hemodynamic stability resonated with findings observed by Goyal *et al*., who performed ESP Block on a child aged 5 years[14]. Similarly, Nagy S. Ali *et al*., reported hemodynamic stability and better patient satisfaction in patients who received ESP block undergoing emergency laparotomy[15].

The procedural simplicity of the ultrasound-guided ESP block was evident in our study as there were no multiple attempts required to administer block and the efficacy was evident from the prolonged pain free period postoperatively. This simplicity is also highlighted by Akyuz *et al*., in his study and concluded that ESPB was simple to perform, has been found useful in the treatment of persistent low back pain after disc surgery[16]. Other authors have also reported the safety and simplicity of ESP block either USG guided or landmark guided [11,17].

There were no complications in the ESPB group similar result was observed by Kendall *et al*., in his study. (respiratory depression, local systemic toxicity, hematoma)[18]. Decassi *et al*., also enumerated certain adverse effects like muscle weakness, LAST and pneumothorax but none were observed in our study[4].

Yong QUI *et al*., reported a systematic review where they reported that there were only 2 randomised control trials (RCTs) to justify the efficacy of ESP block and the rest reports were either single cases or a series of cases with not enough evidence to substantiate the efficacy of ESP block for post operative analgesia after lumbar spine surgery[19]. Hence, we recommend further trials with larger sample size and comparison among variety of local anaesthetic with or without adjuvants.

We accept some limitations of study. Further studies with large sample size need to be conducted. The efficacy of ESP Block needs to be studied in major spine surgeries. The range of nerve block and onset of analgesia could not be assessed in our study.

CONCLUSION

It is concluded that ESPB is an effective regional anaesthesia technique to enhance recovery after spine surgery by prolonging the pain-free period post-operatively and limiting the use of opioids.

CONFLICT OF INTERESTS

There are no conflicts of interest.

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