EFFICACY OF BILATERAL ULTRASOUND GUIDED ERECTOR SPINAE PLANE BLOCK ON POSTOPERATIVE PAIN IN LUMBAR SPINE SURGERIES; A DOUBLE-BLIND RANDOMISED PLACEBO CONTROL TRIAL

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ABSTRACT:

Background: Severe post-operative pain following spine surgery is a significant cause of morbidity, extended length of stay and marked opioid usage.The objective of this research was to compare the efficacy of bilateral USG guided erector spinae plane block (ESPB) on postoperative pain using visual analogue score (VAS) at 0 and 4 hours in lumbar spine surgeries.

Materials and Method: Eighty patients of age group 18-70 yrs of ASA physical status I & II of both genders undergoing lumbar spine surgery were randomly allocated in two groups. In Group '1' (n=40) patients received bilateral USG guided ESPB using 20 ml of study solution i.e. 0.2% ropivacaine each side after induction of General Anaesthesia (GA). In Group '2' (n=40) patients received bilateral USG guided ESPB using 20 ml normal saline each side after induction of general anaesthesia. In both groups postoperative VAS scores at various intervals (0,4,6,8,12, and 24 hours), the timing of the first dose of rescue analgesia, and the total postoperative analgesic requirements within 24 hours between two groups was measured. Additionally intraoperative hemodynamics (SBP, DBP, HR) and the incidence of postoperative nausea and vomiting in both groups was also compared.

Results: Both the groups were comparable with respect to mean age & gender. VAS score of Group 1 was significantly lower at 0,4,6 and 8 hours than Group 2 with $p < 0.05$. Mean duration of analgesia in Group 1 was significantly higher than Group 2 with $p < 0.05$. Consumed dose of rescue analgesic (Inj. Tramadol) was higher in Group 2 than Group 1 with $p < 0.05$.

Conclusion: Intraoperative hemodynamics was better maintained; requirement of rescue analgesia was also prolonged and total opioid consumption in 24 hours was less in Group 1 as compared to Group 2.

Keywords: Lumbar spine Surgery, Erector spinae Block, Ultrasound, Tramadol, VAS Score

INTRODUCTION:

Postoperative pain management in spinal fusion surgery is challenging and usually includes administration of extensive amounts of opioids which can cause well known side-effects such as respiratory depression, sedation, nausea, vomiting, and constipation [1]. The novel erector spinae plane (ESP) block is a simple and safe alternative analgesic technique for acute post operative pain management. ESP block is one of the newer intrafascial technique that can be performed by deep needle approach where local anesthetic drug is injected below the erector spinae muscle which is closer to costo transverse foraminae and origin of dorsal & ventral rami of spinal nerve .When local anesthetic drug is injected into the intrafascial plane deep to erector spinae muscle it spreads craniocaudally to anaesthetise the dorsal rami of spinal nerves that innervate the paraspinal muscle and bony vertebra[2-4].

Although it was first used to treat postoperative pain following thoracic, breast, abdominal, and hip surgeries, its use in lumbar spine surgery has drawn more attention because of its ability to address the specific challenges associated with lower back procedures. As there are no nearby structures that needles could harm and the sonoanatomy is identifiable, the chance of problems from an ESP block is extremely minimal [2,5]. It also maintains motor neuron and bladder function, allowing for early mobilization and an immediate postoperative neurological examination of spinal cord function can be done since motor function remains intact.

MATERIALS AND METHODS:

After getting approval from the institutional ethics committee and obtaining written consent from each patient, the study was conducted among eighty patients of ASA physical status I and II, aged between 18-70 years, who were undergoing lumbar spine surgery under general anaesthesia at a tertiary care teaching hospital between September 2020 to October 2022.

Following are the exclusion criteria:

- ASA status III or above
- BMI >30kg/m^2
- Infection at the site of block.
- Coagulation disorders.
- Allergy to local anaesthetics.

Sample design:

Group 1(study group)- Patients will receive bilateral USG guided ESPB using 20ml of study solution i.e. 0.2% ropivacaine after induction of general anaesthesia.

Group 2 (control group)- Patients will receive bilateral USG guided ESPB using 20ml normal saline after induction of general anaesthesia.

Procedure and data collection:

All patients underwent pre-anaesthetic evaluation and those meeting inclusion criteria were enrolled and randomly assigned to groups. All patients received general anesthesia according to a standardized protocol.The day before surgery, patients had a detailed medical history, physical examination, and standard investigations (CBC, PT, RFT, INR, LFT). They were also briefed on the Visual Analogue Scale (VAS) for pain. After confirming an 8-hour fasting period, patients were prepped with a 20-G IV cannula and standard monitors (ECG, NIBP, SpO2). Baseline vitals were recorded, and premedication was administered: glycopyrrolate 0.2 mg and midazolam 1 mg IV and nalbuphine (0.1 mg/kg). Anaesthesia was induced with propofol (2-3 mg/kg), and vecuronium (0.1 mg/kg), followed by tracheal intubation. Patients were then positioned prone. A high-frequency linear ultrasound transducer was used to visualize the target vertebral level. After proper skin sterilization, a 10 cm stimuplex needle was inserted and positioned using saline. Group 1 received 20 ml of 0.2% ropivacaine bilaterally, while Group 2 received 20 ml of normal saline bilaterally. Anaesthesia was maintained with an oxygen-nitrous oxide mix, isoflurane, and intermittent vecuronium. BP and HR were recorded every 30 minutes. Both groups received IV paracetamol 1 gram and IV ondansetron 4 mg before the end of surgery. Patients were reversed with neostigmine (0.05 mg/kg) and glycopyrrolate (0.01 mg/kg) and then extubated prior to transport to post anaesthesia care unit. Postoperative pain was assessed using VAS at 0, 4, 6, 8, 12, and 24

hours. Rescue analgesia was given if VAS > 4. Patients were monitored in PACU for two hours for side effects like nausea and vomiting.

ESPB TECHNIQUE:

Under aseptic technique a 10 cm stimuplex needle was introduced in an in-plane approach, a cephalic to caudal direction until L3 transverse process was hit, then the needle was slightly withdrawn. Confirmation of the correct position of the needle tip was done by injecting 0.5–1 ml of local anaesthetic (LA). Correct needle tip location was confirmed by visualising LA spread lifting the erector spinae muscle off the bony shadow of the transverse process. Once confirmed, 20 ml of 0.2% Ropivacaine was administered in group 1 under vision bilaterally after confirming negative aspiration of blood, and 20 ml normal saline was administered bilaterally in group 2. LA distribution was observed in both cranial and caudal directions.This paravertebral spread is achieved by covering three to four vertebral levels of dorsal and ventral rami, respectively, cranially and caudally[6]. By obstructing the dorsal and ventral rami, this multi-dermatomal sensory block covers the anterior, posterior, and lateral thoracic and abdominal walls [7].

RESULTS AND STATISTICAL ANALYSIS

Based on the results of a previous study which measured post operative VAS score at 4 hr, for both the group, i.e, 3.23 ± 0.711, and 2.67 ± 0.504, at 5% level of significance and 95% power, the minimum required sample size for each group was 33. By taking 20% attrition, the total sample size is 80 i.e. 40 in each group.

Statistical analysis was done by using the IBM SPSS software version 23. For continuous variable, the data was presented as Median ± IQR and the categorical variables were presented as percentage. p- value ≤ 0.05 was considered as statistically significant.

Table 1: Comparison of demographic data between the groups

			Group		P Value
			1	2	
SEX	FEMALE	Count	18	17	0.822
		% within Group	45.0%	42.5%	
	MALE	Count	22	23	
		% within Group	55.0%	57.5%	
AGE(YEARS)		MEAN ±SD	49.08 ±13.69	51.30±11.30	0.431
WEIGHT(KG)		MEAN ±SD	67.53 ±8.85	66.23 ±9.16	0.520
ASA		ASA 1/ASA 2	21/19	22/18	0.823
DURATION OF SURGERY (IN MINS)		MEAN±SD	186.75±25.86	187.5±24.26	0.893

Group 1-erector spinae plane block, group 2-normal saline group

ASA: American Society of Anaesthesiologists, KG: Kilogram, SD: Standard Deviation

Table 1 represents comparison of demographic data, ASA status, weight and duration of the surgery between the groups. All the parameters were comparable between both the groups.

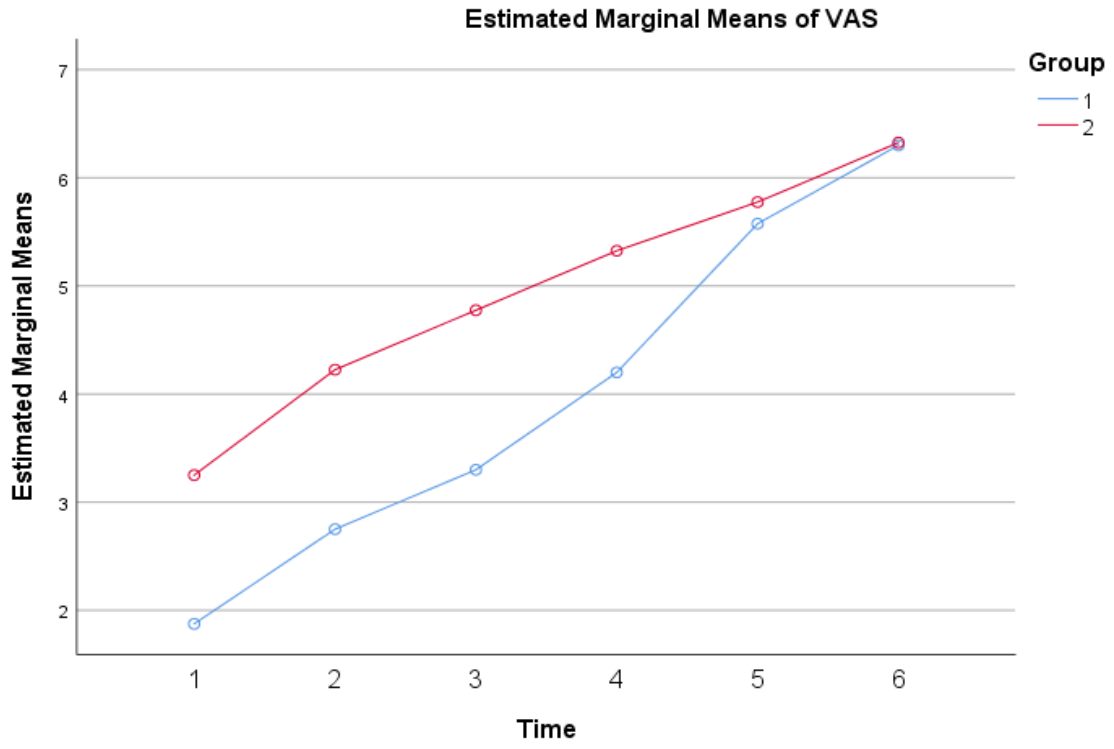
TABLE 2: COMPARISON OF VAS BETWEEN THE GROUPS

Group		Mean	Std. Deviation	N	P Value w.r.t Time	P Value w.r.t Group
VAS at PACU (0 HR)	1	1.88	0.46	40	<0.001	<0.001
	2	3.25	0.59	40		
	Total	2.56	0.87	80		
VAS SCORE(4HR)	1	2.75	0.49	40	<0.001	<0.001
	2	4.23	0.48	40		
	Total	3.49	0.89	80		
6 HOUR	1	3.30	0.56	40	<0.001	<0.001
	2	4.78	0.42	40		
	Total	4.04	0.89	80		
8 HOUR	1	4.20	0.56	40	<0.001	<0.001

	2	5.33	0.47	40		
	Total	4.76	0.77	80		
12 HOUR	1	5.58	0.50	40	0.534	0.632
	2	5.78	0.48	40		
	Total	5.68	0.50	80		
24 HOUR	1	6.30	0.46	40	0.789	0.832
	2	6.33	0.47	40		
	Total	6.31	0.47	80		

VAS: Visual Analogue Score, HR: Heart Rate, N: Number

GRAPH 1: MEAN VAS SCORES AT 0,4,6,8,12 AND 24TH HOURS



X axis: time (1:0th hour, 2:4th hour, 3:6th hour, 4:8th hour, 5:12th hour, 6:24th hour,

Y axis: Marginal means of VAS score

VAS: Visual Analogue Scale

Inter-group comparison of VAS Score at different points of time at postoperative period was done using independent-t test. We found that VAS score in group 1 with respect to time were significantly lower at 0,4,6 and at 8 hours as compared with group 2 with *p* value of <0.001.

However, at 12- and 24-hours patients in group 1 had similar mean VAS score as group 2**.** The difference was minimal and was not statistically significant (*p*=0.534, 0.789)

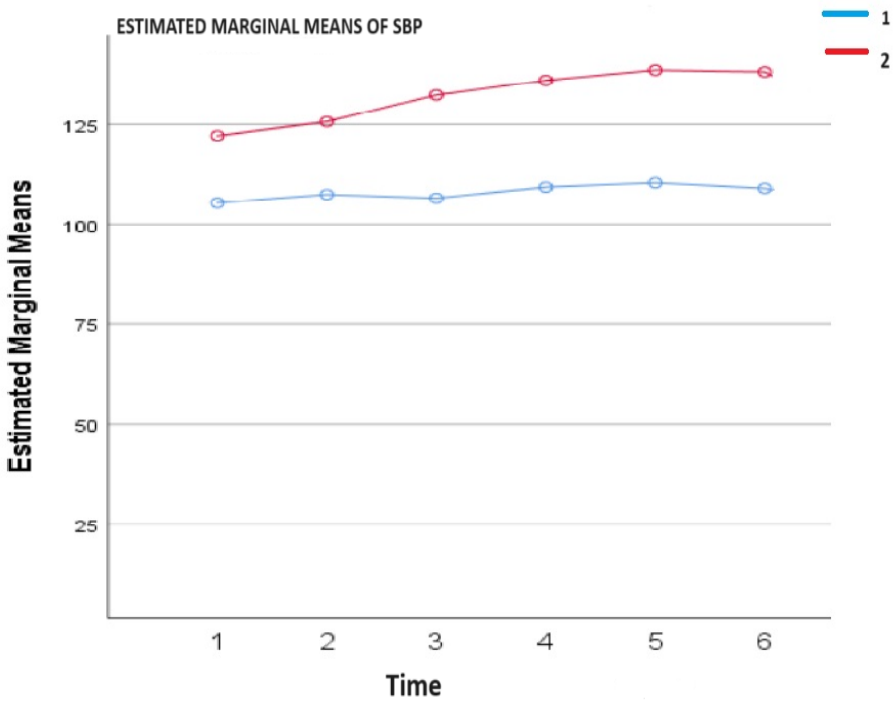
TABLE 3: COMPARISON OF SYSTOLIC BLOOD PRESSURE (SBP) RECORDED

Group		Mean	Std. Deviation	P Value w.r.t Time	P Value w.r.t Group
SBP (0 mins)	1	105.35	7.36	<0.001	<0.001
	2	122.18	5.91		
	Total	113.76	10.76		
SBP (30 mins)	1	107.43	6.82		
	2	125.70	5.49		
	Total	116.56	11.06		
SBP (1 hour)	1	106.50	7.76		
	2	132.35	7.93		
	Total	119.43	15.16		
SBP (1.5hr)	1	109.28	6.86		
	2	135.98	6.62		
	Total	122.63	15.01		
SBP (2hr)	1	110.35	6.31		
	2	138.53	7.59		
	Total	124.44	15.78		
SBP (2.5 Hr)	1	108.98	25.92		
	2	138.10	23.97		
	Total	123.54	28.81		
SBP (3 hr)	1	103.35	35.48		
	2	125.53	48.80		
	Total	114.44	43.84		

INTRAOPERATIVELY BETWEEN THE TWO GROUPS

SBP-SYSTOLIC BLOOD PRESSSURE, GROUP 1-0.2% ROPIVACAINE, GROUP 2-PLACEBO GROUP, N-NUMBER

GRAPH 2: TREND OF SYSTOLIC BLOOD PRESSURE (MEAN) AT EVERY 30 MINS INTERVAL BETWEEN TWO GROUPS



X axis: intraoperative time from skin incision (1: 30 minutes, 2:1 hours, 3: 1.5 hours, 4:2 hour, 5: 2.5 hours, 6: 3hours)

Y axis: Marginal means of systolic blodd pressure

SBP: systolic blood pressure

TABLE 4: COMPARISON OF DIASTOLIC BLOOD PRESSURE (DBP) RECORDED INTRAOPERATIVELY BETWEEN THE TWO GROUPS

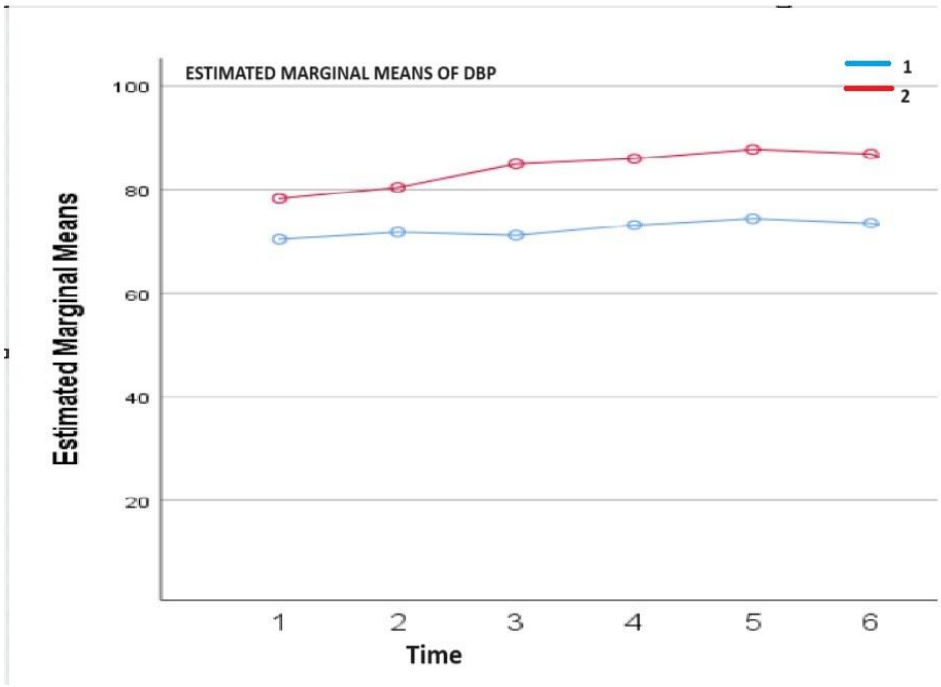
Group		Mean	Std. Deviation	P Value w.r.t Time	P Value w.r.t Group
DBP (0 mins)	1	70.38	5.92	<0.001	<0.001
	2	78.20	4.95		
	Total	74.29	6.70		
DBP (30 mins)	1	71.73	5.38		
	2	80.40	5.96		
	Total	76.06	7.13		
DBP (1 hour)	1	71.13	5.70		
	2	84.88	5.86		
	Total	78.00	8.99		
DBP (1.5hr)	1	73.13	5.70		

	2	85.93	4.54		
	Total	79.53	8.23		
DBP(2hr)	1	74.38	5.16		
	2	87.73	5.86		
	Total	81.05	8.67		
DBP (2.5 hr)	1	73.50	17.72		
	2	86.85	15.01		
	Total	80.18	17.65		
DBP(3HR)	1	69.73	23.98		
	2	78.23	30.43		
	Total	73.98	27.56		

Group 1-Erector spinae plane block, group 2-Normal saline group

DBP: Diastolic Blood Pressure, mins : minutes

GRAPH 3: TREND OF DIASTOLIC BLOOD PRESSURE (MEAN) AT EVERY 30 MINS INTERVAL BETWEEN TWO GROUPS



X axis: intraoperative time from skin incision (1: 30 minutes, 2:1 hours, 3: 1.5 hours, 4:2 hour, 5: 2.5 hours, 6: 3hours)

Y axis: Marginal means of diastolic blood pressure

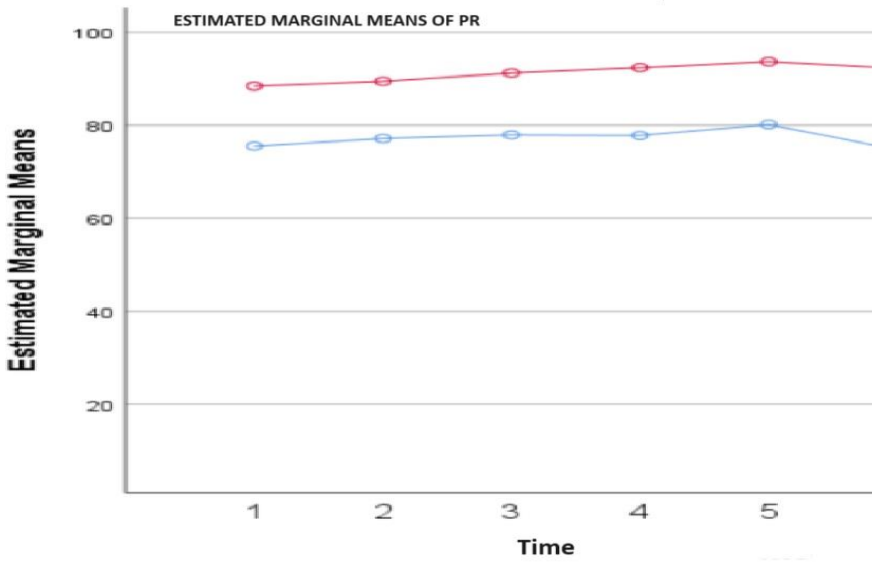
DBP: Diastolic systolic blood pressure

TABLE 5: COMPARISON OF PULSE RATE(PR) RECORDED INTRAOPERATIVELY BETWEEN THE TWO GROUPS

Group		Mean	Std. Deviation	P Value w.r.t Time	P Value w.r.t Group
PR (0 MINS)	1	75.51	5.90	<0.001	0.061
	2	88.40	5.22		
	Total	82.04	8.52		
PR (30 MINS)	1	77.15	6.02		
	2	89.45	5.01		
	Total	83.38	8.27		
PR (1 hr)	1	77.92	5.59		
	2	91.23	6.25		
	Total	84.66	8.92		
PR (1.5 hr)	1	77.79	6.23		
	2	92.38	6.30		
	Total	85.18	9.62		
PR (2 hr)	1	80.15	5.01		
	2	93.68	6.03		
	Total	87.00	8.76		
PR (2.5 HR)	1	74.77	18.24		
	2	92.25	15.68		
	Total	83.62	19.04		
PR (3 HR)	1	71.87	25.07		
	2	83.73	32.33		
	Total	77.87	29.40		

PR-PULSE RATE, GROUP 1-0.2% ROPIVACAINE, GROUP 2-PLACEBO GROUP, N-NUMBER

GRAPH 4: PULSE RATE (BEATS /MIN) AT EVERY 30 MINS INTERVAL



X axis: intraoperative time from skin incision (1: 30 minutes, 2:1 hour, 3: 1.5 hours, 4:2 hour, 5: 2.5 hours, 6: 3hours)

Y axis: Marginal means of pulse rate

PR: pulse rate

Table 3 reveals that patients administered 0.2% ropivacaine experienced significantly lower intraoperative SBP compared to those receiving normal saline in the ESP group ($p<0.001$). This trend is visually represented in Graph 2. Additionally, Table 4 indicates that Group 1 consistently maintained lower diastolic blood pressure throughout the surgery, with a highly significant p-value of <0.001, as also shown in Graph 3. Furthermore, Group 1 exhibited a significantly lower pulse rate during surgery ($p<0.05$), corroborated by Table 5 and Graph 3.

TABLE 6: COMPARISON OF POSTOPERATIVE OPIOID REQUIREMENT (TRAMADOL IN mg)

Group		Mean	Std. Deviation	P Value
TOTAL ANALGESIC (mg in 24 hrs)	1	232.5	52.6	<0.001
	2	387.5	51.6	

Group 1-erector spinae plane block, group 2-normal saline group

S.D: standard deviation, mg: milligram

Table 8 shows the total dose of analgesic administered in first 24 hours in Group 1 was 232.5±52.6 mg and Group 2 was 387.5±51.6 mg, which was found to be statistically significant with a p-value of <0.001.

Table 7: COMPARISON OF FIRST DOSE OF RESCUE ANALGESIA BETWEEN THE TWO GROUPS

Group	Mean in mins	Std.devn	p-value
Group 1	413.25	70.11	
Group 2	72.25	36.51	<0.001

Group 1-erector spinae plane block, group 2-normal saline group

S.D: standard deviation, mg: milligram

Table 9 shows the mean duration of first dose of rescue analgesia in Group 1 is 413.25±70.11 and in Group 2 was 72.25±36.51. The difference was found to be statistically significant with the p-value of <0.001.

TABLE 7: COMPARISON OF INCIDENCE OF POSTOPERATIVE NAUSEA AND VOMITING BETWEEN THE GROUPS

			Group		P Value
			1	2	
PONV	no	Count	34	32	0.556
		% within Group	85.0%	80.0%	
	yes	Count	6	8	
		% within Group	15.0%	20.0%	

Group 1-erector spinae plane block, group 2-normal saline group

PONV: post operative nausea vomiting

We measured PONV in the recovery room. Majority of the patient in both groups did not experience PONV. Only 6 out of 40 patient group 1 and 8 out of 40 patients in group 2 suffered from PONV. This difference though was not statistically significant.

DISCUSSION:

Opioids have traditionally been the mainstay of analgesic therapy but – they may not control pain adequately. But at high dose associated with signicant adverse effects (sedation, cognitive impairment, constipation) and risk of long-term habituation and dependence [8]. This study investigates the efficacy of bilateral ultrasound-guided ESPB using ropivacaine, a relatively new regional anaesthesia technique.

This study demonstrates that bilateral ESPB with ropivacaine significantly reduces postoperative pain in patients undergoing lumbar spine surgeries. Patients in the ESPB group had notably lower Visual Analog Scale (VAS) scores at multiple time points post-surgery compared to the control group. Additionally, the time to first rescue analgesia was significantly extended, and the overall consumption of analgesics within the first 24 hours was lower in the ESPB group.

The introduction of ESPB by Forero et al. in 2016[2] marked a significant advancement in regional anaesthesia, particularly for thoracic neuropathic pain. This technique was subsequently extended to lumbar spine surgeries. Krishna et al. (2018) [9] reported significant

reduction in postoperative pain scores and opioid consumptions in patients receiving ESPB as compared to control groups.The findings of the current study are consistent with these earlier reports, further validating ESPB's role in managing postoperative pain in lumbar spine surgeries.

Ultrasound guidance is crucial for ESPB, offering real-time needle visualization and effective anesthetic spread. Studies by Chin et al [10] and Tsui et al [11]. emphasize its benefits, such as higher success rates and fewer complications. This study supports these findings, demonstrating precise needle placement and effective nerve block using ultrasound techniques.

The study's analysis of VAS scores confirms ESPB with ropivacaine's effectiveness in providing sustained postoperative pain relief. While Bellantonio et al [12] reported longer pain relief (36 hours) due to a higher ropivacaine dose, Rana et al.'s [13] findings matched ours with similar dosages and duration. Efficiency of ESPB block for lumbar spine surgery has been proven in many studies[14-16].

In our study, we assessed intraoperative hemodynamics in all patients and found significantly lower SBP, DBP, and HR in Group 1 compared to Group 2, consistent with Ghamry et al.'s [17] findings that hemodynamic responses indicate a successful block. However, unlike Ghamry et al., we found no difference in PONV incidence between groups. This discrepancy may be due to their use of strong opioids like fentanyl and morphine, whereas we used weaker opioids like nalbuphine and tramadol. Additionally, our institution's routine use of IV dexamethasone for postoperative care may have provided an extra antiemetic effect, although we did not record dexamethasone use or somnolence levels in our patients.

This study supports including ESPB with ropivacaine in ERAS protocols for lumbar spine surgeries due to its effective postoperative pain management. However, further research with larger, multicenter trials is needed to validate these findings, explore long-term outcomes, and optimize dosing and anesthetic combinations for enhanced ESPB efficacy and safety.

CONCLUSION:

This study confirms the efficacy and safety of bilateral USG-guided ESPB with ropivacaine for postoperative pain management in lumbar spine surgeries, aligning with previous research.

The findings validate ESPB's effectiveness, emphasizing its value in regional anesthesia and supporting its continued use in clinical practice for enhanced pain management. Therefore, ESP block can be used as a part of multimodal analgesia in Lumbar spine surgeries.

STUDY LIMITATIONS:

The limitations are that it is a single centre trial. All the potential post-anaesthesia and ESPB complications were not looked into. This study only focused on early postoperative relief from pain. We didn't investigate the role of ropivacaine in ESPB in development of chronic pain and its impact on quality of patients' life. Patient's satisfaction score was also not measured in the perioperative period.

REFERENCES:

1. Bajwa, S. J. & Haldar, R. Pain management following spinal surgeries: an appraisal of the available options. J. Craniovert. Jun Spine 6, 105–110. https://doi.org/10.4103/0974-8237.161589 (2015)
2.Forero M, Adhikary SD, Lopez H, Tsui C, Chin KJ. The erector spinae plane block: a novel analgesic technique in thoracic neuropathic pain. Reg Anesth Pain Med 2016;41:621-7.

3.Josh P. Melvin, Rudolph J. Schrot, Ki Jin Chin. Low thoracic erector spinae plane block for perioperative analgesia in lumbosacral spine surgery: a case series. Can J Anesth(2018) 65:1057-1065

4. K.J. Chin,S.Adhikary,N.Sarwani,M.Forero. The analgesic efficacy of pre-operative bilateral erector spinae plane (ESP) block in patients having ventral hernia repair.Anaesthesia 2017; 72:452-60

5. Beek J., Smits R.J.H., Fenten M.G.E., Filippini-de Moor G.P.G. ESPB: Het Erector Spinae Plane-Blok. A&I. 12, 50–53 (2019). Accessed April 5, 2019

6. Sandeep Krishnan, Marco Cascella : Erector Spinae Plane Block,ncbi update,july 18;2021.

7.G Nogueira, V Artilheiro and G Costa: Erector spinae plane block for open nephrectomy: a new paediatric success ,October 2019 , Regional anaesthesia and Pain Medicine 44(Suppl 1):A195.1-A195.

8.Savarese JJ, Tabler NG Jr. Multimodal analgesia as an alternative to the risks of opioid monotherapy in surgical pain management. J Healthc Risk Manag 2017; 37: 24-30

9.Krishna SN, Chauhan S, Bhoi D, et al. A comparison of analgesic efficacy of Erector Spinae Plane Block with thoracic epidural analgesia following thoracic surgeries. *J Anaesthesiol Clin Pharmacol*. 2018;34(4):462-467

10.Chin KJ, Adhikary S, Forero M. Understanding ESP and fascial plane blocks: a challenge to omniscience. Reg Anesth Pain Med. 2018;43:807-8

11.Tsui BCH, Suresh S. Ultrasound imaging for regional anaesthesia in infants, children, and adolescents: a review of current literature and its application in the practice of regional anaesthesia. Anaesthesiology. 2017;126(6):1094-1101. doi: 10.1097/ALN.0000000000001635.

12.Bellantonio, D., Bolondi, G., Cultrera, F. et al. Erector spinae plane block for perioperative pain management in neurosurgical lower-thoracic and lumbar spinal fusion: a single-centre prospective randomised controlled trial. BMC Anesthesiol 23, 187 (2023)

13.Sourav Rana,Bimal Kumar Hajra,Priti Banerjee.a comparative study of efficacy of erector spinae plane (esp) block for post-operative anaelgesia by 0.2% ropivacaine in lumbar spine surgery:International journal of scientific research;Volume - 10 | Issue - 03 | March - 2021 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr

14.Teng-Jiao Zhang, Jing-Jing Zhang, Zong-Yang Qu, Hong-Ye Zhang, Yong Qiu & Zhen Hua (2020) Bilateral Erector Spinae Plane Blocks for Open Posterior Lumbar Surgery, Journal of Pain Research, 13:, 709-717, DOI: 10.2147/JPR.S248171

15.Renee J. C. van den Broek , Robbin van deGeer1 , Niek C. Schepel2 , Wai-Yan Liu2 , R.Arthur Bouwman1 & BarbaraVersyck,Evaluation of adding the Erector spinae plane block to standard anesthetic care in patients undergoing posterior lumbar interbody fusion surgery,(2021) 11:7631,https://doi.org/10.1038/s41598-021-87374-w

16.Nashibi M, Tafrishinejad A, Safari F, Asgari S, Sezari P, Mottaghi K. Evaluation of ultrasound guided erector spinae plane block efficacy on post operative pain in lumbar spine surgery: a randomized clinical trial. Agri. 2022 Jul;34(3):174-179. English. doi: 10.14744/agri.2021.04864. PMID: 35792689.

17.MR El Ghamry,1 AS Elgebaly,1 AG Anwar,1 MN Shaddad2.Ultrasound-guided erector spinae plane block for acute pain management in patients undergoing posterior lumbar interbody fusion under general anaesthesiaSouthern African Journal of Anaesthesia and Analgesia 2019; 25(6):26-31