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COMPARATIVE RANDOMIZED STUDY BETWEEN ERECTOR SPINAE PLANE BLOCK AND SINGLE SHOT EPIDURAL BLOCK FOR POSTOPERATIVE PAIN MANAGEMENT IN ABDOMINAL SURGERY

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Abstract

Background: The epidural block is a well-established method for providing effective analgesia during abdominal surgeries. The erector spinae plane block (ESPB), a field block technique, has demonstrated promising outcomes in different surgical procedures. This study compares the two techniques in open abdominal hysterectomy surgeries, focusing on pain management following surgery, the time to the 1st analgesic request, total consumption of morphine following surgery, hemodynamic stability during operation.

Methodology: This double-blinded randomized controlled investigation included 60 female cases, divided into 2 groups. The epidural group received a single-shot epidural block under ultrasound guidance using twenty milliliters of 0.25 percent bupivacaine. The ESPB group underwent bilateral single-shot erector spinae plane blocks, also guided by ultrasound, with twenty milliliters of 0.25 percent bupivacaine administered on each side. Data collected included levels of pain following surgery, time to the 1st analgesic request, total consumption of morphine following surgery, hemodynamics during surgery, and any adverse events**.**

Results: The time to the 1st analgesic request has been significantly prolonged in the ESPB group (10.71±3.58 hours) compared to the epidural group (6.53±2.19, *P_value less than 0.001). Mean consumption of morphine was also lower in the ESPB group (3.84±0.61mg vs. 7.06±1.87mg; *P-value less than 0.001). While the visual analogue scale scores for pain were lower in the ESPB group, fewer patients in the ESPB group experienced intraoperative hypotension and bradycardia.

Conclusion: Compared to a single-shot epidural block, ESPB offers prolonged analgesia after surgery , reduced consumption of opioid, and greater hemodynamic stability through surgery in open abdominal hysterectomy surgeries.

Keywords: Erector spinae plane block, Pain, open abdominal hysterectomy, Epidural, Neuraxial analgesia

Background

Following cesarean sections, hysterectomy is the 2nd most frequent obstetric procedure. Moderate to severe pain following surgery is typically experienced after a total abdominal hysterectomy; if left untreated, this pain increases the risk of venous thrombosis, prolongs hospital stays, causes chronic

pain, and decreases patient satisfaction [1,2]. Although it is the standard of treatment, opioid-based analgesia can have unfavorable side impacts, involving itching, nausea and vomiting following surgery, constipation, and even potentially deadly respiratory depression [3, 4].

Epidural analgesia is frequently utilized for management of pain in abdominal surgeries, but it can be associated with hemodynamic instability. A key challenge for anesthetists is the potential migration of the epidural catheter, which might result in unpredictable absorption of local anesthetics (LAs) [5]. The erector spinae plane block , 1st defined by Forero et al. in 2016, is an interfacial plane block that provides effective pain relief following surgery, particularly in abdominal and thoracic surgeries [6]. ESPB is considered one of the safest and simplest analgesic techniques, targeting both ventral and dorsal rami of lumbar and thoracic spinal nerves. When administered at lower thoracic level, it offers effective analgesia for surgeries such as abdominal hysterectomy [7] and cesarean sections [8]. Regional anesthesia, as part of a multimodal approach to management of pain following operation, remains a critical component, though epidural blocks carry certain risks. The search for an alternative that provides effective pain relief with fewer side effects is a key goal for anesthetists [6].

We hypothesized that erector spinae plane block would provide longer-lasting analgesia following surgery compared to lumbar epidural analgesia in cases of abdominal hysterectomy.

Methods:

This prospective, randomized, double-blind comparative trial has been carried out in the obstetric operating theater at Al Zahraa university hospital from June to December 2022. The objective of the research was to compare analgesic effectiveness of ultrasound-guided erector spinae plane (ESP) and single-shot epidural block in cases having total abdominal hysterectomy surgery under general anesthesia.

Sample size justification:

The number of cases needed for each group has been determined prior to the investigation by conducting a power calculation based on the data that has been collected. ***(Abdel Hamid et al., 2022).*** In the investigation, postop morphine consumption (mg) in ESPB group 3.88±0.54 and Epidural group

7.12±1.94; so, it may be relied upon in this investigation, depend on this assumption through a this previous study, the effect size was large (f =0.89). A total sample size of 56 cases, but the number will be increased to 60 patients to show the power of the study and appropriate results, divided into equal two groups, has been determined to provide 90% power for independent samples T test at the level of five percent significant and confidence interval ninety-five percen utilizing G. Power 3.19.2 software.

60 patients were enrolled following the ethics committee's sanction at Faculty of Medicine for Girls of AL-AZHAR University. Written informed consent has been gathered from all participants. The inclusion criteria were females aged forty to sixty-five years who had been categorized as ASA I–II (American Society of Anesthesiologists), had a BMI (kilogram per square meter) of twenty-five to thirty-five, and were having total abdominal hysterectomy operation with general anesthesia.

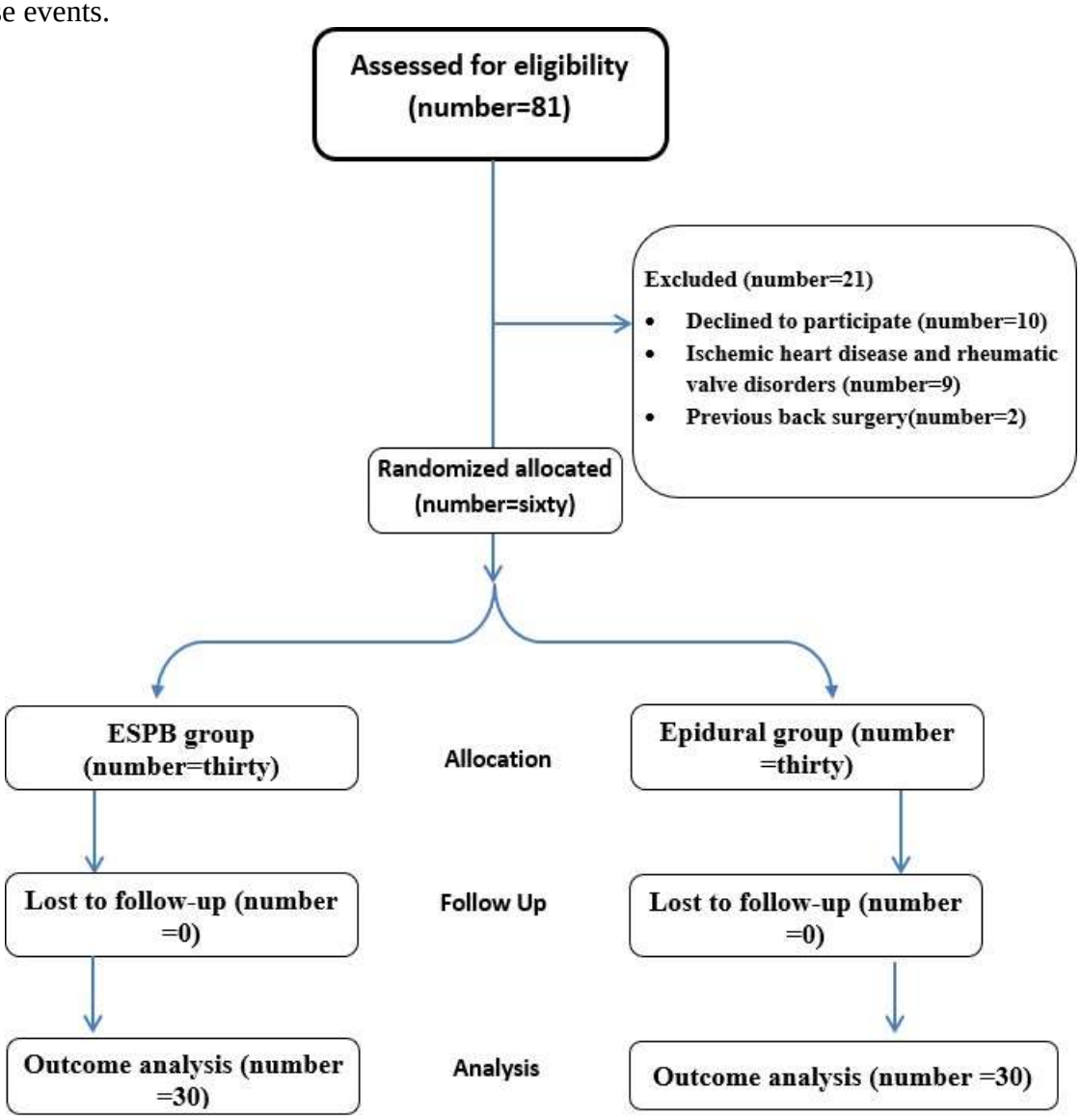
Cases with a physical status of ASA III-IV, a history of allergies or hypersensitivity for local anesthesia drugs, coagulopathies, platelet count < 80000/ Micro L, back skin lesions, a history of back surgery, psychiatric, patients refusing participation and failed block were excluded.

Randomization:

The cases have been randomly assigned to either ESPB group (number=thirty) or the single injection epidural group (number=thirty) in two equal groups upon their arrival in the operating room. The computer-generated randomization codes have been stored in sealed envelopes. The anesthetist responsible for conducting the block received the sealed envelopes from an investigator who wasn’t inculded in cases care. The collection of data before surgery, the assessment of pain

throughout the first twenty-four hours following operation, and the administration of analgesia were the responsibilities of a blinded investigator who specialized in anesthesia and pain management. Furthermore, the technique to which each patient was assigned was unknown to them.

The primary objectives measured was the time until the 1st request for rescue analgesia, defined as the initial point within the first 24 hours when the VAS exceeded 4 (starting from the time of either the neuraxial block or ESPB procedure). Additional objectives included the total morphine used postoperatively within the first 24 hours, assessments of pain following surgery, intraoperative and postoperative mean arterial blood pressure (MABP) and heart rate, as well as any adverse events.



Flow chart

Anesthesia and blockade:

For all patients who enrolled at the study, they arrived in the preparatory room one hour before the procedure. The VAS was explained to all patients beforehand. All cases have been following up using noninvasive blood pressure measurement, pulse oximetry and electrocardiography, and their baseline vital signs have been documented.

An intravenous (IV) line was also established for fluid administration and premedication with midazolam 0.05 milligram per kilogram.

Standard following up techniques, as noninvasive blood pressure measurement pulse oximetry, and electrocardiography, have been carried out upon arrival in the operating room.

Anesthesia induction was achieved with fentanyl one microgram per kilogram and propofol two milligram per kilogram, followed by facilitation of endotracheal tube placement with 0.5 milligram per kilogram IV atracurium. Anesthesia has been maintained with 1.2 percent isoflurane in fifty percent oxygen and 50% air, along with a continuous infusion of atracurium at 0.1 milligram per kilogram per hour. Ventilation targeted a tidal volume of six to seven milliliters per kilogram and an ETCO2 of 32 -
36 mmHg. All patients were administrated one gram paracetamol infusion. Once anesthesia was stabilized, all patients were positioned laterally to receive a regional block.

In the epidural group; each case has been placed laterally, and an echogenic 18G Tuohy needle has been guided into epidural space with ultrasound assistance, following strict aseptic procedures. A curved array ultrasound probe with a frequency of 1.4–5 megahertz has been positioned at an angle of ninety degrees in a transverse orientation and moved cephalad or caudad to achieve transverse interspinous view at L3 –L4 level. This level has been determined by counting from the first sacral vertebra to the third lumbar vertebra (L3). The case received twenty milliliters of 0.25 percent plain bupivacaine following aspiration confirmed the absence of blood or cerebrospinal fluid. Though less frequently utilized, the single-shot technique facilitated a quicker motor recovery and eliminated the necessity for catheter placement and its undesirable effects.

In the ESPB group, ultrasound-guided erector spinae plane block. The erector spinae plane block has been carried out at the T9 level while the case was in a lateral decubitus position following skin sterilization. A high-frequency linear ultrasound transducer (three to five megahertz) has been placed sagittally at a site three centimeters lateral to T9 spinous process. A hyper-echoic shadow of the erector spinae muscle and the transverse process (TP) has been detected. The 22-gauge short bevel needle has been introduced in a cranial-to-caudal trajectory toward the TP, in-plane with the ultrasound transducer, until it made contact with the TP and went through all muscle layers. The needle tip location has been confirmed by detecting the erector spinae muscle separated from the TP's bony shadow on ultrasound imaging with normal saline. A twenty milliliter of 0.25 percent bupivacaine has been injected following confirmation. The procedure has been subsequently repeated on the opposite side of the back. The dissemination of the local anesthetic as an anechoic shadow within the paravertebral spaces from T7 to T12 was confirmed by ultrasound imaging.

Surgery was permitted 20 minutes after the block. A block was considered unsuccessful if there was an elevation in heart rate and/or blood pressure (BP) by more than twenty percent from baseline upon skin incision. This has been managed with an additional dose of fentanyl at 0.5 microgram per kilogram, and, if fentanyl alone was insufficient, isoflurane concentration was increased. The total dose of fentanyl was documented.

After surgery, all patients received ondansetron 8mg, and were extubated once they met the extubation criteria and have been transferred to the post-anesthesia care unit (PACU) for observation. Cases who experienced breakthrough pain (VAS above 4), was administered rescue analgesia (intravenous morphine at 0.05 mg/kg) by the investigator. Additional doses were given at intervals of at least 30 minutes until the VAS was 4 or lower. Ketorolac 15 mg was administrated IV to patients who were still complaining of pain with VAS 4 or lower. One gram of intravenous paracetamol was administered every 6 hours, regardless of the VAS score.

From the time of skin incision to skin closure, all hemodynamic variables have been documented every ten minutes. Subsequently, they have been recorded during the immediate period following surgery, as well as at two- and four-hours following operation. Hypotension has been described as a twenty percent reduction in systolic blood pressure (SBP) from baseline or an SBP of below ninety millimeters of mercury. Tachycardia has been defined as a heart rate (HR) of 100 beats per minute or higher, while bradycardia has been defined as an HR of sixty beats per minute or lower.

Postoperative management involved assessing and recording pain at rest using VAS at 30 minutes, and then at two, four, six, eight, 10, 12, 18, and 24 hours. Time zero was defined as the moment the patient recovered from general anesthesia. The time of the 1st request for analgesia has been also documented.

Complications including vomiting and nausea, hematoma formation, local anesthetic toxicity, urinary retention, Sensory and motor impairment and respiratory depression (respiratory rate < 8 breaths/min), were monitored and documented.

Statistical analysis:

The statistical package for social sciences, version 26.0 (SPSS Inc., Chicago, Illinois, States), has been utilized to analyze the data that was gathered. When the distribution of the quantitative data was parametric (normal), it has been represented as ranges and mean± standard deviation. Conversely, non-parametric variables have been presented as median with inter-quartile range (IQR). Additionally, qualitative variables have been represented as numbers and percentages. The Shapiro-Wilk Test and Kolmogorov-Smirnov Test have been utilized to investigate the normality of data.

The ***subsequent tests have been carried out***: The Mann-Whitney U test has been utilized for 2-group comparisons in non-parametric data, while the independent-samples t-test of significance has been utilized when comparing among 2 means. ***The Chi- square test and Fisher's*** exact test were utilized to compare groups with qualitative data, with the exception of cases where the expected count in any cell was below five. The margin of error accepted was five percent, and the ***confidence interval*** has been set at ninety-five percent Therefore, the p-value has been deemed significant as follows: Probability (P-value) A P-value of less than 0.05 has been regarded as significant, a P-value of less than 0.001 as highly significant, and a P-value of more than 0.05 as insignificant.

Result;

The both groups were comparable with raged to of age, ASA physical status, BMI, and surgery duration. Instatistically significant variances have been observed among the groups for these parameters (Table 1).

Table (1): Comparison among groups regarding to demography.

Demographic data	**ESPB group *(number=30)***	**Epidural group *(number=30)***	**Test value**	**p- value**	**Sig.**
Age "years"	44.46±17.26	42.90±18.96	-0.333	0.740	NS
BMI [wt/(ht)^2]	30.81±3.81	29.81±4.70	-0.905	0.369	NS
Duration of surgery (min)	128.07±12.81	124.44±12.17	-1.125	0.265	NS

Using: t-Independent Sample t-test for Mean±SD;
*p-value higher than 0.05 is insignificant; *p-value less than 0.05 is significant; **p-value lower than 0.001 is highly significant*

The time to the 1st analgesic requirement (VAS > 4) within the 1st twenty-four hours was significantly longer in the ESPB group compared to the epidural group (10.71 ± 3.58 vs. 6.53 ± 2.19, correspondingly;

*P-value less than 0.001). The maximum time to the 1st analgesic need in the ESPB group was 21 hours. Additionally, morphine consumption during the 1st twenty-four hours was lower in the ESPB group compared to in the epidural group (3.84 ± 0.61 vs. 7.06 ± 1.87, correspondingly; *P-value less than 0.001) (Table 2, Figure 1).

Table (2): Comparison among groups regarding morphine consumption.

	ESPB group	**Epidural group**	**Test value**	**p-value**	**Sig.**
First time to rescue analgesia (h)	10.71±3.58	6.53±2.19	-5.455	0.001	S
Postop morphine consumption (mg)	3.84±0.61	7.06±1.87	8.966	0.001	HS
Number of morphine boluses	1 (1-1)	2 (2-2)	3.196	0.001	HS
One bolus	*28 (93.3%)*	*4 (13.3 %)*	38.615	0.001	HS
Two boluses	*2 (6.7%)*	*24 (80%)*			
Three boluses	*0 (0%)*	*2 (6.7%)*			

utilizing: U=Mann-Whitney test for non-parametric data "Median (Interquartile range: IQR)" x2: Chi-square test for Number (%) or Fisher's exact test, when appropriate

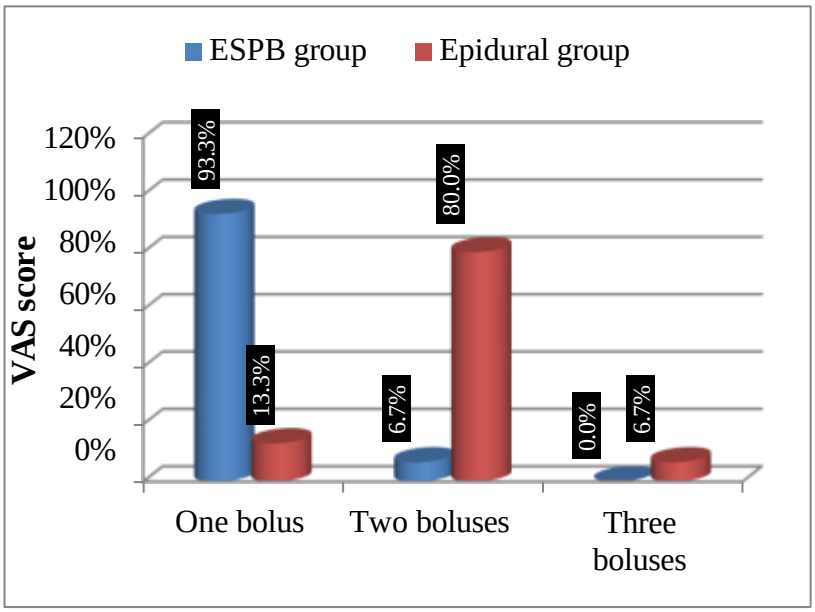


Fig. (1): Comparison between groups according to number of morphine boluses.

The epidural group exhibited a significantly greater mean VAS score than the ESPB group at thirty minutes, two hours, four hours, six hours, and eight hours (*P-vale less than 0.05). All other time intervals, nevertheless, didn't exhibit any statistically significant distinction between the groups (*P- value greater than 0.05) (Figure 2).

Rescue analgesia has been administered to both groups at intervals between the scheduled evaluation times, and by the following evaluation, the morphine had already reduced the pain. This explains why the graph consistently demonstrates VAS scores below 4 throughout.

There was a higher frequency of bradycardia and hypotension through surgery in epidural group compared to in erector spinae plane block group. For example, the heart rate at 30 minutes intraoperative was 79.45 ± 8.75 in the ESPB group and 69.91 ± 5.22 in the epidural group, while the mean arterial blood pressure (MABP) at 30 minutes intraoperative was 63.77 ± 6.75 and 56.23 ± 8.63, respectively (Figure 3,4).

No complications following surgery, including hematoma, PONV, or motor and sensory deficits, have been reported.

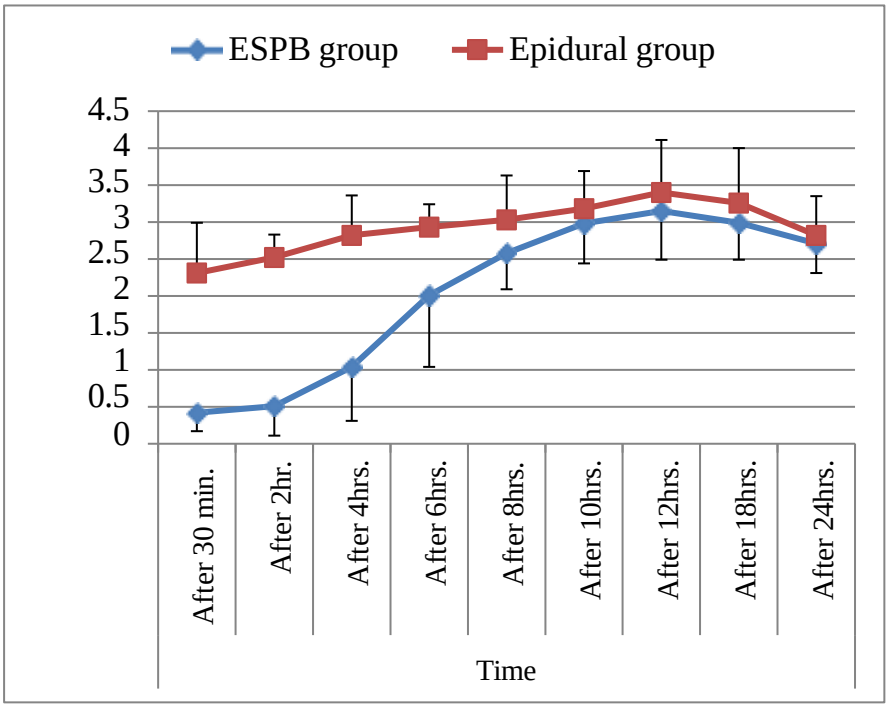


Fig. (2): Comparison among groups according to VAS score.

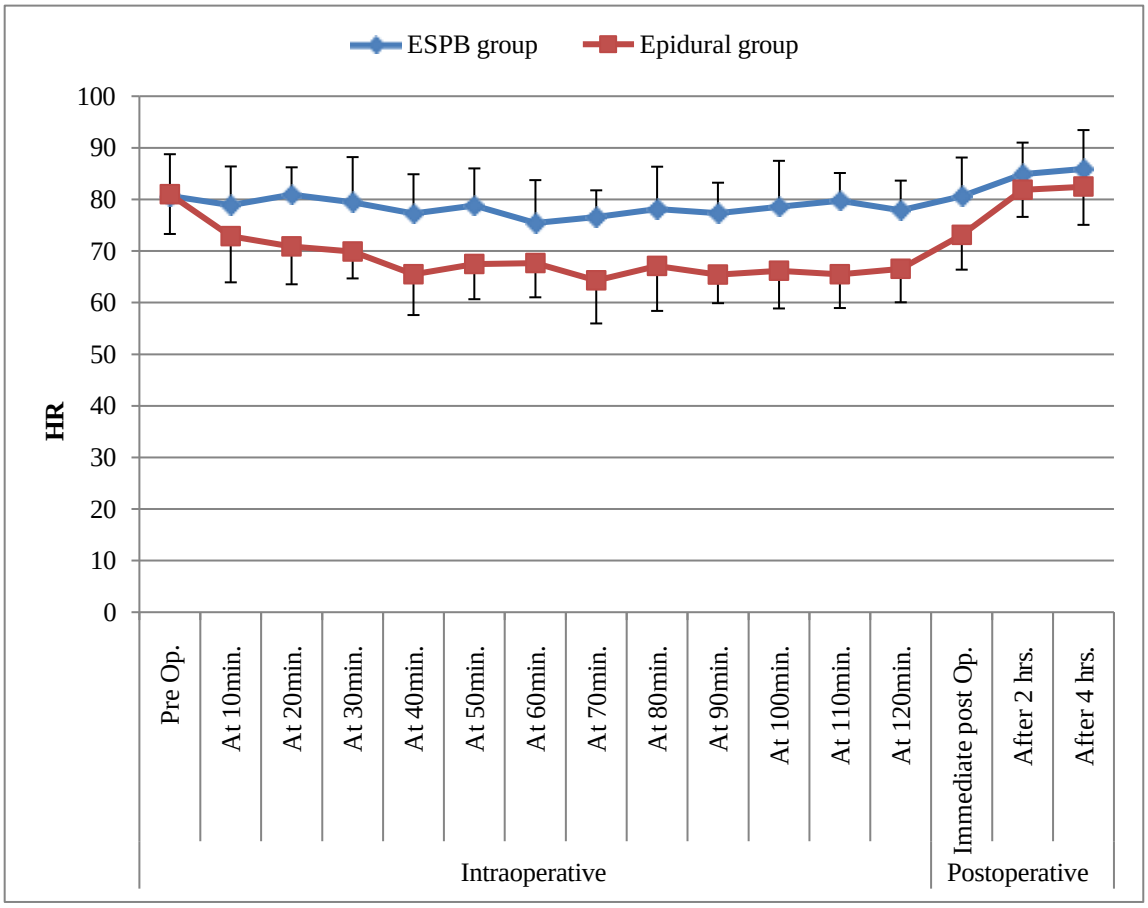


Fig. (3): Comparison among groups regarding HR "beat/min".

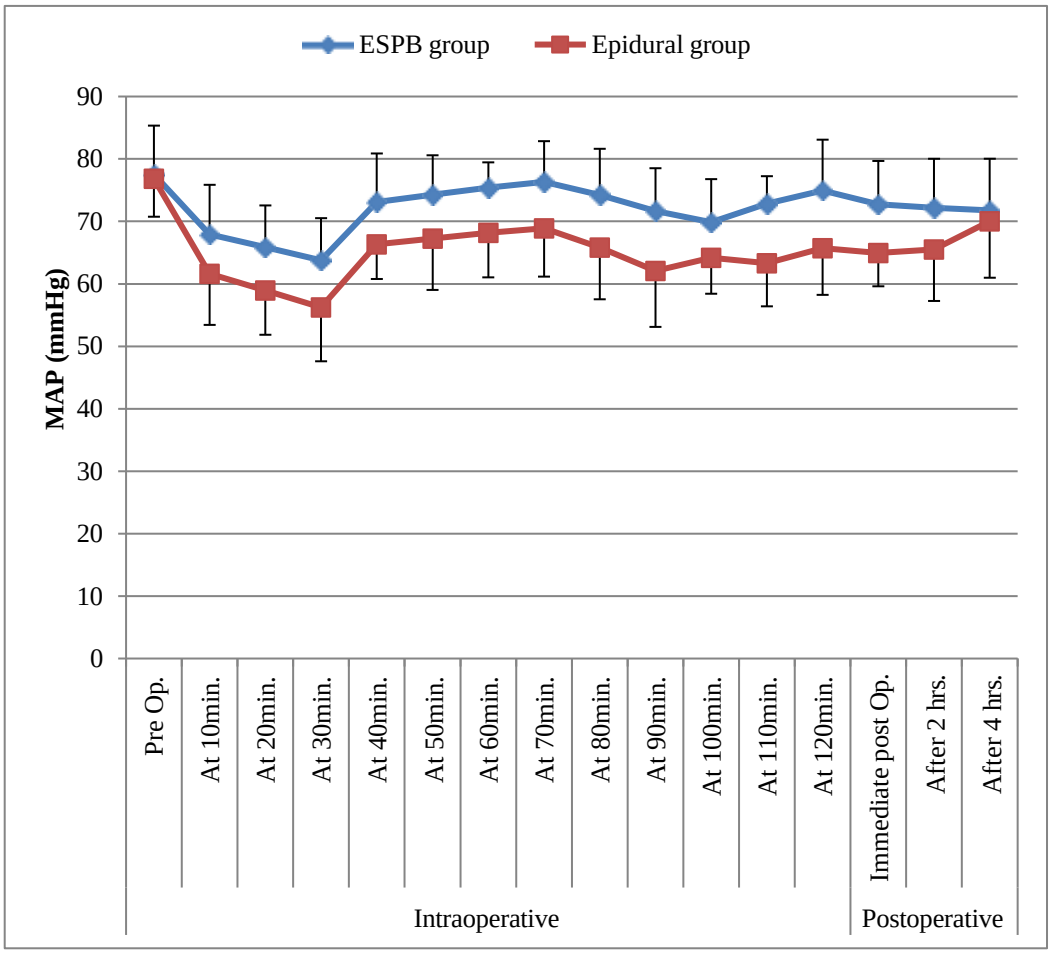


Fig. (4): Comparison between groups according to MAP (mmHg).

Discussion:

In this investigation, we found that bilateral ESPB resulted in extended analgesia following operation and decreased consumption of morphine within the 1st twenty-four hours when contrasted with epidural block. Furthermore, the epidural block exhibited a more unstable hemodynamic profile, with a higher frequency of hypotension & bradycardia, in comparison to the ESPB. Our results are consistent with prior research on ESPB in thoracic procedures [18], abdominal [11,12], and lumbar spine operation [10].

Erector spinae plane block is a relatively novel para-spinal block method that has been 1st introduced in 2016 to manage chronic neuropathic chest pain [6]. It has since been demonstrated to be efficient in managing pain following surgery in a variety of operative procedures, like breast, abdominal, thoracic, and hip procedures【16】. The technique includes the injection of local anesthetic (LA) between deep fascia of erector spinae muscle and transverse processes of the vertebrae.

In our investigation, the ESPB group demonstrated superior analgesia in comparison with the epidural group, as reflected by lower VAS scores at postoperative time points (thirty minutes, two hours, four hours, six hours, and eight hours). We attribute this to the larger, yet safe, dose of local anesthetic used in ESPB, which provided prolonged pain control.

The spread of local anesthetic from the epidural space to spinal cord, cerebrospinal fluid and nerve roots, is the mechanism by which epidural analgesia, a technique that is both extremely efficient and well-

established, attains its effect. Regrettably, we were incapable to receive a single large dose to the epidural group.

In the early duration following operation, the VAS scores of both ESPB and single-shot epidural blocks have been demonstrated to be similar, as evidenced by earlier comparisons in other procedures, including cardiac and thoracic surgeries 【13, 14 】. Our findings have been supported by these outcomes.

Our outcomes are in line with earlier investigation on ESPB in abdominal hysterectomy【11, 12】 and ovarian cancer【9】 surgeries, where the block was compared to different analgesic regimens, including intravenous opioids and transversus abdominis plane block. All these investigations demonstrated a significant variance in pain scores, with the ESPB group consistently reporting lower pain scores throughout the duration of the study.

On the other hand, a comparison was made between ESPB and single-shot epidural blocks in lumbar spine surgeries【10】. The epidural group demonstrated superior analgesia compared to the ESPB group throughout the early duration following operation (at IPOP, one hour, and two hours). The anatomical distinctions between the thoracic and lumbar paravertebral compartments might be the cause of this discrepancy from our results【15】. Multilevel analgesia is achieved in thoracic region due to the clear anatomical boundaries, which cause even small quantities of local anesthetic to spread caudally and cranially. In contrast, the lumbar region lacks such clearly defined boundaries, resulting in the local anesthetic spreading anteriorly in the paravertebral space, impacting the lumbar plexus and psoas muscle. This could result to the block that is less dense in the lumbar region.

The time to the 1st morphine needs has been significantly extended in ESPB group in comparison with the other groups, as demonstrated in prior investigations comparing ESPB with epidural, TAPB, or IV opioids for different operations. Furthermore, the ESPB group reported a significantly lower total consumption of opioid within the 1st twenty-four hours following surgery [9,10,11]. This is in accordance with our results.

ESPB's blockade of the rami communicantes, which impacts sympathetic fibers, might result in systemic hypotension, albeit to a lesser extent compared to epidural block【17】. This is in agreements with our outcomes. Earlier research additionally suggests that the frequency of hypotension is greater with epidural and paravertebral blocks than with ESPB【14】【18】. This indicates that erector spinae plane block is a safer alternative for elderly, high-risk, and vulnerable cases with limited cardiovascular reserves, as a sympathetic blockade might lead to severe hypotension and hypoperfusion in these patients. In abdominal hysterectomy, ESPB might be regarded as a viable alternative to epidural analgesia, as it offers adequate relief of pain with fewer side impacts. Furthermore, it is a simple method to carry out.

The possibility of complications with this method is minimal, as the target area for the block is distant from critical structures like major blood vessels, the pleura, and the medulla. Additionally, the extended analgesia provided by erector spinae plane block eliminates the need for multiple doses of local anesthetic, avoiding issues related to catheter use, such as dislodgment and leakage【16】.

Conclusion:

The erector spinae plane block offered longer-lasting analgesia and reduced opioid use throughout the 1st twenty-four hours postoperatively in comparison with a single-shot epidural block in total abdominal hysterectomy operation. It also resulted in a lower incidence of intraoperative hypotension and bradycardia.

Study Limitations:

A key limitation of this study was the utilization of on-demand morphine rather than of patient- controlled analgesia (PCA), which might have provided better quality analgesia.

Future Direction:
The findings of this study suggest the need for further research, including a broader range of open abdominal surgery procedures.

Confidentiality of data
The authors state that they have no conflict of interest.

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