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Comparison of Erector Spinae Plane Block with Transversus Abdominis Plane Block for Postoperative Pain Management in Patients undergoing Total Abdominal Hysterectomy: A Randomized Controlled Trial

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ABSTRACT

Introduction

Transversus abdominis plane (TAP) and Erector spinae plane (ESP) blocks are used regional anaesthesia techniques for abdominal surgery. This study compares the analgesic efficacy of ESP versus TAP blocks in patients undergoing total abdominal hysterectomy.

Methods

This prospective randomized study enrolled 44 patients undergoing total abdominal hysterectomy under general anesthesia. Patients were randomly assigned to two equal groups. Group A received bilateral erector spinae plane block, while Group B received bilateral transversus abdominis plane block under ultrasound guidance using 20 ml of 0.25% bupivacaine on each side. Outcomes assessed included time to first rescue analgesia, 24-hour analgesic consumption, postoperative pain scores at predefined intervals, and complications.

Results

The median time to first request for rescue analgesia was 1 hour in both groups and was not statistically significant ($p = 0.408$). The 24-hour median dose of rescue analgesia was 50 mg tramadol in the ESP group and 100 mg in the TAP group, which was statistically significant ($p = 0.022$). Comparison of Numeric Rating Scale (NRS) scores between the two groups at 0 and 1 hour postoperatively showed statistically significant differences ($p = 0.010$ and $p < 0.001$, respectively). NRS scores at 6, 8, 12, and 24 hours did not differ significantly between the groups, although median scores were lower in both. Complication rates were not significant in either group.

Conclusion

ESP block significantly reduced 24-hour rescue analgesia consumption compared with TAP. NRS scores differed at 0 and 1 hour, but were similarly low thereafter, indicating comparable overall postoperative analgesic efficacy profiles.

Keywords
Bupivacaine; gynaecological surgeries; pain management; regional anesthesia; visceral pain

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INTRODUCTION

Hysterectomy is one of the common gynecological surgeries worldwide.[1-2] Despite advances in surgical and anesthetic techniques, postoperative pain following hysterectomy is categorized as moderate to severe.[3] Inadequately controlled pain can delay ambulation, prolong hospital stay, increase opioid consumption, and negatively affect recovery and patient satisfaction.[4] Effective postoperative analgesia is therefore a cornerstone of enhanced recovery after surgery. Multimodal analgesia, which combines systemic analgesics with regional anesthesia techniques, is widely recommended to improve pain control while reducing opioid-related adverse effects.[4-5]

The Transversus Abdominis Plane (TAP) block has been extensively used for postoperative analgesia in abdominal surgeries, including hysterectomy.[6-7] By providing somatic analgesia to the anterior abdominal wall, TAP block has been shown to reduce postoperative pain scores and opioid requirements, and it is currently the standard regional analgesic technique in our center. However, a major limitation of the TAP block is its inability to reliably address visceral pain, which constitutes a significant component of postoperative pain following open abdominal hysterectomy.[6-7] The Erector Spinae Plane (ESP) block is a relatively newer regional anesthesia technique with favorable safety profile, and potential to provide both somatic and visceral analgesia. Emerging evidence suggests that ESP block may offer superior and longer-lasting analgesia for abdominal surgeries.[8]

This study aims to compare the effectiveness of ESP block with TAP block as components of multimodal postoperative analgesia in patients undergoing open total abdominal hysterectomy, evaluated through postoperative pain scores, first rescue analgesic request and analgesic requirements over 24 hours.

METHODS

This prospective, randomized interventional study (Clinical Trial: NCT05521841) was conducted among consenting participants aged >18 years with American Society of Anesthesiologists Physical Status (ASA PS) I and II undergoing elective open total abdominal hysterectomy under general anesthesia at Tribhuvan Univesity Teaching Hospital from December 2022 to April 2023, following ethical approval from the Institutional Review Committee. Participants who refused consent, had contraindications to peripheral nerve blocks, allergy to local anesthetics, or body weight <50 kg were excluded from the study. The sample size was calculated based on a study by Kamel et al.[9] using the formula: $n = 2(z\alpha + z\beta)^2S^2 / d^2$ where $z\alpha = 1.96$ at a 95% confidence level and $z\beta = 1.65$ at 95% power. The mean time to first morphine requirement was 14.81 ± 3.52 hours in the ESP group and 10.58 ± 2.35 hours in the TAP group. The mean difference (d) was 4.23 hours, and the larger standard deviation (S = 3.52) was used for calculation. The calculated sample size was 19 participants per group. Considering a 10% dropout rate, two additional participants were added to each group, resulting in a final sample size of 22 participants per group.

General anesthesia with endotracheal intubation was administered to all patients undergoing total abdominal hysterectomy according to the institutional protocol. After completion of surgery, participants received either a bilateral erector spinae plane (ESP) block (Group A) or a bilateral transversus abdominis plane (TAP) block (Group B) using the sealed-envelope technique. Anesthesia was maintained with isoflurane and oxygen during block performance. The block was given by an anaesthesiologist who had met the learning curve for both the procedure.[10] For Group A, a linear ultrasound transducer was placed in a cephalocaudal orientation at the T10 vertebral level with the patient in the lateral position. After identification of the transverse process, trapezius, and erector spinae muscles, a 25-gauge Quincke spinal needle was inserted using an in-plane cephalad-to-caudal approach. Following confirmation of correct plane separation, 20 mL of 0.25% bupivacaine was injected in 5-mL increments after negative aspiration. The procedure was repeated contralaterally. For Group B, the linear transducer was placed transversely over the lateral abdominal wall at the mid-axillary line between the costal margin and iliac crest. After visualization of the abdominal wall muscles, the needle was

advanced in-plane into the plane between the internal oblique and transversus abdominis muscles. Following negative aspiration, 20 mL of 0.25% bupivacaine was administered in 5-mL increments on each side.

Both groups received a standardized multimodal analgesic regimen consisting of fentanyl 2 µg/kg bolus followed by 0.5 µg/kg hourly, with additional doses as required, paracetamol 15 mg/kg, and dexamethasone 4 mg intraoperatively. After completion of block, patients were extubated, following which patients were transferred to the recovery room. Pain was assessed using the Numerical Rating Scale (NRS) at 0 (at transfer to recovery room), 1, 6, 8, 12, and 24 hours postoperatively by nursing staff. The time to first rescue analgesia was recorded when patients reported pain (NRS >3), and injection tramadol 50 mg was administered intravenously. If pain persisted after 10 minutes, additional doses of tramadol 50 mg were given at 10-minute intervals up to a maximum of 150 mg. Ketorolac was planned as second-line rescue analgesia if pain persisted. Intravenous paracetamol 15 mg/kg was administered every 6 hours in both groups. Any block-related complications were documented.

RESULTS

A total of forty four patients were included in the study, 22 in each group. The demographic profile were similar in between the two groups. The duration of surgery and distribution of ASA I and II were also similar. The details are provided in the Table 1.

Table 1. Patient characteristics and duration of surgery in the two group

Demographic variables	ESP Group A		TAP Group B		p
	Mean/ Median/no.	SD/IQR/%	Mean/Median/no	SD/IQR/%	
Age (years)*	46.0	8.3	46.1	7.6	0.955
Weight (kg)*	60.4	6.1	61.8	9.6	0.565
Height (cm)*	152.5	3.3	150.4	4.1	0.069
Duration of Surgery (mins)#	135	60	142.5	60	0.887
ASA PS I**	13	59.09%	16	72.72%	0.34
ASA PS II**	9	40.9%	6	27.27%	

*mean; #median; ** number

Regarding the request for rescue analgesia, the median time for Group A and Group B was 1 hour, with an interquartile range (IQR) of 17.012 hours and 2.037 hours respectively which is statistically insignificant (p= 0.408). However, regarding the requirement of rescue analgesia in 24 hours, the median dosage of Tramadol in Group A and Group B was 50mg and 100 mg respectively with IQR of 62.5 and 50 minutes respectively which was statistically significant. (p value 0.022) and the details are provided in Table 2. Similarly regarding NRS score, it was statistically significant at 0 and 1 hour. The details at different intervals are given in Table 3.

Table 2. Comparison of Rescue analgesia Request time and Rescue analgesia dosage

Variable	ESP				TAP				
	Median	Q1	Q3	IQR	Median	Q1	Q3	IQR	P
Rescue analgesia request time (hrs.)	1	0.1875	17.25	17.012	1	0.2125	2.25	2.037	0.408
Rescue analgesia dosage (mg)	50	50	100	50	100	87.5	150	62.5	0.022

Table 3. Comparison of NRS

NRS (hours)	ESP Group A			TAP Group B			p
	Median (NRS)	Q1	Q3	Median (NRS)	Q1	Q3	
NRS at 0	1.5	0	2.25	2.5	2	3	0.010
NRS at 1	2	2	3	3	3	4	<0.001
NRS at 6	2	2	3	3	2	3	0.058

NRS at 8	2	1.75	3	3	2	4	0.076
NRS at 12	3	2	3	3	2	4	0.284
NRS at 24	3	3	4	3	2	4	0.279

Regarding complications, 2 and 3 patients from Group A and B respectively had PONV but it was not statistically significant. None of the other complications were observed in either group. The details are given in Table 4.

Table 4. Comparison of complications of the patient in each of the groups

Complication	ESP Group A (freq/%)	TAP Group B (freq/%)	p
PONV	2/9.1%	3/13.6%	1
Drowsiness	0	0	
Respiratory depression	0	0	
Motor block	0	0	

DISCUSSION

This study demonstrated that the ESP block group required significantly less rescue analgesia over 24 hours compared with the TAP block group (tramadol 50 mg vs 100 mg), which was statistically significant (p = 0.022). Similarly, the ESP block was associated with significantly lower pain scores at 0- and 1-hour post-block compared with the TAP block. However, the median time to first request of rescue analgesia was 1 hour in both groups. The interquartile range (IQR) was wider in Group A (ESP block: 17.01 hours) compared with Group B (TAP block: 2.04 hours), but this difference was not statistically significant (p = 0.408). The incidence of complications such as respiratory depression, postoperative nausea and vomiting (PONV), drowsiness, and motor block did not differ significantly between the two groups.

The median time to first rescue analgesia (tramadol) was not significantly different between the ESP and TAP block groups. However a wider IQR observed in the ESP group suggests greater interindividual variability in analgesic duration, indicating a less consistent analgesic response compared with the TAP block. Notably, the time to first rescue analgesia observed in this study was shorter than that reported in other studies. This finding contrasts with the study by Kamel et al.[9], in which the time to first morphine requirement was significantly longer in both ESP group (14.81 ± 3.52 hours) and TAP group (10.58 ± 2.35 hours) and the difference was statistically significant (p < 0.0001) in between the two. This difference may be attributed to their use of 20 mL of 0.375% bupivacaine with adrenaline (5 µg/mL) on each side at the T9 level. In contrast, our study used a lower concentration of bupivacaine (0.25%) without any adjuvant, which may have contributed to the earlier request for rescue analgesia. Similarly, Shukla et al.[11] reported a significantly longer mean duration of analgesia in the ESP group (4.73 ± 0.7 hours) compared with the TAP group (2.60 ± 0.51 hours), both of which were longer than those observed in our study. This difference may be explained by the use of additives such as lignocaine and fentanyl in their study, despite using the same concentration of bupivacaine.

Regarding postoperative rescue analgesic consumption, the median dose of tramadol over 24 hours was 50 mg in the ESP block group and 100 mg in the TAP block group, with interquartile ranges (IQR) of 60.5 mg and 50 mg, respectively. This difference was statistically significant (p = 0.022). These findings are consistent with those of similar studies comparing ESP and TAP blocks, in which the ESP block was associated with significantly reduced rescue analgesic requirements over 24 hours. Kamel et al.[9] reported significantly lower 24-hour morphine consumption in the ESP block group (6.02 ± 1.2 mg) compared with the TAP block group (7.31 ± 2.3 mg). Similarly, Shukla et al.[11] observed significantly higher 24-hour tramadol consumption in the TAP block group (233.33 ± 25.82 mg) than in the ESP block group (193.33 ± 17.59 mg). In another study by Hamad et al.[12], total fentanyl consumption during the first 24 postoperative hours was significantly higher in the control group (485 ± 20.39 µg)

compared with the ESP block group (445 ± 67.49 µg). Postoperative 24 hour analgesic requirements are influenced by analgesics administered during the perioperative period including intraoperative and postoperative period. In our study, perioperative analgesia was standardized in both groups, except for rescue analgesia. Therefore, the observed significant reduction in tramadol consumption indicates that the ESP block is more effective than the TAP block in reducing postoperative rescue analgesic requirements over 24 hours. This finding is further supported by evidence from meta-analyses. [13-14]

Regarding pain intensity, statistically significant differences in Numeric Rating Scale (NRS) scores were observed at 0 and 1 hour postoperatively, with lower scores in the ESP block group ($p < 0.05$). Beyond the first postoperative hour, NRS scores did not differ significantly between the two groups ($p > 0.05$). In contrast, Kamel et al.[9] reported significantly lower visual analogue scale (VAS) scores in the ESP group at 30 minutes, 2 hours, and at later time points including 12, 16, 20, and 24 hours ($p < 0.0001$). Similarly, Shukla et al.[11] demonstrated significantly lower NRS scores in the ESP group compared with the TAP group from the 2nd to the 6th postoperative hour ($p < 0.05$). These discrepancies may be attributed to differences in perioperative analgesic protocols, including the use of adjuvants in regional blocks and the administration of longer-acting systemic opioids in the intraoperative and postoperative periods. In our study, although a statistically significant difference in NRS scores was observed between the two groups during the first postoperative hour, the median NRS score in both groups was 3 or less thereafter (at the 6th, 8th, 12th, and 24th hours), indicating comparable analgesic efficacy of the two blocks over time. This finding is consistent with the study by Rosato et al.[15], who compared ESP and TAP blocks using 0.37% ropivacaine with 2 mg dexamethasone in patients undergoing laparoscopic hysterectomy and observed a significant difference only in the immediate postoperative period, with similar NRS scores thereafter. Likewise, in our study, both groups received 0.25% bupivacaine without any adjuvant, which may explain the comparable pain control beyond the early postoperative period.

The demographic variables were comparable between the two groups with respect to age, height, weight, American Society of Anesthesiologists physical status (ASA PS), and duration of surgery. Ultrasound guidance enables anesthesiologists to visualize relevant anatomical structures, including muscles and nerves, before injecting local anesthetic, thereby reducing the risk of complications. In our study, no block-related complications were observed. None of the patients experienced respiratory depression, drowsiness, or motor block. Postoperative nausea and vomiting (PONV) occurred in two patients in the ESP group and three patients in the TAP group; however, this difference was not statistically significant.

ESP block significantly reduced 24-hour rescue analgesia compared with TAP. NRS scores differed at 0 and 1 hour, but were similarly low thereafter, indicating comparable overall postoperative analgesic efficacy profiles of both groups. However postoperative pain assessment in our study was limited to the first 24 hours, which may not have captured differences in longer-term analgesic efficacy or recovery outcomes.

CONCLUSION

This study demonstrates that the erector spinae plane (ESP) block provides superior postoperative analgesic benefits compared with the transversus abdominis plane (TAP) block in patients undergoing abdominal hysterectomy, as evidenced by a significant reduction in 24-hour rescue analgesic consumption and lower pain scores in the immediate postoperative period. Though pain scores were significantly lower with the ESP block during the first postoperative hour, beyond this period, both blocks offered comparable analgesic efficacy, with acceptable pain control throughout the first 24 hours. Importantly, the incidence of adverse effects and block-related complications was low and comparable between groups, underscoring the safety of both techniques under ultrasound guidance.

CONFLICT OF INTEREST

None

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