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Comparative Study of Ultrasound-guided Post-Operative Analgesia using Opioid versus Opioid-free Analgesia in Elective Abdominal Surgeries under Spinal Anaesthesia

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Abstract

Introduction: The reliance on opioid-based analgesia for postoperative pain control, while effective, is frequently accompanied by adverse effects such as respiratory depression, postoperative nausea and vomiting, delayed recovery, and the potential for opioid dependence. In the context of enhanced recovery protocols, there is growing interest in opioid-sparing and opioid-free analgesic strategies.

Objectives: This study aimed to evaluate the comparative efficacy of opioid based versus opioid-free postoperative analgesia in patients undergoing elective lower abdominal surgeries under spinal anesthesia. Particular emphasis was placed on assessing pain scores, hemodynamic parameters, incidence of PONV, and total opioid consumption within the first 24 hours postoperatively.

Methods: A prospective observational study was conducted at a tertiary care institution involving adult patients (aged 18-60 years) undergoing elective lower abdominal surgery under spinal anesthesia. Participants were stratified into two groups: Group A received conventional opioid-based analgesia with intravenous tramadol, whereas Group B received an opioid-free regimen incorporating a single-injection, ultrasound-guided erector spinae plane (ESP) block at the T9 level using 20 ml of 0.25% bupivacaine. Postoperative pain was assessed using the Visual Analogue Scale (VAS) at 2, 4, 12, and 24 hours. Hemodynamic parameters, PONV incidence, and total opioid consumption were systematically documented.

Results: The opioid-free group demonstrated significantly lower VAS scores at all measured time points ($p < 0.05$), improved hemodynamic stability, and a markedly reduced incidence of PONV. The requirement for rescue analgesia was also substantially diminished in this group compared to the opioid-based cohort.

Conclusion: Ultrasound-guided ESP block provides effective and sustained postoperative analgesia in lower abdominal surgeries performed under spinal anesthesia. The technique facilitates opioid-free recovery, minimizes opioid associated side effects, and supports enhanced postoperative outcomes, thereby underscoring its value as an integral component of multimodal analgesia protocols.

Keywords: Opioid-free analgesia; Erector spinae plane block; Ultrasound-guided regional anesthesia; Postoperative pain; Visual Analogue Scale; Multimodal analgesia

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Introduction

Pain management is a cornerstone of modern healthcare, significantly influencing patient recovery, satisfaction, and overall quality of life. Among the pharmacological options, opioid analgesia has long been regarded as the gold standard for managing moderate to severe pain due to its potent efficacy. Opioids such as morphine, oxycodone, and fentanyl act by binding to μ-opioid receptors in the central and peripheral nervous systems, modulating pain perception and providing substantial analgesic relief. However, despite their effectiveness, opioids are frequently associated with a wide range of adverse effects, including nausea, vomiting, constipation, respiratory depression, tolerance, dependence, and the potential for misuse and addiction [1,2].

The alarming rise in opioid prescriptions, misuse, and overdose deaths over the past two decades has prompted a global reassessment of perioperative pain management strategies [3]. Identifying patients at risk of receiving excess opioids and optimizing non-opioid analgesic strategies have therefore become urgent priorities. Opioid-sparing analgesia involves the use of multimodal techniques to reduce or eliminate opioid consumption while maintaining adequate pain control. This approach typically includes non-opioid medications such as non-steroidal anti-inflammatory drugs (NSAIDs), acetaminophen, gabapentinoids, and local anesthetics, as well as regional anesthesia techniques including peripheral nerve and fascial plane blocks [4,5]. The goal is to enhance recovery, minimize opioid-related complications, and improve patient satisfaction. Emerging evidence suggests that multimodal opioid-sparing analgesia can provide comparable, and in some cases superior, analgesia while significantly reducing opioid-related side effects and dependency [6,7].

This thesis aims to explore the comparative benefits and limitations of opioid based versus opioid-sparing analgesia, with a focus on the use of ultrasound guided ESPB in patients undergoing elective abdominal surgeries. By assessing pain control, hemodynamic stability, opioid consumption, and adverse effects, this study seeks to contribute to evidence-based clinical decision-making and support the broader goal of safe and effective pain management.

Material and Methods

This was an observational prospective study conducted at SNMC; Agra a 750-bedded tertiary care university teaching hospital. This study was conducted between February 2023 to August 2024 on 60 patients aged 18-60 years undergoing elective lower abdominal surgery. SPSS software was used for statistical analysis. Parametric and non-parametric data were analyzed using Student's t test, paired t-test, and Chi-square test, with significance set at $p<0.05$.

Inclusion Criteria

Age 18-60 years, ASA physical status I or II, Voluntary informed consent.

Exclusion Criteria

ASA grade III or IV, Age 60 years, Hemodynamic instability, GCS 4 hours, known allergy to opioids/local anesthetics, History of substance abuse, Antiplatelet therapy or coagulopathy, Patients unable to comprehend VAS, Postoperative ventilator support anticipated, Pregnancy.

Methodology

Grouping and Randomization.

A total of 60 patients were randomly divided into two groups

- Group 1 - Opioid-Free Analgesia
- Group 2 - Opioid-Based Analgesia

All patients underwent a preoperative assessment and standard monitoring. Intravenous access was secured and pre-loading done with Ringer's lactate at 10 mL/kg. All patients received spinal anesthesia in the sitting position using a 25G Quincke needle inserted at the L3-L4 or L4-L5 interspace. A total of 3.5 ml of 0.5% hyperbaric bupivacaine was injected intrathecally under aseptic precautions [8].

Group 1 patients received a bilateral ultrasound-guided Erector Spinae Plane Block (ESPB) at T9 before spinal anesthesia. High-frequency linear ultrasound probe (6-13 MHz) was placed longitudinally ~3 cm lateral to the midline to identify the trapezius, rhomboid major (if present), and erector spinae overlying the transverse process. The needle was inserted in-plane in a cranial-to-caudal direction until the transverse process was contacted [9,10]. After negative aspiration, 1-2 ml of 2% lidocaine was used for infiltration. Then, 20 ml of 0.25% bupivacaine was injected between the erector spinae muscle and the transverse process to confirm hydro-dissection [11]. The procedure was repeated contralaterally.

Group 2 patients received only spinal anesthesia as per the above protocols. For postoperative analgesia, IV Tramadol (100 mg) was administered. At the conclusion of surgery, the following hemodynamic parameters were recorded in both groups (heart rate, systolic and diastolic blood pressure, mean arterial pressure, respiratory rate). Postoperative pain was assessed using the Visual Analogue Scale (VAS) at 2, 4, 12, and 24 hours postoperatively [2]. Rescue analgesia with IV Tramadol (100 mg slow) was given if VAS >5. Statistical Analysis Data were tabulated and analyzed using SPSS. Continuous variables were expressed as mean ±standard deviation and compared using t-tests. Categorical variables were compared using Chi-square test. A p-value of <0.05 was considered statistically significant.

Observation and Results

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Table 1: Shows comparison in the two study groups with respect to age.

Age group(yrs)	With Opioid		Without Opioid	
	No.	%	No.	%
< 25	7	23.33	3	10.00
25-50	16	53.33	19	63.33
>50	7	23.33	8	26.67
Total	30	100.00	30	100.00

Chi-square value=1.923, p-value=0.382

Table 2: Shows the demographic characteristics of patients in both the groups.

Sex	With Opioid		Without Opioid	
	No.	%	No.	%
Male	16	53.33	14	46.67
Female	14	46.67	16	53.33
Total	30	100.00	30	100.00

Chi-square value=0.266, p-value=0.605

Table 3: Shows the comparison of heart rate at the end of surgery.

Group	N	Mean	SD	t-value	p-value
With Opioid	30	94.53	10.99	-4.478	<0.0001
Without Opioid	30	82.70	9.41		

Table 4: Shows the comparison of Systolic Blood Pressure reading at the end of surgery.

Group	N	Mean	SD	t-value	p-value
With Opioid	30	123.20	12.77	-0.708	0.4818
Without Opioid	30	120.87	12.72		

Table 5: Shows the comparison of Diastolic Blood Pressure reading at the end of surgery.

Group	N	Mean	SD	t-value	p-value
With Opioid	30	75.9	5	-1.713	0.092
Without Opioid	30	73.6	5.5		

Table 6: Shows the comparison of VAS scores between the two groups 2 hours after the surgery.

VAS	With Opioid		Without Opioid	
	No.	%	No.	%
0			30	100.00
1				
2	16	53.33		
3	9	30.00		
4	5	16.67		
5				
6				
7				
8				
Total	30	100.00	30	100.00

Table 7: Shows the comparison of VAS scores between the two groups 4 hours after the surgery.

VAS	With Opioid		Without Opioid	
	No.	%	No.	%
0			30	100.00
1				
2	11	36.67		
3	7	23.33		
4	4	13.33		
5	8	26.67		
6				
7				
8				
Total	30	100.00	30	100.00

Table 8: Shows the comparison of VAS scores between the two groups 12 hours after the surgery.

VAS	With Opioid		Without Opioid	
	No.	%	No.	%
0	0	0	19	63.33
1	0	0	4	13.33
2	0	0	4	13.33
3	0	0	3	10.00
4	12	40.00	0	0
5	18	60.00	0	0
6	0	0	0	0
7	0	0	0	0
Total	30	100.00	30	100.00

Table 9: Shows the comparison of VAS scores between the two groups 24 hours after the surgery.

VAS	With Opioid		Without Opioid	
	No.	%	No.	%
0			20	66.67
1			1	3.33
2			7	23.33
3			2	6.67
4	9	30.00		
5	15	50.00		
6	6	20.00		
7				
Total	30	100.00	30	100.00

Discussions

Post-operative pain management is a critical aspect of perioperative care that significantly influences patient recovery, clinical outcomes, and overall satisfaction. Uncontrolled postoperative pain can trigger an exaggerated physiological stress response, characterized by elevated heart

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rate, increased blood pressure, and delayed wound healing. Conversely, appropriate an-algesia enables early ambulation and rehabilitation, decreasing the risk of complications such as pneumonia and thromboembolism. From a psychological standpoint, adequate pain control minimizes anxiety, depression, and emotional distress, ultimately fostering a more positive perception of the recovery process and improved compliance with treatment protocols.

In this study, demographic characteristics were comparable between groups. As shown in Table 1, the age distribution of participants ranged from 18 to 60 years. The chi-square test yielded a value of 1.923 with a p-value of 0.382, indicating no statistically significant difference. Gender distribution was also statistically non-significant ($p = 0.605$), with 16 males and 14 females in the opioid group, and 14 males and 16 females in the opioid-free group (Table 2).

Postoperative monitoring of vital hemodynamic variables revealed a significant difference in heart rate between the two groups. The mean postoperative heart rate was notably higher in the opioid group, at 94.53 ±10.99 beats per minute, in comparison to 82.70 ±9.41 beats per minute in the opioid-free group, a difference that was statistically significant ($p < 0.001$). This elevation may reflect a physiological stress response or increased nociceptive input in the opioid group, possibly due to less effective early postoperative analgesia. In contrast, no statistically significant differences were observed in systolic or diastolic blood pressures. The mean systolic blood pressure was 123.30 ± 12.77 mmHg in the opioid group and 120.87 ±12.72 mmHg in the opioid-free group ($p = 0.4818$), while the corresponding diastolic pressures were 75.90 ± 4.99 mmHg and 73.57 ±5.53 mmHg respectively ($p = 0.092$).

Pain intensity was assessed using the Visual Analogue Scale (VAS) at regular intervals postoperatively to compare the analgesic efficacy of opioid-based versus opioid-free regimens. In the immediate postoperative period, all patients in both groups reported a VAS score of 0, consistent with the residual analgesic effect of spinal anesthesia. At the 2-hour postoperative mark, patients in the opioid-free group continued to report no pain (VAS = 0), whereas 16 patients in the opioid group had a VAS score of 2. Although this reflected a mild return of pain sensation in the opioid group, no patient in either cohort had a VAS ≥5 at this stage, and no rescue analgesia was required. At 4 hours postoperatively, the analgesic advantage of the opioid-free group persisted, with all patients maintaining a VAS of 0. However, in the opioid group, 4 patients reported a VAS of 4 and 8 patients had a VAS of 5. These 8 individuals required administration of intravenous tramadol (100 mg) as rescue analgesia, indicating the onset of moderate pain. By 12 hours post-surgery, the opioid-free group still demonstrated superior analgesia, with 19 patients experiencing no pain (VAS = 0). In contrast, the opioid group showed further deterioration in pain control, as 12 patients reported a VAS of 4 and 18 had a VAS of 5, necessitating IV tramadol administration for adequate pain relief. At the 24-hour mark, 20 patients in the opioid-free group remained pain-free (VAS = 0), and the remaining 7 reported only mild discomfort (VAS = 2). The opioid group, however, continued to experience moderate to severe pain: 9 patients had a VAS of 4, 15 reported a VAS of 5, and 6 patients had a VAS of 6. All of these patients received tramadol (100 mg IV) as rescue medication. These data collectively illustrate that the opioid-free regimen, supported by ultrasound-guided erector spinae plane block, provided more consistent and sustained postoperative analgesia over the 24-hour period, with a lower requirement for rescue analgesia and superior pain scores compared to the opioid-based approach.

These findings demonstrate superior analgesia in the opioid-free group, attributed to the efficacy of the ESP block. The results are consistent with previous studies showing reduced postoperative pain scores and analgesic requirements in patients managed with opioid-free protocols and regional nerve blocks.

The findings of the current study regarding VAS scores and patient satisfaction are consistent with those reported by Ragupathy et al., in their prospective, non-randomized study on opioid-free anesthesia (OFA) for laparoscopic surgeries in a tertiary care setting [12].

Similarly, postoperative nausea and vomiting (PONV) were significantly reduced in the OFA group, a finding supported by Feng et al., who demonstrated that OFA reduced the incidence of PONV compared to opioid based techniques (15% vs. 31.7%; OR = 0.38; 95% CI, 0.16-0.91; P = 0.031) [13].

Conclusion

This prospective observational study provides compelling evidence that opioid free postoperative analgesia using ultrasound-guided erector spinae plane (ESP) block offers superior clinical outcomes compared to conventional opioid based regimens in patients undergoing elective lower abdominal surgeries under spinal anesthesia. The ESP block significantly reduced postoperative pain intensity, minimized opioid consumption, and was associated with a markedly lower incidence of opioid-related adverse effects, particularly postoperative nausea and vomiting.

This study, therefore, supports the feasibility, safety, and clinical efficacy of opioid-free an-aesthesia with ESP block as a viable and potentially superior alternative to traditional opioid-based analgesia in the perioperative setting.

Manuscript has been read and approved by all the authors.

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