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Efficacy of Epidural Tramadol as an Adjuvant to Ropivacaine in Postoperative Pain Management

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Abstract

Background

Postoperative pain control is a crucial aspect of recovery following abdominal surgeries, influencing patient comfort, mobility, and overall outcomes. Epidural analgesia has gained prominence for its ability to provide sustained pain relief with minimal systemic side effects. Among local anesthetics, ropivacaine is widely used due to its prolonged action and reduced motor blockade compared to bupivacaine. However, the limited duration of local anesthetics has prompted the use of adjuvants like tramadol, a centrally acting analgesic that works through opioid receptor activation and monoaminergic modulation to enhance and extend analgesic effects. This study aims to evaluate the postoperative analgesic efficacy of epidural 0.2% ropivacaine alone versus 0.2% ropivacaine with tramadol (1 mg/kg) in adult patients undergoing abdominal surgeries under general anesthesia.

Methods

A prospective, randomized, controlled trial was conducted on 50 adult patients scheduled for elective abdominal surgeries. Participants were randomly allocated into two groups. Group R received 10 mL of 0.2% ropivacaine epidurally, while Group RT received 10 mL of 0.2% ropivacaine combined with tramadol (1 mg/kg). The primary endpoint was the duration of postoperative analgesia, while secondary parameters included pain scores assessed using the Visual Analog Scale (VAS), sedation levels measured by the Ramsay Sedation Score, hemodynamic stability, and adverse effects.

Results

Patients in Group RT had a significantly prolonged analgesia duration of 315.6 ± 18.5 minutes compared to 225.3 ± 14.8 minutes in Group R ($p < 0.001$). VAS scores were consistently lower in Group RT at 2, 4, and 6 hours postoperatively ($p < 0.05$). The mean sedation score in Group RT was 3.06 ± 0.12, higher than 1.26 ± 0.44 in Group R. Hemodynamic parameters remained stable in both groups, with no significant changes in heart rate, mean arterial pressure, or oxygen saturation. The incidence of nausea (16% vs. 12%) and vomiting (12% vs. 8%) was slightly higher in Group RT, but no cases of hypotension, bradycardia, or respiratory depression were observed.

Conclusion

The combination of epidural tramadol with ropivacaine effectively prolongs postoperative analgesia, improves pain scores, and enhances patient comfort without causing significant

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hemodynamic instability or severe adverse effects. This approach can be a safe and effective strategy for managing postoperative pain in abdominal surgeries.

Keywords: Postoperative analgesia, epidural anesthesia, ropivacaine, tramadol, abdominal surgery, pain management

Introduction

Managing postoperative pain after major abdominal surgeries is a crucial aspect of patient care, as inadequate pain relief can lead to prolonged recovery, increased complications, and poor patient satisfaction. Among the various analgesic techniques available, epidural analgesia has proven to be one of the most effective, providing superior pain control with minimal systemic adverse effects. [1,2]

Ropivacaine, a long-acting amide local anesthetic, has gained widespread clinical acceptance due to its reduced cardiotoxicity and lesser motor blockade compared to bupivacaine. However, the primary limitation of local anesthetics is their relatively short duration of action, necessitating the use of adjuvants to prolong their efficacy. [3,4] One such promising adjuvant is tramadol, a centrally acting analgesic that exerts its effect through opioid receptor binding as well as inhibition of norepinephrine and serotonin reuptake, thereby enhancing and extending the analgesic effect of local anesthetics. [5,6]

While previous studies have evaluated the efficacy of ropivacaine in epidural analgesia for postoperative pain management [3,7], there is still limited data on the benefits of adding tramadol in this setting, particularly in adult patients undergoing abdominal surgeries. Existing literature supports the use of tramadol as an adjuvant in regional anesthesia techniques, but its specific role in combination with epidural ropivacaine post-abdominal surgery remains underexplored. [8]

This study aims to compare the postoperative analgesic efficacy of 0.2% epidural ropivacaine alone versus 0.2% ropivacaine with tramadol (1 mg/kg) in adult patients undergoing abdominal surgeries under general anesthesia. Key parameters such as duration of analgesia, sedation levels, hemodynamic stability, and adverse effects will be analyzed to assess the potential advantages and safety profile of incorporating tramadol into epidural ropivacaine for enhanced postoperative pain control.

Materials and Methods

This prospective, randomized, controlled clinical study aimed to assess the postoperative analgesic efficacy of epidural 0.2% Ropivacaine alone versus 0.2% Ropivacaine with Tramadol (1 mg/kg) in adult patients undergoing abdominal surgeries under general anesthesia.

A total of 50 patients were randomly assigned into two groups (n=25 each). Group R received 10 mL of 0.2% Ropivacaine, while Group RT received 10 mL of 0.2% Ropivacaine with 1 mg/kg Tramadol via epidural. The single-blind design ensured that patients and postoperative evaluators were unaware of group assignments.

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Eligibility criteria included patients aged 30–60 years, scheduled for elective abdominal surgeries under general anesthesia, with ASA grade I–II. Patients with opioid or local anesthetic allergy, spinal deformities, neurological disorders, coagulation abnormalities, or severe systemic disease were excluded. Those unable to communicate pain levels were also not considered.

Preoperative assessment involved history, physical examination, and laboratory tests (CBC, coagulation profile, liver and renal function tests). Patients received Inj. Metoclopramide (10 mg IM) and Inj. Ranitidine (50 mg IV) and were kept NPO for 6 hours before surgery.

In the operating room, standard monitoring (ECG, NIBP, SpO_2, respiratory rate) was initiated. A 20G IV cannula was inserted, and Ringer's lactate (10 mL/kg) was infused. Epidural anesthesia was administered at L2-L3 intervertebral space using an 18G Tuohy needle with the loss of resistance technique. A 20G epidural catheter was inserted and secured after confirming negative aspiration for blood or CSF. A test dose (3 mL of 1.5% lidocaine with adrenaline 1:200,000) ruled out intravascular or subarachnoid placement.

General anesthesia was induced with Inj. Glycopyrrolate (5 mcg/kg IV), Inj. Midazolam (0.01 mg/kg IV), Inj. Fentanyl (2 mcg/kg IV), Inj. Propofol (2 mg/kg IV), and Inj. Atracurium (0.5 mg/kg IV). Patients were intubated with an appropriate-size endotracheal tube and maintained on 50% nitrous oxide-oxygen, Sevoflurane (1-2%), intermittent fentanyl (20 mcg/hour IV), and atracurium (10 mg IV every 30 minutes). At skin closure, the allocated epidural drug was administered. Postoperative monitoring included pain assessment (VAS, 0-10 scale) every 15 minutes for 2 hours, then hourly up to 12 hours, and sedation assessment (Ramsay Sedation Score, 1-6 scale). Hemodynamic parameters (heart rate, MAP, respiratory rate, and SpO_2) were recorded at similar intervals. Side effects like nausea, vomiting, pruritus, hypotension, and respiratory depression were noted. If VAS ≥4, IV Paracetamol (15 mg/kg) was given as rescue analgesia.

Data analysis was performed using IBM SPSS Statistics v.20. Continuous variables (duration of analgesia, sedation scores, hemodynamics) were analyzed with the unpaired t-test, while categorical data (side effects) were compared using the Chi-square or Fisher's exact test. A p-value < 0.05 was considered statistically significant. Primary endpoint was the duration of postoperative analgesia, measured from epidural drug administration to the first request for rescue analgesia. Secondary endpoints included VAS pain scores, Ramsay Sedation Scores, hemodynamic trends, and adverse effects incidence.

Results:

Table 1: Duration of Postoperative Analgesia

Duration (mins)	Ropivacaine (n, %)	Ropivacaine + Tramadol (n, %)
≤240 minutes	22 (88.0%)	0 (0.0%)
241–300 minutes	3 (12.0%)	9 (36.0%)
301–360 minutes	0 (0.0%)	16 (64.0%)

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Mean ± SD	225.3 ± 14.8	315.6 ± 18.5
P-value	<0.0001	

The duration of pain relief was markedly extended in the Ropivacaine + Tramadol group, with a mean analgesia duration of 315.6 ± 18.5 minutes, significantly longer than 225.3 ± 14.8 minutes recorded in the Ropivacaine-only group ($p < 0.0001$). While nearly 88% of patients in Group R required rescue analgesia within 240 minutes, more than 64% of patients in Group RT experienced sustained relief beyond 300 minutes. These findings suggest that Tramadol effectively prolongs the analgesic action of Ropivacaine when used as an adjuvant.

Table 2: Visual Analog Scale (VAS) Pain Scores

Time Interval Ropivacaine (Mean ± SD) Ropivacaine + Tramadol (Mean ± SD) P-value

2 hours	3.9 ± 0.7	2.1 ± 0.5	<0.05
4 hours	4.7 ± 0.6	2.5 ± 0.4	<0.05
6 hours	5.2 ± 0.5	3.0 ± 0.6	<0.05
8 hours	5.9 ± 0.4	3.6 ± 0.7	<0.05

Pain scores, measured using the Visual Analog Scale (VAS), were significantly lower in the Tramadol group at all observed time intervals. At two hours postoperatively, Group RT had a mean VAS score of 2.1 ± 0.5, compared to 3.9 ± 0.7 in Group R ($p < 0.05$). This trend persisted over subsequent time intervals, reinforcing the enhanced analgesic effect of the combination therapy.

Table 3: Ramsay Sedation Score (RSS) Distribution

Ramsay Sedation Score	Ropivacaine (n, %)	Ropivacaine + Tramadol (n, %)
Score 1	18 (72.0%)	0 (0.0%)
Score 2	7 (28.0%)	3 (12.0%)
Score 3	0 (0.0%)	20 (80.0%)
Score 4	0 (0.0%)	2 (8.0%)
Mean ± SD	1.28 ± 0.45	3.05 ± 0.91
P-value	<0.0001	

Sedation levels, evaluated using the Ramsay Sedation Score (RSS), were notably higher in Group RT, with a mean score of 3.05 ± 0.91 versus 1.28 ± 0.45 in Group R ($p < 0.0001$). While most patients in Group R remained at RSS scores of 1 or 2, indicating minimal sedation, 80% of patients in Group RT exhibited an RSS of 3, signifying mild but clinically safe sedation. This sedation effect may contribute to enhanced patient comfort in the immediate postoperative period.

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Table 4: Hemodynamic Parameters

Time Interval	HR (Ropivacaine)	HR (Ropivacaine + Tramadol)	MAP (Ropivacaine)	MAP (Ropivacaine + Tramadol)	SpO_2 (Ropivacaine)	SpO_2 (Ropivacaine + Tramadol)
Baseline	78.3 ± 1.5	78.6 ± 1.3	92.1 ± 3.1	91.9 ± 2.8	99.4 ± 0.3	99.3 ± 0.4
15 min	77.1 ± 1.4	77.3 ± 1.6	91.8 ± 3.0	91.5 ± 2.9	99.5 ± 0.2	99.4 ± 0.3
30 min	76.5 ± 1.3	76.9 ± 1.2	91.2 ± 2.8	91.3 ± 2.7	99.7 ± 0.2	99.6 ± 0.3
60 min	75.8 ± 1.6	76.2 ± 1.5	91.0 ± 2.5	91.1 ± 2.6	99.7 ± 0.1	99.8 ± 0.2
120 min	74.7 ± 1.8	75.0 ± 1.4	90.7 ± 2.4	90.8 ± 2.3	100.0 ± 0.0	99.9 ± 0.1

Throughout the observation period, both groups maintained stable hemodynamic parameters, including heart rate (HR), mean arterial pressure (MAP), oxygen saturation (SpO_2), and respiratory rate (RR). The heart rate remained between 76–78 bpm in both groups, with MAP values consistently within the physiological range (90–92 mmHg). Oxygen saturation (SpO_2) remained above 99% in both groups, indicating that the addition of Tramadol did not compromise respiratory function. No significant fluctuations in respiratory rate were noted, further establishing the cardiovascular safety of the regimen ($p > 0.05$ for all parameters).

Table 5: Incidence of Adverse Effects

Adverse Effect	Ropivacaine (n, %)	Ropivacaine + Tramadol (n, %)	P-value
Nausea	3 (12.0%)	4 (16.0%)	>0.05
Vomiting	2 (8.0%)	3 (12.0%)	>0.05
Pruritus	0 (0.0%)	3 (12.0%)	>0.05
Hypotension	0 (0.0%)	0 (0.0%)	-
Bradycardia	0 (0.0%)	0 (0.0%)	-
Respiratory Depression	0 (0.0%)	0 (0.0%)	-

Both groups exhibited minimal and comparable rates of side effects, with no statistically significant differences ($p > 0.05$). Nausea was observed in 12% of patients in Group R and 16% in Group RT ($p > 0.05$), while vomiting occurred in 8% and 12% of patients, respectively ($p > 0.05$). These symptoms were mild and effectively managed with ondansetron. Pruritus was present in 12% of patients receiving Tramadol but was absent in the Ropivacaine-only group ($p > 0.05$). Importantly, there were no cases of hypotension, bradycardia, or respiratory depression in either group. The absence of significant hemodynamic or respiratory complications ($p > 0.05$ across all parameters) reinforces the safety of Tramadol as an epidural adjuvant.

Figure 1: Duration of Postoperative Analgesia

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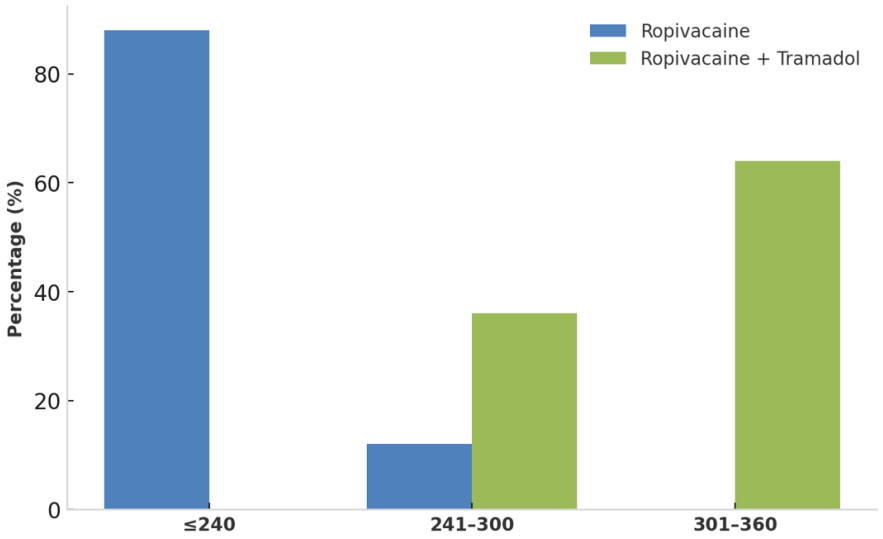
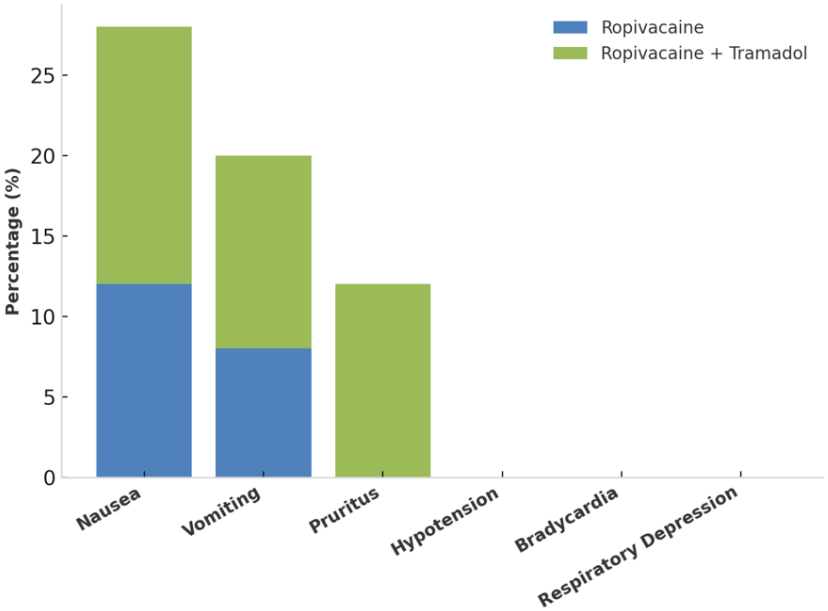


Figure 2: Incidence of Adverse Effects



Discussion:

The combination of tramadol with epidural ropivacaine has gained prominence in postoperative pain management for abdominal surgeries. While clinical data suggests enhanced analgesic efficacy, discrepancies in reported outcomes indicate the need for deeper evaluation. Though tramadol effectively prolongs analgesia, the extent of this effect varies across studies, likely due to differences in dosage, surgical type, and patient characteristics.

Several studies have demonstrated the benefits of this combination. Singh et al. reported a significant increase in analgesia duration with ropivacaine plus tramadol (2 mg/kg) providing 584 ± 58 minutes of relief, compared to 283 ± 35 minutes with ropivacaine alone.[9] A more

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pronounced effect was observed in caudal anesthesia, where Krishnadas et al. found that adding tramadol extended analgesia to 913.00 ± 315.50 minutes, while ropivacaine alone lasted 437.75 ± 75.68 minutes.[10] Further, Karthik et al. compared tramadol and midazolam as adjuvants and noted that both improved analgesia, but tramadol produced a longer-lasting sensory blockade.[11]

Despite these positive findings, the wide variation in reported durations suggests that multiple factors influence outcomes. Differences in tramadol dosage (1 mg/kg vs. 2 mg/kg), surgical procedures (upper vs. lower abdominal), and patient profiles may all contribute to these inconsistencies. This underscores the need for standardization in future trials to establish optimal dosing strategies and determine which patient subgroups derive the greatest benefit.

Pain relief is a critical factor in postoperative recovery, and the combination of ropivacaine with tramadol has been shown to significantly reduce pain scores when compared to ropivacaine alone. The Visual Analog Scale (VAS) scores were consistently lower in patients receiving the combination therapy, highlighting superior analgesic efficacy. However, while these reductions in pain scores are statistically significant, their clinical relevance in terms of functional recovery and patient satisfaction requires further exploration.

Singh et al. reported that VAS scores were significantly lower in the tramadol group (2 mg/kg) compared to the ropivacaine-only group, reinforcing tramadol's role in prolonging analgesia. Additionally, the mean duration of pain relief was substantially longer in the ropivacaine-tramadol group (584 ± 58 min) compared to ropivacaine alone (283 ± 35 min).[9] Similarly, Yadav et al. observed that patients receiving either ropivacaine alone or in combination with tramadol reported significantly lower pain scores at rest and during movement when compared to saline at 1, 3, 4, 8, 12, and 16 hours postoperatively.[12] These findings suggest that tramadol, when used as an epidural adjuvant, provides prolonged and effective postoperative analgesia, reducing the need for frequent rescue analgesics.

One of the important considerations when using tramadol as an epidural adjuvant is its sedative effect, which may have both benefits and drawbacks. Increased sedation can contribute to better patient comfort immediately after surgery, but excessive drowsiness may delay recovery, hinder early mobilization, and increase the risk of falls. This becomes particularly relevant in the context of enhanced recovery after surgery (ERAS) protocols, where early movement and rehabilitation play a crucial role in reducing postoperative complications.

In one study, the Ramsay Sedation Score (RSS) was significantly higher in patients receiving ropivacaine with tramadol (mean score: 3.06) compared to ropivacaine alone (mean score: 1.26).[11] While an RSS of 3 indicates a responsive yet relaxed state, this level of sedation may impact early postoperative mobility, which is a key goal in fast-track recovery programs. Another study comparing dexmedetomidine and tramadol for post-spinal anesthesia shivering found that 80% of patients in the tramadol group exhibited an RSS of 3, suggesting that tramadol has a consistent sedative effect across different clinical scenarios.[13]

Given these findings, careful patient selection and dose adjustments may be necessary to optimize pain relief while minimizing excessive sedation. Further research is needed to assess whether the sedation associated with tramadol has any long-term impact on recovery

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outcomes, particularly in surgeries where early mobilization is essential for preventing complications such as deep vein thrombosis and pulmonary complications.

The addition of tramadol to epidural ropivacaine has generally been associated with stable hemodynamic parameters, yet many studies lack detailed statistical analysis to confirm its cardiovascular safety. While most researchers report no significant variations in heart rate, blood pressure, or oxygen saturation, the supporting data often remains incomplete or inadequately analyzed.

One study observed no statistically significant differences in heart rate or blood pressure ($p > 0.05$) between the ropivacaine-alone group and the ropivacaine-tramadol group, indicating that tramadol does not compromise hemodynamic stability.[11] Similarly, Singh et al. documented that hemodynamic parameters remained stable across three study groups—ropivacaine alone, ropivacaine with tramadol 1 mg/kg, and ropivacaine with tramadol 2 mg/kg—but did not present a detailed statistical breakdown of the findings.[9]

A study comparing different doses of tramadol (50 mg vs. 100 mg) combined with ropivacaine found that pulse rate and oxygen saturation (SpO_2) remained unaffected between groups, but mean arterial pressure was significantly lower in the 100 mg tramadol group. This suggests that higher doses of tramadol could potentially lead to mild hypotensive effects, warranting caution in patients with pre-existing cardiovascular conditions. Given the growing interest in multimodal analgesia, future studies should focus on robust statistical evaluations to ensure the cardiovascular safety of tramadol as an adjuvant in diverse patient populations.

The overall incidence of side effects with epidural tramadol-ropivacaine remains low and comparable to ropivacaine alone. Most studies report nausea, vomiting, and pruritus at minimal levels, suggesting a favorable side effect profile. However, isolated findings raise concerns that require further exploration through larger trials.

While one study reported an increased incidence of vomiting (35.55%) in the tramadol group, others found no significant rise in nausea or vomiting.[11] The variability in these results may be influenced by differences in tramadol dosage and patient sensitivity. Singh et al. also noted no significant increase in pruritus with the addition of tramadol, reinforcing its tolerability as an epidural adjuvant.[9] Importantly, the feared risk of respiratory depression, a major concern with opioid-based analgesics, was not significantly increased with tramadol use, further supporting its safety in epidural applications.

Although these findings present a reassuring safety profile, the possibility of rare adverse effects cannot be ruled out. More large-scale studies are essential to confirm these observations and identify any uncommon complications that might influence clinical decision-making. The balance between effective pain relief and minimal side effects remains a key consideration when integrating tramadol into multimodal analgesia protocols.

While tramadol has been widely studied as an epidural adjuvant to ropivacaine, direct comparisons with other agents remain limited. Among the available studies, midazolam and dexmedetomidine are frequently discussed alternatives. However, tramadol appears to provide a longer duration of analgesia and sensory blockade in most comparisons.

Krishnadas et al. reported that patients who received ropivacaine with tramadol experienced a significantly prolonged duration of analgesia (913 ± 315.5 minutes) compared to those

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receiving ropivacaine with midazolam (769.2 ± 331.9 minutes).[10] While exact analgesia durations are not consistently detailed across studies, the general consensus suggests that tramadol extends the pain-free period more effectively than midazolam.[10,16]

Despite these promising findings, there remains a paucity of comprehensive comparative research that examines the full spectrum of analgesic efficacy, side effects, and patient-reported outcomes between tramadol and other adjuvants. Additionally, newer agents like dexmedetomidine, which have demonstrated potent analgesic and sedative properties, warrant further investigation in this context. Future studies must focus on well-structured, head-to-head comparisons to establish the most effective and safest adjuvant for epidural ropivacaine.

The prolonged duration of analgesia and superior pain scores associated with tramadol as an epidural adjuvant make it a viable option for postoperative pain management in abdominal surgeries. However, to ensure safe and optimal usage, further exploration is required in several critical areas.

First, determining the ideal tramadol dose is essential to maximize analgesia while minimizing adverse effects, particularly in relation to sedation. Although mild sedation may be beneficial for patient comfort, excessive drowsiness could hinder recovery, delay mobilization, and increase fall risk. Second, the long-term safety profile of tramadol remains unclear, particularly in patients requiring multiple surgeries or repeated epidural analgesia. Future studies should investigate whether cumulative exposure to tramadol influences neurotoxicity, tolerance, or other systemic effects. Patient-specific factors such as age, body mass index (BMI), and genetic polymorphisms affecting tramadol metabolism may impact its efficacy as an adjuvant. Identifying these variables will allow for a more personalized approach to pain management, optimizing outcomes for different patient populations.

Beyond immediate postoperative pain relief, tramadol's potential role in influencing long-term outcomes, including chronic postsurgical pain and opioid consumption, should be assessed. If tramadol can reduce the reliance on systemic opioids, it could serve as a critical tool in multimodal analgesia strategies aimed at minimizing opioid-related side effects and dependency risks.

Cost-effectiveness analysis is needed to compare tramadol-ropivacaine combinations with other analgesic regimens. While tramadol is relatively inexpensive, its overall economic impact, including hospital stay duration, requirement for additional analgesics, and patient satisfaction, must be evaluated to establish its true value in clinical practice.

Conclusion:

The combination of epidural ropivacaine with tramadol has shown promising results in prolonging postoperative analgesia while maintaining a favorable safety profile. Studies indicate significantly extended pain relief and lower VAS scores, making it a viable option for abdominal surgeries. However, the associated sedation and inter-individual response variations necessitate further research to optimize dosage and patient selection. Future trials should focus on long-term safety, comparative efficacy with newer adjuvants, and cost-effectiveness analyses. With proper refinements, tramadol could establish itself as a cornerstone in multimodal epidural analgesia protocols.

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References:

1. Gan TJ. Poorly controlled postoperative pain: prevalence, consequences, and prevention. J Pain Res. 2017 Sep 25;10:2287-2298. doi: 10.2147/JPR.S144066.

2. Meissner, W., Coluzzi, F., Fletcher, D., Huygen, F., Morlion, B., Neugebauer, E., … Pergolizzi, J. (2015). Improving the management of post-operative acute pain: priorities for change. Current Medical Research and Opinion, 31(11), 2131–2143. https://doi.org/10.1185/03007995.2015.1092122.

3. Kuthiala G, Chaudhary G. Ropivacaine: A review of its pharmacology and clinical use. Indian J Anaesth. 2011 Mar;55(2):104-10. doi: 10.4103/0019-5049.79875.

4. D. A. H. de Beer, M. L. Thomas, Caudal additives in children—solutions or problems?, BJA: British Journal of Anaesthesia, Volume 90, Issue 4, April 2003, Pages 487–498, https://doi.org/10.1093/bja/aeg064.

5. Grond S, Sablotzki A. Clinical pharmacology of tramadol. Clin Pharmacokinet. 2004;43(13):879-923. doi: 10.2165/00003088-200443130-00004. PMID: 15509185.

6. Edinoff AN, Kaplan LA, Khan S, Petersen M, Sauce E, Causey CD, Cornett EM, Imani F, Moradi Moghadam O, Kaye AM, Kaye AD. Full Opioid Agonists and Tramadol: Pharmacological and Clinical Considerations. Anesth Pain Med. 2021 Sep 6;11(4):e119156. doi: 10.5812/aapm.119156.

7. Bhasin S, Dhar M, Sreevastava DK, Nair R, Chandrakar S. Comparison of Efficacy of Epidural Ropivacaine versus Bupivacaine for Postoperative Pain Relief in Total Knee Replacement Surgeries. Anesth Essays Res. 2018 Jan-Mar;12(1):26-30. doi: 10.4103/aer.AER_134_17.

8. Shin HW, Ju BJ, Jang YK, You HS, Kang H, Park JY. Effect of tramadol as an adjuvant to local anesthetics for brachial plexus block: A systematic review and meta-analysis. PLoS One. 2017 Sep 27;12(9):e0184649.

9. Singh AP, Singh D, Singh Y, Jain G. Postoperative analgesic efficacy of epidural tramadol as adjutant to ropivacaine in adult upper abdominal surgeries. Anesth Essays Res. 2015 Sep-Dec;9(3):369-73. doi: 10.4103/0259-1162.161805.

10. Krishnadas A, Suvarna K, Hema VR, Taznim M. A comparison of ropivacaine, ropivacaine with tramadol and ropivacaine with midazolam for post-operative caudal epidural analgesia. Indian J Anaesth. 2016 Nov;60(11):827-832. doi: 10.4103/0019-5049.193672.

11. Karthik V J, Selvam M, Charles S, Thalaiappan M, Comparative study of ropivacaine with tramadol and ropivacaine with midazolam for post-operative epidural analgesia. Indian J Clin Anaesth 2021;8(4):527-531

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 12, 2024

12. Yadav, T., Golhar, M., Johar, S., Malhotra, N., & Gupta, R. (2021). A study to evaluate the efficacy of instillation of ropivacaine with tramadol through surgical drains for post-operative analgesia in patients undergoing mastectomy. Asian Journal of Medical Sciences, 12(6), 23–28. Retrieved from https://www.nepjol.info/index.php/AJMS/article/view/34795

13. Kundra TS, Kuthiala G, Shrivastava A, Kaur P. A comparative study on the efficacy of dexmedetomidine and tramadol on post-spinal anesthesia shivering. Saudi J Anaesth. 2017 Jan-Mar;11(1):2-8. doi: 10.4103/1658-354X.197344.

14. Velkumar V. Comparison of postoperative analgesic efficacy of epidural ropivacaine and ropivacaine with tramadol in adults undergoing abdominal surgeries under general anaesthesia. Int J Med Anesthesiol. 2022;5(1):21-23. doi:10.33545/26643766.2022.v5.i1a.337.

15.Rao MK, Lakshmi AB. Post-operative epidural analgesia with tramadol (50 mg vs 100 mg) with ropivacaine in lower abdominal surgery. Int J Acad Med Pharm. 2022;922-926.

16. Karthik V J, Selvam M, Charles S, Thalaiappan M, Comparative study of ropivacaine with tramadol and ropivacaine with midazolam for post-operative epidural analgesia. Indian J Clin Anaesth 2021;8(4):527-531