RESEARCH PAPER

Epidural Dexamethasone versus Intravenous Dexamethasone for Postoperative Analgesia in Patients Undergoing Major Abdominal Surgeries: A Randomized Controlled Study

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ABSTRACT

Background: Effective postoperative pain control is essential for enhanced recovery following major abdominal surgeries. Dexamethasone has demonstrated analgesic and anti-inflammatory properties when administered through different routes. This study compared the efficacy of epidural dexamethasone and intravenous dexamethasone for postoperative analgesia in patients undergoing major abdominal surgeries. **Methods:** This prospective randomized controlled study was conducted on 135 patients of ASA physical status I–II, aged 18–70 years, undergoing elective major abdominal surgeries under general anaesthesia. Patients were randomly allocated into three equal groups (n=45 each). Group A received epidural ropivacaine with intravenous dexamethasone 8 mg, Group B received epidural ropivacaine with epidural dexamethasone 8 mg, and Group C received epidural ropivacaine with normal saline (control). The primary outcome was duration of analgesia. Secondary outcomes included postoperative pain scores, rescue analgesic consumption, hemodynamic parameters, adverse effects, time to ambulation, and duration of hospital stay. **Results:** Baseline demographic characteristics were comparable among the groups. The duration of analgesia was significantly longer in Group B (13.91 ± 2.07 h) compared with Group A (8.86 ± 1.41 h) and Group C (5.66 ± 1.03 h) ($p<0.001$). Postoperative NRS pain scores at 1, 6, 12 and 24 hours were significantly lower in Group B than in the other groups ($p<0.001$). Total tramadol consumption during the first 24 hours was lowest in Group B (67.96 ± 21.99 mg) compared with Group A (116.22 ± 22.82 mg) and Group C (187.60 ± 32.53 mg) ($p<0.001$). Total ropivacaine requirement was also significantly reduced in Group B (48.58 ± 5.46 mL) versus Group A (67.20 ± 6.99 mL) and Group C (77.32 ± 7.51 mL) ($p<0.001$). Patients receiving epidural dexamethasone ambulated earlier (18.38 ± 4.30 h) and had shorter hospital stays (4.28 ± 0.99 days) than those in the intravenous and control groups ($p<0.001$). The incidence of adverse effects was comparable among groups. **Conclusion:** Epidural dexamethasone significantly prolongs postoperative analgesia, reduces pain scores and analgesic requirements, and facilitates earlier recovery compared with intravenous dexamethasone and control treatment. Epidural administration of dexamethasone appears to be an effective and safe adjunct for postoperative pain management following major abdominal surgeries.

Keywords: Dexamethasone; Epidural analgesia; Intravenous dexamethasone; Postoperative pain; Major abdominal surgery; Ropivacaine; Multimodal analgesia.

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Introduction

Introduction

Postoperative pain following major abdominal surgeries remains a significant clinical concern and can adversely affect recovery, increase morbidity, prolong hospital stay, and reduce patient satisfaction. Effective postoperative analgesia is therefore an essential component of perioperative care, facilitating early mobilization, reducing cardiopulmonary complications, and improving overall surgical outcomes. Despite advances in multimodal analgesic strategies, achieving optimal pain relief with minimal adverse effects continues to be a challenge. **Horn et al.** [1]

Dexamethasone, a long-acting synthetic glucocorticoid, has emerged as a valuable adjunct in perioperative pain management owing to its anti-inflammatory, analgesic, and antiemetic properties. It acts by inhibiting phospholipase A2, thereby suppressing the production of prostaglandins and leukotrienes, while also reducing the release of pro-inflammatory cytokines involved in nociceptive transmission. Its prolonged biological half-life of 36–54 hours makes it particularly suitable for

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postoperative analgesia. **Ahmed et al.** [2], **Olausson et al.** [3]

Intravenous dexamethasone is widely used in perioperative practice to reduce postoperative pain, inflammation, and nausea and vomiting. Several studies have demonstrated its ability to reduce postoperative pain scores and opioid requirements through both central and peripheral anti-inflammatory mechanisms. However, systemic administration may be associated with adverse effects such as hyperglycaemia, immunosuppression, and delayed wound healing. **Ganapathi et al.** [4], **Singh et al.** [5]

Epidural administration of dexamethasone has gained increasing attention as an alternative route for enhancing postoperative analgesia. By delivering the drug close to spinal nerve roots and the dorsal horn of the spinal cord, epidural dexamethasone may provide targeted anti-inflammatory effects, suppress nociceptive transmission, and prolong the action of local anaesthetics. This may reduce opioid consumption and improve postoperative comfort. **Jo et al.** [6], **Min et al.** [7]

Major abdominal surgeries are associated with extensive tissue trauma and severe postoperative pain. Epidural analgesia remains one of the most effective techniques for pain control after such procedures. The addition of dexamethasone to epidural regimens has been suggested to enhance analgesic efficacy by reducing local inflammation and neural sensitization. Previous studies have reported prolonged analgesia, reduced rescue analgesic requirements, and improved pain scores with epidural dexamethasone. **Jebaraj et al.** [8], **Singh et al.** [5]

Although the analgesic benefits of both intravenous and epidural dexamethasone have been reported, direct comparisons between these two routes remain limited. Furthermore, concerns regarding the safety and optimal use of epidural dexamethasone warrant further evaluation. **Van Boxem et al.** [9]

In the era of enhanced recovery after surgery (ERAS), where effective pain control, opioid-sparing strategies, and early mobilization are emphasized, determining the optimal route of dexamethasone administration has important clinical implications. Therefore, the present study was undertaken to compare the analgesic efficacy of epidural dexamethasone and intravenous dexamethasone in patients undergoing major abdominal surgeries. **Grossi et al.** [10]

Materials and Methods

Study design and setting

This was a prospective randomized comparative study conducted in the Department of Anaesthesiology and Intensive Care, Acharya Shri Chander College of Medical Sciences and Hospital (ASCOMS), Jammu, from June 2024 to November 2025. Ethical approval was obtained from the institutional ethical committee before initiation of the study. Informed written consent was taken from all participants.

Study population

A total of 135 patients of either sex, aged 18–70 years, belonging to ASA physical status I and II, and scheduled for elective major abdominal surgery under general anaesthesia were enrolled. The sample size was 135, with 45 patients in each group, based on power analysis to detect a significant difference in the primary outcome, duration of analgesia.

Inclusion criteria

Patients included in the study were ASA physical status I or II and between 18 and 70 years of age.

Exclusion criteria

Patients were excluded if they had BMI >40, anticipated postoperative elective ventilation, emergency surgery, hemodynamic instability, allergy to the study drug, cardiovascular disease, diabetes, coagulopathy, spinal deformity, infection over the lumbar region, renal or liver disease, or a history of long-term steroid therapy. Lower segment caesarean section cases were also excluded.

Group allocation

Patients were allocated by computer-based software into three equal groups of 45 each:

Group A: Epidural 0.2% ropivacaine 8 mL + 2 mL normal saline + intravenous dexamethasone 8 mg.

Group B: Epidural 0.2% ropivacaine 8 mL + epidural dexamethasone 8 mg in 2 mL.

Group C (Control): Epidural 0.2% ropivacaine 8 mL + 2 mL normal saline.

Pre-anaesthetic preparation

All patients underwent pre-anaesthetic evaluation one day before surgery, including detailed history, general and systemic examination, and airway assessment. Routine and additional investigations were performed as required. Baseline demographic details such as age, sex, and weight were recorded. Patients were familiarized with the Numeric Rating Scale (NRS) for pain assessment. They were kept fasting for 8 hours before surgery and received oral Anxit 0.25 mg and Pantoprazole 40 mg the night before surgery. Sedative premedication was avoided on the morning of surgery, and intravenous access was secured with an appropriate cannula. Ringer lactate infusion was started.

Intraoperative management

On arrival in the operating room, standard multipara monitoring was attached, including blood pressure, pulse rate, oxygen saturation, ECG, and ETCO2. Epidural catheterization was performed in the sitting position under aseptic precautions using an 18G Tuohy needle after local infiltration with 3 mL of 2% lidocaine. Loss of resistance to air was used to identify the epidural space, and a test dose of 3 mL of 2% lidocaine with adrenaline 1:200,000 was given after negative aspiration. The level and depth of catheter insertion were noted. General anaesthesia was then induced and maintained according to the institutional protocol. Fifteen minutes before reversal of

neuromuscular block and extubation, the study drugs were administered as per group allocation.

Postoperative assessment

In the postoperative period, pain was assessed using the Numeric Rating Scale at 1, 6, 12, and 24 hours. The primary outcome was duration of analgesia, defined as the time from the single-shot epidural drug administration to the first rescue analgesic requirement. Rescue analgesia consisted of tramadol 1 mg/kg intravenously, followed by epidural infusion of 0.2% ropivacaine at 5 mL/hour through an infusion pump. Total ropivacaine consumption over 24 hours was calculated. Side effects were noted, and blood glucose levels were monitored every 12 hours for the first 24 hours.

Statistical analysis

Data were compiled, coded, and analyzed using statistical software such as SPSS or R. Normality was assessed with the Shapiro-Wilk test. Continuous variables were presented as mean ± standard deviation or median with interquartile range, depending on distribution. Categorical variables were expressed as frequencies and percentages. One-way ANOVA was used for normally distributed continuous variables, while the Kruskal-Wallis test was used for non-parametric data. Chi-square test or Fisher's exact test was used for categorical variables. A p-value of less than 0.05 was considered statistically significant.

Outcome measures

The main outcome was duration of analgesia. Secondary outcomes included postoperative pain scores, total tramadol requirement, total ropivacaine consumption, perioperative hemodynamic stability, adverse effects, postoperative blood glucose trends, time to ambulation, and duration of hospital stay.

Results

A total of 135 patients were included in the study, with 45 patients in each group. The three groups were comparable at baseline with respect to age, sex, weight, and duration of surgery, suggesting that the groups were well matched before the intervention. Baseline hemodynamic parameters were also similar between the groups, with no significant difference in heart rate or systolic blood pressure at the start of the study.

Table 1. Baseline characteristics of study participants (merged demographic table)

Baseline variable	Group A (IV dexamethasone)	Group B (Epidural dexamethasone)	Group C (Control)
Age group (years)			
18–30	8	9	7
31–50	21	20	22
51–70	16	16	16
Mean age (years)	44.2 ± 12.1	43.8 ± 11.5	45.0 ± 13.0
Sex			
Male	23	24	22
Female	22	21	23
Weight (kg), mean ± SD	67.9 ± 8.4	69.9 ± 9.9	66.6 ± 6.3
Duration of surgery (min), mean ± SD	135.6 ± 23.3	136.4 ± 22.9	139.7 ± 21.2

Weight and duration of surgery did not differ significantly between groups, which supports the baseline comparability of the study population.

Primary outcome: time to first rescue analgesia

The duration of analgesia was significantly longer in the epidural dexamethasone group. Group B had the longest time to first rescue analgesia at 13.91 ± 2.07 hours, followed by Group A at 8.86 ± 1.41 hours, while Group C had the shortest duration at 5.66 ± 1.03 hours. This difference was highly significant ($F = 318.304$, $p < 0.001$), showing a clear analgesic advantage with epidural dexamethasone.

Table 2. Time to first rescue analgesia

Group	Mean ± SD (hours)	95% CI
Group A (IV dexamethasone)	8.86 ± 1.41	8.44–9.28
Group B (Epidural dexamethasone)	13.91 ± 2.07	13.29–14.53
Group C (Control)	5.66 ± 1.03	5.35–5.97

The postoperative pain scores at rest were consistently lower in Group B at all assessed time points. At 1, 6, 12, and 24 hours, Group B had lower NRS values than both Group A and Group C, and all differences were statistically significant ($p < 0.001$).

Table 3. Numeric rating scale (NRS) at rest

Time after surgery	Group A	Group B	Group C	p-value
1 hour	3.93 ± 0.89	2.21 ± 0.95	4.52 ± 0.82	<0.001
6 hours	4.52 ± 0.84	3.01 ± 0.87	5.12 ± 0.82	<0.001
12 hours	5.38 ± 0.72	3.16 ± 0.80	6.01 ± 0.73	<0.001

24 hours	3.81 ± 0.74	2.10 ± 0.74	4.86 ± 0.78	<0.001

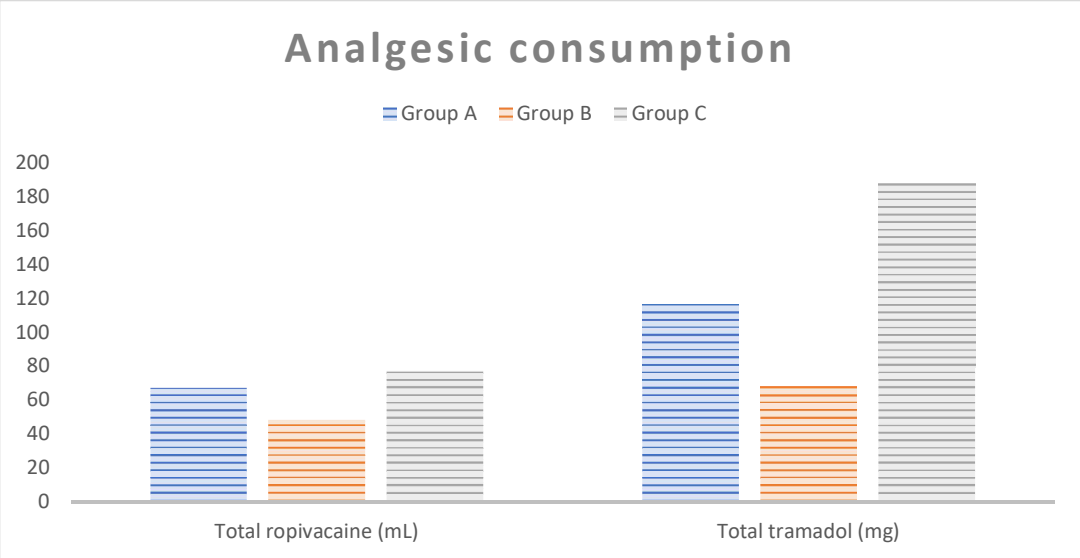
Analgesic consumption followed the same pattern. Total ropivacaine use over 24 hours was lowest in Group B at 48.58 ± 5.46 mL, compared with 67.20 ± 6.99 mL in Group A and 77.32 ± 7.51 mL in Group C. Total tramadol requirement was also lowest in Group B at 67.96 ± 21.99 mg, followed by Group A at 116.22 ± 22.82 mg and Group C at 187.60 ± 32.53 mg. Both differences were highly significant ($p < 0.001$), indicating a stronger opioid-sparing and local anaesthetic-sparing effect with epidural dexamethasone.

Table 4;

Blood glucose at 12 h (mg/dL)	**126.9 ± 14.6**	**120.5 ± 17.7**	**100.7 ± 12.7**	**<0.001**
Blood glucose at 24 h (mg/dL)	109.9 ± 11.3	107.7 ± 10.8	97.6 ± 11.9	<0.001

Blood glucose values were comparable preoperatively, but both steroid groups showed a postoperative rise at 12 and 24 hours, with higher values than the control group.

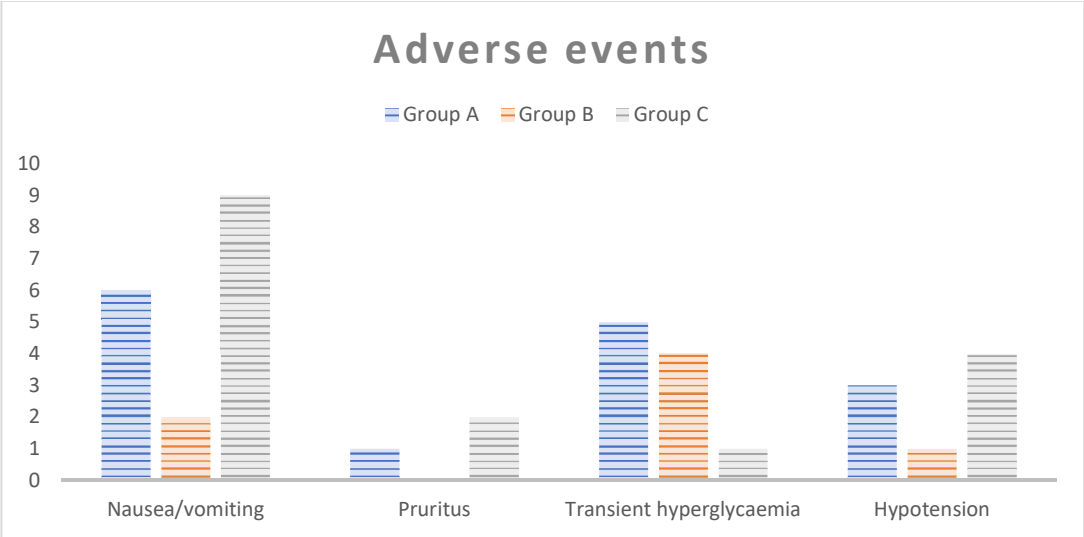
Figure 1. Analgesic consumption in 24 hours



Hemodynamic responses also favored Group B. Intraoperatively, Group B showed the lowest mean heart rate fluctuation and systolic blood pressure fluctuation, with both values significantly better than Group A and Group C. Postoperatively, heart rate and systolic blood pressure remained lower in Group B at 1, 6, and 12 hours, again with statistically significant differences between groups.

Safety outcomes were acceptable in all three groups. Nausea and vomiting occurred in 6 patients in Group A, 2 patients in Group B, and 9 patients in Group C. Pruritus, transient hyperglycaemia, and hypotension were infrequent, and none of these adverse events showed a statistically significant difference among the groups.

Figure 2. Adverse events and blood glucose trend



Functional recovery was also better in the epidural dexamethasone group. Group B ambulated earlier, at 18.38 ± 4.30 hours, compared with 22.65 ± 3.70 hours in Group A and 27.40 ± 5.43 hours in Group C. The duration of hospital stay was shortest in Group B at 4.28 ± 0.99 days, followed by Group A at 5.00 ± 1.47 days and Group C at 5.98 ± 1.32 days. Both outcomes were highly significant ($p < 0.001$).

Discussion

The present study compared epidural dexamethasone with intravenous dexamethasone for postoperative analgesia in patients undergoing major abdominal surgeries. The findings showed a clear advantage of epidural dexamethasone over intravenous dexamethasone and control in terms of duration of analgesia, lower postoperative pain scores, reduced ropivacaine and tramadol requirement, and better intraoperative hemodynamic stability. Since the groups were comparable for age, sex, weight, and duration of surgery, the observed differences are more likely related to the route of dexamethasone administration rather than baseline imbalance.

The most important finding of the study was the significantly longer time to first rescue analgesia in the epidural dexamethasone group. **Jo et al. [4]** also reported that epidural dexamethasone reduced postoperative pain scores and decreased rescue analgesic requirement after major abdominal surgery. Likewise, **Hefni et al. [11]** observed a dose-dependent prolongation in the time to first analgesic request with epidural dexamethasone, with the higher dose showing the greatest benefit. In contrast, the effect of intravenous dexamethasone appears smaller, although still beneficial. **Mitchell et al. [14]** and **Waldron et al. [15]** reported reduced postoperative pain and opioid use with intravenous dexamethasone, but the magnitude of benefit was generally less than that seen with neuraxial administration. This supports the present result that epidural dexamethasone provides a more durable analgesic effect than intravenous dexamethasone.

Postoperative pain scores in our study were consistently lower in the epidural dexamethasone group at 1, 6, 12, and 24 hours. This sustained reduction in Numeric Rating Scale values suggests better quality of analgesia throughout the early postoperative period. Similar findings were observed by **Jo et al. [4]**, who noted lower pain scores in patients receiving epidural dexamethasone. **Hong et al. [12]** also reported that epidural dexamethasone reduced pain scores after major abdominal surgery and that the higher dose produced more consistent analgesia. The present study therefore strengthens the evidence that epidural dexamethasone offers not only delayed but also more stable postoperative pain control.

The reduction in total ropivacaine consumption and tramadol requirement in the epidural dexamethasone group is another important finding. This suggests an opioid-sparing and local anaesthetic-sparing effect. **Jebaraj et al. [8]** found that adding dexamethasone to epidural local anaesthetic reduced postoperative morphine consumption and the need for rescue analgesia. Similarly, **Ghanem et al. [13]** showed improved postoperative analgesia and reduced rescue drug requirement with a dexamethasone-containing neuraxial technique. The present study is in line with these observations and indicates that epidural dexamethasone can improve analgesic efficiency in major abdominal surgery.

Intraoperative hemodynamic stability was also better in the epidural dexamethasone group, with lower fluctuations in heart rate and systolic blood pressure. This likely reflects superior attenuation of the surgical stress response and more effective neuraxial analgesia. **Ghanem et al. [13]** reported comparable hemodynamics while showing improved analgesia with a neuraxial dexamethasone regimen, which supports the view that dexamethasone enhances analgesia without causing instability. In the present study, the better hemodynamic profile in Group B further supports the clinical usefulness of epidural dexamethasone during major abdominal operations.

With regard to safety, the incidence of nausea, vomiting, pruritus, and hypotension was low and comparable among the groups. Although postoperative blood glucose values were higher in the dexamethasone groups, the rise was transient and did not appear to affect the overall clinical course. **Razavizadeh et al. [16]** and **Waldron et al. [15]** also reported that dexamethasone is generally safe in perioperative use, though transient hyperglycaemia remains a known effect. In our study, the balance of benefit and safety clearly favored epidural dexamethasone

Conclusion

The present study demonstrates that epidural dexamethasone is superior to intravenous dexamethasone as an adjuvant for postoperative analgesia in patients undergoing major abdominal surgeries. Epidural administration significantly prolonged the duration of analgesia, reduced postoperative pain scores, decreased ropivacaine and tramadol requirements, and provided better perioperative hemodynamic stability compared with intravenous dexamethasone and control treatment.

Although both routes of dexamethasone administration improved postoperative analgesic outcomes compared with control, the benefits were consistently greater with epidural dexamethasone. The incidence of adverse effects was comparable among the groups, and the observed postoperative rise in blood glucose levels in steroid-treated patients was transient and clinically manageable.

These findings suggest that epidural dexamethasone is an effective and safe adjunct to epidural analgesia and may contribute to enhanced postoperative recovery by improving pain control and reducing opioid consumption. Further multicentre studies with larger sample sizes are warranted to confirm these findings and establish standardized dosing recommendations for routine clinical practice.

Conflict of Interest: Nil

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