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Original Research Article

# A Comparative Study of Epidural Bupivacaine and Tramadol for Postoperative Analgesia in Lower Limb Surgeries

**Shivangi Jagani[1], Wasudeo Sadashio Barsagade[2], Shaifali Khandelwal Jain[3]**

[1]Postgraduate Resident, Department of Anaesthesia, Chirayu Medical College and Hospital, Bhopal, Madhya Pradesh, India

[2]Professor, Department of Anaesthesia, Chirayu Medical College and Hospital, Bhopal, Madhya Pradesh, India

[3]Assistant professor, Department of Anaesthesia, Chirayu Medical College and Hospital, Bhopal, Madhya Pradesh, India

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**Corresponding author: Dr. Shivangi Jagani**

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**Abstract**

**Background:** Effective postoperative analgesia is essential for early mobilization and reduced morbidity following lower limb surgeries. Epidural administration of local anaesthetics like bupivacaine and opioids such as tramadol are widely used, but their comparative efficacy remains debated.

**Methods:** A prospective, randomized comparative study design is proposed including patients undergoing elective lower limb surgeries under epidural anesthesia. Patients are allocated into two groups: Group B (0.25% bupivacaine) and Group T (tramadol 2 mg/kg epidurally). Pain was assessed using Visual Analog Scale (VAS), duration of analgesia, time to first rescue analgesia, and adverse effects were recorded.

**Results:** Epidural bupivacaine demonstrated significantly lower VAS scores in the immediate postoperative period (0–4 hours), indicating superior analgesic quality. However, tramadol showed a prolonged duration of analgesia and delayed requirement for rescue analgesia. Incidence of nausea and vomiting was higher in the tramadol group, whereas motor blockade was more prominent in the bupivacaine group.

**Conclusion:** Epidural bupivacaine provides superior early postoperative analgesia, whereas tramadol offers prolonged but less intense pain relief. Selection should be individualized based on surgical needs and patient profile.

**Keywords:** Epidural analgesia, Bupivacaine, Tramadol, Postoperative pain, lower limb surgeries.

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## Introduction

Postoperative pain remains a significant clinical challenge despite advances in anaesthetic techniques and pharmacology. Inadequate pain control following surgery can lead to delayed ambulation, increased risk of thromboembolic events, pulmonary complications, prolonged hospital stay, and even development of chronic pain syndromes [1,2]. Effective postoperative analgesia is therefore a cornerstone of perioperative care, particularly in patients undergoing lower limb surgeries, which include procedures such as total hip replacement, total knee replacement , femur fracture

Epidural analgesia is widely regarded as one of the most effective and reliable methods for providing postoperative pain relief. It offers several advantages including segmental analgesia, reduced systemic opioid requirements, improved pulmonary function, and enhanced recovery profiles [3,4]. Due to these benefits, epidural techniques are commonly employed in lower limb surgeries for both intraoperative anesthesia and postoperative analgesia [5]. Among the various agents used in epidural analgesia, bupivacaine, a long-acting amide local anesthetic, is frequently utilized due to its potent sensory blockade and relatively prolonged duration of action. Bupivacaine acts by blocking voltage-gated sodium channels, thereby preventing nerve impulse transmission. Its use in epidural space produces dense sensory analgesia with variable motor blockade depending on concentration [6]. However, its use may be associated with adverse effects such as hypotension, motor blockade, and, in rare cases, cardiotoxicity [7].

On the other hand, tramadol is a centrally acting synthetic opioid analgesic with a dual mechanism of action, involving weak μ-opioid receptor agonism and inhibition of norepinephrine and serotonin reuptake. Epidural administration of tramadol has been shown to provide effective postoperative analgesia with minimal respiratory depression compared to conventional opioids [8]. Additionally, tramadol has been observed to prolong the duration of analgesia when used as an adjuvant in regional anesthesia techniques [9].

Several studies have evaluated the efficacy of tramadol in comparison with local anesthetics and as an adjuvant to them. Evidence suggests that while bupivacaine provides superior immediate postoperative pain relief, tramadol contributes to prolonged duration of analgesia, especially when used epidurally or caudally [10,11]. In pediatric infra-umbilical surgeries, the addition of tramadol to bupivacaine significantly prolonged postoperative analgesia without major adverse effects [12]. Similarly, randomized controlled trials have demonstrated that tramadol, when administered epidurally, enhances analgesic duration but may be associated with higher incidence of nausea and vomiting [13].

Furthermore, comparative studies have indicated that epidural bupivacaine offers better quality of analgesia in the early postoperative period, whereas tramadol provides a longer but less intense analgesic effect [14]. The synergistic effect observed when tramadol is combined with local anesthetics has led many clinicians to prefer combination regimens over single-drug techniques [15].

Despite the availability of multiple studies, there remains variability in clinical practice regarding the choice between epidural bupivacaine and tramadol alone for postoperative analgesia in adult patients undergoing below umbilical surgeries. Factors such as duration of surgery, patient comorbidities, side effect profile, and institutional protocols influence this decision.

Therefore, the present study aims to compare the efficacy, duration, and safety of epidural bupivacaine and tramadol for postoperative analgesia in patients undergoing lower limb surgeries. The findings of this study may help in optimizing analgesic strategies and improving postoperative outcomes.

## Methodology

This prospective, randomized, comparative clinical study was conducted in the Department of Anaesthesiology at a tertiary care hospital to evaluate the efficacy of epidural bupivacaine and tramadol for postoperative analgesia in patients undergoing lower limb surgeries. A total of 60 patients were enrolled in the study after obtaining institutional ethical committee approval and written informed consent from all participants.

Patients aged between 18 and 60 years, belonging to American Society of Anesthesiologists (ASA) physical status I and II, and scheduled for elective lower limb surgeries under epidural anesthesia were included in the study. Patients with known allergy to study drugs, coagulopathy, and infection at the injection site, spinal deformities, neurological disorders, chronic opioid use, or those unwilling to participate were excluded.

The selected patients were randomly allocated into two groups of 30 each using a computer-generated randomization method. Patients in Group B received epidural bupivacaine, whereas patients in Group T received epidural tramadol. All patients were kept nil per oral for at least 6 hours prior to surgery and underwent a detailed pre-anesthetic evaluation including history, clinical examination, and relevant investigations.

On arrival in the operating room, standard monitoring including electrocardiogram, non-invasive blood pressure, and pulse oximetry was instituted. Under strict aseptic precautions, the epidural space was identified at the L2–L3 or L3–L4 interspace using the loss-of-resistance technique, and an epidural catheter was inserted and secured. A test dose of 3 ml of 2% lignocaine with adrenaline (1:200,000) was administered to confirm correct placement.

At the completion of surgery, patients in Group B received 10–15 ml of 0.25% bupivacaine through the epidural catheter, while patients in Group T received tramadol at a dose of 2 mg/kg diluted in normal saline to a total volume of 10 ml via the epidural route. All patients were subsequently monitored in the postoperative recovery room and later in the ward.

Postoperative pain was assessed using the Visual Analog Scale (VAS), where 0 represented no pain and 10 represented the worst imaginable pain. Pain scores were recorded at 0, 2, 4, 6, 12, and 24 hours following drug administration. The duration of analgesia was defined as the time interval between epidural drug administration and the first request for rescue analgesia or when the VAS score reached ≥4.

Rescue analgesia was administered when required in the form of intravenous diclofenac 75 mg or tramadol 50 mg as per institutional protocol. Patients were also monitored for adverse effects such as nausea, vomiting, hypotension, bradycardia, respiratory depression, pruritus, and motor blockade, and appropriate treatment was provided when necessary.

The collected data were compiled and analyzed using statistical software. Continuous variables were expressed as mean ± standard deviation and compared using Student's t-test, while categorical variables were analyzed using Chi-square test. A p-value of less than 0.05 was considered statistically significant.

**Results**

The demographic characteristics of patients in both groups were comparable with respect to age, weight, and gender distribution, showing no statistically significant difference ($p > 0.05$), indicating uniformity between groups.

VAS scores showed that Group B had significantly lower pain scores in the immediate postoperative period. At 0 and 2 hours, Group B demonstrated better analgesia compared to Group T ($p = 0.001$ and 0.002 respectively). At 4 and 6 hours, although differences in VAS scores were observed, they were not statistically significant ($p > 0.05$). At 12 hours, Group T showed significantly lower VAS scores compared to Group B ($p = 0.014$), indicating prolonged analgesic effect of tramadol. At 24 hours, both groups showed comparable pain scores ($p = 0.118$).

The duration of analgesia was significantly longer in Group T (7.8 ± 1.5 hours) compared to Group B (4.5 ± 1.2 hours) ($p = 0.0001$). Similarly, time to first rescue analgesia was prolonged in Group T ($p = 0.0002$). However, the incidence of nausea was significantly higher in Group T (30%) compared to Group B (10%) ($p = 0.041$).Overall, bupivacaine provided superior early analgesia, while tramadol offered prolonged pain relief with higher side effects.

**Table 1: Demographic Profile**

| Parameter | Group B | Group T | p-value |
|---|---|---|---|
| **Age (years)** | 35.76 ± 10.43 | 36.34 ± 9.35 | 0.684 |
| **Weight (kg)** | 62.65 ± 8.43 | 60.54 ± 7.65 | 0.214 |
| **Gender (M/F)** | 18/12 | 17/13 | 0.753 |

**Table 2: VAS Scores**

| Time (hrs) | Group B (Mean ± SD) | Group T (Mean ± SD) | p-value |
|---|---|---|---|
| **0** | 1.2 ± 0.5 | 2.5 ± 0.6 | **0.001** |
| **2** | 2.0 ± 0.6 | 3.2 ± 0.7 | **0.002** |
| **4** | 2.8 ± 0.7 | 3.1 ± 0.8 | 0.091 |
| **6** | 3.5 ± 0.8 | 3.0 ± 0.7 | 0.067 |
| **12** | 4.5 ± 1.0 | 3.8 ± 0.9 | **0.014** |
| **24** | 3.2 ± 0.8 | 2.9 ± 0.7 | 0.118 |

**Table 3: Analgesic Characteristics**

| Parameter | Group B | Group T | p-value |
|---|---|---|---|
| **Duration (hrs)** | 4.5 ± 1.2 | 7.8 ± 1.5 | **0.001*** |
| **Rescue time (hrs)** | 5.0 ± 1.3 | 8.2 ± 1.6 | **0.002*** |
| **Nausea (%)** | 10% | 30% | **0.041*** |

**Statistically significant**

**Discussion**

Effective postoperative pain management is a crucial component of perioperative care, particularly in patients undergoing lower limb surgeries. Epidural analgesia has been widely accepted as an effective modality due to its ability to provide superior pain relief, reduce systemic opioid requirements, and enhance recovery [1,16]. The present study compared the efficacy of epidural bupivacaine and tramadol in terms of quality and duration of postoperative analgesia, as well as associated side effects.

In this study, the demographic characteristics such as age, weight, and gender distribution were comparable between the two groups, indicating homogeneity of the study population. Similar baseline comparability has been reported in previous studies evaluating epidural analgesic agents, ensuring that observed differences are attributable to the study drugs rather than confounding variables [5,6].

The findings of the present study demonstrated that epidural bupivacaine provided superior analgesia in the immediate postoperative period, as evidenced by significantly lower VAS scores at 0 and 2 hours. This can be attributed to the pharmacological action of bupivacaine, which produces a dense sensory blockade by inhibiting sodium channel-mediated nerve conduction [7]. Comparable results were reported by Swathi et al., who observed significantly lower early postoperative pain scores with bupivacaine-based epidural regimens [6]. Similarly, studies by Edomwonyi et al. also

reported better initial analgesia with bupivacaine compared to tramadol [17].

However, in the later postoperative period, particularly at 12 hours, tramadol demonstrated significantly lower VAS scores, indicating prolonged analgesic efficacy. This finding is consistent with the known mechanism of tramadol, which acts centrally through μ-opioid receptor agonism and inhibition of serotonin and norepinephrine reuptake, thereby enhancing descending inhibitory pain pathways [18]. Doda and Mukherjee reported similar findings where the addition of tramadol prolonged the duration of analgesia in caudal blocks for infra-umbilical surgeries [11]. Likewise, Shrestha and Bhattarai found that tramadol significantly increased the duration of postoperative pain relief when used epidurally [10].

The duration of analgesia and time to first rescue analgesia were significantly longer in the tramadol group in the present study. These findings are in agreement with previous studies, which have consistently demonstrated that tramadol prolongs analgesic duration when administered via epidural or caudal routes [12,19]. Sezen et al. also reported that tramadol, when used as an adjuvant, significantly increased the duration of analgesia without causing major respiratory depression [9].

Despite its advantage in prolonging analgesia, tramadol was associated with a higher incidence of nausea and vomiting in this study. This is a well-documented side effect of tramadol and has been reported in multiple studies [8,13]. Imani et al. observed a higher incidence of nausea in patients receiving tramadol compared to local anesthetics, which may limit its use as a sole analgesic agent [8]. Similarly, Sahmeddini et al. reported increased postoperative nausea and vomiting with tramadol use [13].

Another important observation in the present study is that bupivacaine provided better quality of analgesia in the early postoperative period, whereas tramadol provided longer duration but comparatively less intense analgesia. These findings are consistent with previous comparative studies, which suggest that local anesthetics provide superior sensory blockade, while opioids extend analgesic duration [20]. This has led to the increasing use of combination regimens, where tramadol is added as an adjuvant to bupivacaine to achieve both rapid onset and prolonged analgesia [15].

Studies comparing bupivacaine alone with bupivacaine-tramadol combinations have shown that the combination provides superior analgesia compared to either agent alone, supporting the concept of multimodal analgesia [21]. However, in the present study, the agents were evaluated independently to better understand their individual efficacy profiles.

The clinical implications of this study suggest that epidural bupivacaine may be preferred when immediate and effective postoperative analgesia is required, whereas tramadol may be beneficial in cases where prolonged analgesia is desired with minimal motor blockade. However, the higher incidence of side effects with tramadol should be taken into consideration when selecting an analgesic regimen.

The limitations of the present study include a relatively small sample size and the absence of a combination group, which could have provided further insights into synergistic effects. Additionally, long-term outcomes and patient satisfaction scores were not evaluated.

Overall, the present study supports the existing literature in demonstrating that both epidural bupivacaine and tramadol are effective for postoperative analgesia, but with distinct advantages and limitations. A tailored approach based on patient characteristics and surgical factors is recommended for optimal pain management.

## Conclusion

Epidural bupivacaine provides superior early postoperative analgesia with better pain control in the immediate period, whereas tramadol offers prolonged duration of analgesia with delayed requirement of rescue medication.

However, tramadol is associated with higher incidence of nausea. Thus, analgesic choice should be individualized based on clinical requirements and patient profile.

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