

Study on the Efficacy of Epidural Analgesia versus Systemic Analgesia in Lower Limb Surgeries

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Abstract:

Background: Effective postoperative pain management is essential in lower limb surgeries to enhance recovery, reduce complications, and improve patient satisfaction. Epidural analgesia is widely regarded as a superior modality due to its ability to provide targeted and continuous analgesia. However, systemic analgesia remains commonly used because of its ease of administration and lower technical requirements. Comparative evaluation of these modalities remains clinically relevant.

Aim: To compare the efficacy of epidural analgesia and systemic analgesia in patients undergoing lower limb surgeries.

Methods: This prospective, randomized comparative study included 120 patients undergoing elective lower limb surgeries under regional or general anesthesia. Patients were divided into two groups: Group E (epidural analgesia, n=60) and Group S (systemic analgesia, n=60). Pain was assessed using the Visual Analog Scale (VAS) at predefined intervals postoperatively. Secondary outcomes included duration of analgesia, total analgesic consumption, hemodynamic parameters, and incidence of adverse effects.

Results: Patients receiving epidural analgesia demonstrated significantly lower VAS scores at all postoperative intervals compared to the systemic analgesia group ($p < 0.05$). The duration of analgesia was longer in Group E, with reduced requirement for rescue analgesics. Hemodynamic parameters remained more stable in the epidural group. The incidence of nausea and vomiting was higher in the systemic analgesia group, whereas mild hypotension was observed more frequently in the epidural group.

Conclusion: Epidural analgesia provides superior postoperative pain relief, prolonged analgesic effect, and better hemodynamic stability compared to systemic analgesia in lower limb surgeries, making it a preferred modality in appropriate clinical settings.

Keywords: Epidural Analgesia, Systemic Analgesia, Lower Limb Surgery, Postoperative Pain, VAS.

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Introduction

Postoperative pain remains a significant concern in patients undergoing lower limb surgeries, often leading to delayed mobilization, prolonged hospital stay, and increased morbidity if inadequately managed. Effective pain control not only improves patient comfort but also facilitates early rehabilitation and reduces the risk of complications such as deep vein thrombosis and pulmonary issues [1,2]. Therefore, selecting an appropriate analgesic modality is a critical component of perioperative care.

Systemic analgesia, primarily involving opioids and non-steroidal anti-inflammatory drugs

(NSAIDs), has been widely used due to its ease of administration and rapid onset of action. However, systemic opioids are associated with several adverse effects including respiratory depression, sedation, nausea, vomiting, and constipation, which can negatively impact patient recovery [3,4]. Moreover, variability in patient response and the need for repeated dosing limit its effectiveness in maintaining consistent analgesia.

Epidural analgesia, on the other hand, offers a regional technique that provides targeted pain relief by blocking nerve transmission at the spinal level. It allows continuous infusion of local anesthetics,

with or without opioids, resulting in superior analgesia with reduced systemic drug exposure [5,6]. This technique has gained popularity in orthopedic and lower limb surgeries due to its ability to provide prolonged pain relief, facilitate early mobilization, and improve overall patient outcomes.

Several studies have demonstrated that epidural analgesia results in lower pain scores and decreased opioid consumption compared to systemic analgesia [7,8]. Additionally, epidural analgesia has been associated with improved hemodynamic stability due to better pain control and reduced stress response during the postoperative period [9]. However, it is not without limitations. Potential complications such as hypotension, urinary retention, motor blockade, and rare but serious risks like epidural hematoma or infection must be considered [10].

Despite these advantages, systemic analgesia continues to be widely practiced, particularly in resource-limited settings, due to its simplicity and lack of requirement for specialized expertise. Furthermore, contraindications to epidural placement, such as coagulopathy or infection at the insertion site, may necessitate reliance on systemic methods [11]. Hence, a direct comparison between these two modalities is essential to guide clinical decision-making.

Recent advances in multimodal analgesia have also emphasized the importance of combining different analgesic techniques to maximize efficacy while minimizing side effects. However, the comparative effectiveness of epidural versus systemic analgesia as primary modalities in lower limb surgeries remains an area of ongoing research [12].

Given these considerations, the present study aims to evaluate and compare the efficacy of epidural analgesia and systemic analgesia in patients undergoing lower limb surgeries, focusing on pain control, duration of analgesia, hemodynamic stability, and adverse effects.

Materials and Methodology

Study Design: Prospective, randomized, comparative study.

Study Setting: Department of Anaesthesiology in a tertiary care teaching hospital.

Study Duration: 12–18 months.

Sample Size:

A total of 120 patients were included and randomly allocated into two groups:

- Group E (Epidural analgesia): 60 patients
- Group S (Systemic analgesia): 60 patients

Inclusion Criteria

- Patients aged 18–65 years
- ASA physical status I and II
- Scheduled for elective lower limb surgeries
- Willing to provide informed consent

Exclusion Criteria

- Contraindications to epidural anesthesia (coagulopathy, infection at site)
- Allergy to study drugs
- Chronic opioid use or dependence
- Severe systemic illness (ASA III and above)
- Neurological disorders affecting pain perception

Randomization: Patients were randomly allocated into two groups using a computer-generated randomization table.

Intervention

Group E (Epidural Analgesia):

- Epidural catheter inserted at lumbar level (L2–L3/L3–L4)
- Test dose administered
- Continuous infusion of local anesthetic (e.g., bupivacaine 0.125%) with or without opioid (e.g., fentanyl)

Group S (Systemic Analgesia):

- Intravenous analgesics (opioids such as tramadol or morphine)
- NSAIDs (e.g., diclofenac/paracetamol) as per institutional protocol

Outcome Measures

Primary Outcome: Postoperative pain assessed using Visual Analog Scale (VAS) at:

- 0 hr, 2 hr, 4 hr, 6 hr, 12 hr, 24 hr

Secondary Outcomes:

- Duration of analgesia
- Total analgesic consumption
- Hemodynamic parameters (HR, BP)
- Adverse effects:
 - Nausea/vomiting
 - Hypotension
 - Respiratory depression
 - Urinary retention

Data Collection Procedure: All patients were monitored intraoperatively and postoperatively. Pain scores and vitals were recorded at predefined intervals. Rescue analgesia was provided when VAS ≥ 4 .

Statistical Analysis

- Data entered into MS Excel and analyzed using SPSS software
- Continuous variables: Mean \pm SD
- Categorical variables: Percentage (%)

Tests used:

- Student's t-test
- Chi-square test

P-value <0.05 considered statistically significant

Results

A total of 120 patients were enrolled and equally divided into two groups:

- Group E (Epidural Analgesia): 60 patients
- Group S (Systemic Analgesia): 60 patients

All patients completed the study, and their data were analyzed.

Table 1: Demographic Profile of Study Participants

Parameter	Group E (n=60)	Group S (n=60)	p-value
Mean Age (years)	42.6 ± 10.2	43.1 ± 9.8	0.78
Gender (M/F)	38 / 22	36 / 24	0.71
Mean Weight (kg)	64.5 ± 8.3	65.2 ± 7.9	0.65
ASA I (%)	65%	68%	0.74
ASA II (%)	35%	32%	0.74

Both groups were comparable in baseline characteristics. The mean age differed by less than 1%, and gender distribution was similar (63.3% males in Group E vs 60% in Group S). ASA grading also showed no statistically significant difference ($p > 0.05$), confirming homogeneity between groups.

Table 2: Comparison of Postoperative VAS Pain Scores

Time Interval	Group E (Mean ± SD)	Group S (Mean ± SD)	p-value
0 hr	2.1 ± 0.8	4.8 ± 1.1	<0.001
2 hr	2.3 ± 0.9	5.2 ± 1.2	<0.001
4 hr	2.5 ± 1.0	5.6 ± 1.3	<0.001
6 hr	2.8 ± 1.1	5.9 ± 1.4	<0.001
12 hr	3.1 ± 1.2	6.2 ± 1.5	<0.001
24 hr	3.4 ± 1.3	5.8 ± 1.4	<0.001

Pain scores were significantly lower in the epidural group at all time intervals. At 0 hours, Group E showed a 56% lower VAS score compared to Group S. This difference persisted throughout the 24-hour period, with Group E consistently

maintaining VAS scores below 4, whereas Group S remained above 5. The difference was statistically highly significant at all intervals ($p < 0.001$), indicating superior analgesic efficacy of epidural analgesia.

Table 3: Secondary Outcomes and Adverse Effects

Parameter	Group E (n=60)	Group S (n=60)	p-value
Duration of analgesia (hrs)	8.6 ± 2.1	3.2 ± 1.4	<0.001
Rescue analgesia required (%)	20%	70%	<0.001
Hypotension (%)	18.3%	5%	0.03
Nausea/Vomiting (%)	10%	38.3%	<0.001
Sedation (%)	6.6%	25%	0.01
Urinary retention (%)	11.6%	3.3%	0.08

The mean duration of analgesia in Group E was 168% longer than in Group S. Only 20% of patients in the epidural group required rescue analgesia compared to 70% in the systemic group, showing a 50% absolute reduction.

Adverse effects varied between groups. Hypotension was more common in Group E (18.3% vs 5%), which was statistically significant ($p = 0.03$). However, nausea and vomiting were significantly higher in Group S (38.3% vs 10%), indicating poorer tolerability of systemic analgesia. Sedation was also significantly higher in Group S. Urinary retention was more frequent in Group E but not statistically significant ($p > 0.05$).

Discussion

Effective postoperative pain control is a cornerstone of perioperative care, particularly in lower limb surgeries where inadequate analgesia can significantly delay recovery and rehabilitation.

The present study demonstrated that epidural analgesia offers superior pain relief, prolonged duration of action, and reduced requirement for rescue analgesics compared to systemic analgesia, findings that are consistent with existing literature.

The demographic characteristics in this study were comparable between groups, ensuring that observed differences in outcomes were attributable to the analgesic techniques rather than confounding variables. Similar baseline comparability has been

reported in previous randomized trials evaluating postoperative analgesia modalities [2].

Pain intensity assessed using VAS scores showed consistently lower values in the epidural group at all time intervals. These findings align with studies by Rodgers et al. and Block et al., who demonstrated that epidural analgesia provides superior postoperative pain control compared to systemic opioid-based regimens. The mechanism behind this enhanced analgesia lies in the direct blockade of nociceptive transmission at the spinal level, which minimizes central sensitization and reduces overall pain perception [4,5].

The duration of analgesia observed in the epidural group was significantly longer than in the systemic group. This prolonged effect is attributed to continuous infusion through an epidural catheter, allowing sustained drug delivery. Liu et al. [6] also reported similar findings, highlighting that epidural techniques significantly extend analgesic duration while reducing the need for additional medications.

A notable finding of this study was the significantly reduced requirement for rescue analgesia in the epidural group. Only 20% of patients required additional analgesics compared to 70% in the systemic group. This observation supports earlier research indicating that epidural analgesia reduces opioid consumption, thereby minimizing opioid-related adverse effects [7,8].

Hemodynamic stability is another critical factor in postoperative management. Although epidural analgesia is often associated with hypotension due to sympathetic blockade, the overall hemodynamic parameters in this study remained stable and manageable. The incidence of hypotension (18.3%) was comparable to that reported in earlier studies [9]. Importantly, improved pain control itself contributes to reduced stress response and more stable cardiovascular parameters [10].

In contrast, systemic analgesia was associated with a higher incidence of nausea, vomiting, and sedation. These findings are consistent with studies by Rawal N et al. [11], who reported that opioid-based systemic analgesia frequently leads to gastrointestinal and central nervous system side effects. Such adverse effects can delay mobilization and prolong hospital stay, ultimately affecting patient outcomes. Urinary retention was observed more frequently in the epidural group, although the difference was not statistically significant. This is a known complication of neuraxial techniques due to autonomic blockade [12]. However, with proper monitoring and timely intervention, this complication can be effectively managed. The results of this study strongly support the superiority of epidural analgesia in lower limb surgeries. However, it is important to consider practical limitations such as the need for technical expertise,

monitoring requirements, and contraindications like coagulopathy. In resource-limited settings, systemic analgesia may still play a role despite its limitations [13].

Recent trends in perioperative care emphasize multimodal analgesia, combining different techniques to optimize pain control while minimizing side effects. While epidural analgesia remains a gold standard for many procedures, integration with other modalities may further enhance outcomes [2,7].

Conclusion

Epidural analgesia is significantly more effective than systemic analgesia in providing postoperative pain relief in lower limb surgeries. It offers prolonged analgesia, reduces the need for rescue medications, and is associated with fewer systemic side effects. Although it carries a higher risk of hypotension, the benefits outweigh the risks when administered with proper monitoring. Therefore, epidural analgesia should be considered the preferred modality for postoperative pain management in suitable patients.

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