INTERMITTENT EPIDURAL BOLUS VERSUS CONTINUOUS INFUSION OF ROPIVACAINE COMBINED WITH MORPHINE FOR POSTOPERATIVE ANALGESIA IN LOWER EXTREMITY PROCEDURES: A COMPARATIVE ANALYSIS:

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Abstract :

Background:
Effective postoperative analgesia is essential for early mobilization, enhanced recovery, and improved patient outcomes following lower limb surgeries. Epidural administration of local anesthetics combined with opioids is widely used for postoperative pain control. Ropivacaine, with its favorable safety profile and differential sensory blockade, along with morphine, provides prolonged analgesia. However, the optimal mode of epidural drug delivery—intermittent bolus versus continuous infusion—remains unclear.

Aim:
To compare the efficacy and safety of epidural ropivacaine combined with morphine administered as intermittent boluses versus continuous infusion for postoperative analgesia in patients undergoing lower limb surgeries.

Methods:
This prospective randomized study was conducted on 30 patients (ASA I and II) undergoing elective lower limb surgeries. Patients were divided into two groups: Group IB (intermittent bolus) and Group CI (continuous infusion), with 15 patients in each group. Epidural analgesia

using ropivacaine 0.1% with morphine was initiated postoperatively when the Visual Analogue Scale (VAS) score exceeded 4. Group IB received 6 mL hourly boluses, while Group CI received continuous infusion at 6 mL/hour. Pain scores (VAS), time to first rescue analgesia, total analgesic consumption, hemodynamic parameters, and adverse effects were assessed.

Results:
The intermittent bolus group demonstrated significantly lower VAS scores at 12 and 24 hours compared to the continuous infusion group ($p < 0.05$). Time to first rescue analgesia was significantly prolonged in Group IB, with reduced total analgesic consumption. Hemodynamic parameters remained stable and comparable in both groups. The incidence of adverse effects was low and similar between groups, with no serious complications observed.

Conclusion:
Intermittent epidural bolus administration of ropivacaine with morphine provides superior postoperative analgesia compared to continuous infusion, with prolonged pain relief and reduced drug consumption, without compromising safety. This technique may be preferred for postoperative pain management in lower limb surgeries.

Keywords:
Epidural analgesia, Ropivacaine, Morphine, Intermittent bolus, Continuous infusion, Postoperative pain, Lower limb surgery.

Introduction:

Modern perioperative care has evolved significantly with increasing emphasis on early mobilization, enhanced recovery, and minimization of postoperative complications. Rapid advancements in surgical techniques and anesthetic practices have shifted the focus toward optimizing postoperative analgesia while reducing systemic side effects. In this context, regional anesthesia has gained widespread acceptance among anesthesiologists due to its ability to provide superior analgesia, reduce opioid consumption, facilitate early ambulation, and improve patient satisfaction (1,2).

Spinal and epidural anesthesia techniques are commonly employed for lower limb surgeries owing to their effectiveness and safety profile. Traditionally, Bupivacaine has been the most widely used local anesthetic for neuraxial blocks. However, its use is associated with several adverse effects, including central nervous system toxicity, significant hypotension, bradycardia, prolonged motor blockade, and potential cardiotoxicity, particularly at higher doses or inadvertent intravascular administration (3,4). These limitations prompted the development of newer local anesthetic agents with improved safety profiles.

Ropivacaine, a long-acting amide local anesthetic and the pure S-enantiomer, was introduced as a safer alternative to Bupivacaine. Structurally similar to Bupivacaine, Ropivacaine exhibits reduced lipid solubility, which contributes to lower cardiotoxicity and neurotoxicity (5). It has demonstrated a favorable pharmacodynamic profile, characterized by differential blockade with preferential sensory over motor block. This property is particularly advantageous in postoperative settings where early mobilization is desired. Extensive clinical studies have

validated the safety and efficacy of Ropivacaine in various regional anesthesia techniques, including epidural anesthesia and peripheral nerve blocks such as brachial plexus block (6).

Recent investigations have further established the utility of Ropivacaine in neuraxial anesthesia, demonstrating comparable analgesic efficacy to Bupivacaine while allowing faster recovery of motor function. This characteristic makes Ropivacaine especially suitable for lower limb surgeries, where early rehabilitation and ambulation are critical components of postoperative care (7,8).

To enhance the quality and duration of analgesia, opioids are frequently used as adjuvants in neuraxial anesthesia. Morphine, a hydrophilic opioid, has a high affinity for central opioid receptors and provides prolonged analgesia when administered epidurally or intrathecally (9). It was the first opioid approved by the Food and Drug Administration for neuraxial use and continues to be widely utilized due to its long-lasting analgesic effects. Intrathecal and epidural morphine have been shown to provide effective postoperative pain relief, particularly in major orthopedic procedures such as total knee and hip surgeries (10).

Despite the effectiveness of epidural analgesia using local anesthetic–opioid combinations, the optimal method of drug delivery remains a subject of ongoing research. Epidural analgesia can be administered either as intermittent boluses or continuous infusion. Intermittent bolus techniques may provide better spread of the drug within the epidural space, resulting in improved analgesic efficacy, whereas continuous infusion offers the advantage of steady plasma levels and consistent analgesia. However, differences in analgesic quality, total drug consumption, hemodynamic stability, and side effect profile between these two techniques warrant further evaluation.

Therefore, this study aims to compare the efficacy and safety of epidural Ropivacaine combined with Morphine administered as intermittent boluses versus continuous infusion for postoperative analgesia in patients undergoing lower limb surgeries.

Aim

To compare the efficacy and safety of epidural Ropivacaine combined with Morphine administered as intermittent boluses versus continuous infusion for postoperative analgesia in patients undergoing lower limb surgeries.

Objectives

To evaluate and compare the quality of postoperative analgesia between intermittent epidural bolus and continuous epidural infusion techniques using Ropivacaine with Morphine, assessed by pain scores (VAS).

Materials and Methodology:

This prospective randomized study was conducted at Sree Mookambika Institute of Medical Sciences over a period of six months from August 2024 to February 2025. A total of 30 patients undergoing elective lower limb surgeries were enrolled after obtaining approval from the Institutional Ethics Committee and written informed consent. Patients belonging to American

Society of Anesthesiologists (ASA) physical status I and II were included and were randomly allocated into two groups of 15 each: Group IB (intermittent bolus) and Group CI (continuous infusion).All patients were preoperatively evaluated and counseled. In the operating room, standard monitoring including electrocardiogram, non-invasive blood pressure, and pulse oximetry was instituted according to ASA guidelines. Under aseptic precautions and mild sedation with intravenous midazolam (1–2 mg), a lumbar epidural catheter was inserted in the sitting position at the L2–L3 or L3–L4 interspace using a Tuohy needle and loss-of-resistance technique. After confirming correct placement with negative aspiration, a test dose of 3 mL of 2% lignocaine with adrenaline was administered. Subsequently, spinal anesthesia was performed using a 26G Quincke needle, and 3 mL of 0.5% hyperbaric bupivacaine was injected into the subarachnoid space after confirmation of free cerebrospinal fluid flow. The epidural catheter was secured, and sensory blockade was assessed using cold/warm sensation after 5 minutes. At the end of surgery, patients were shifted to the post-anesthesia care unit (PACU).

In Group CI, epidural analgesia was administered using an infusion pump containing 50 mL solution of ropivacaine 0.1% with morphine 1 mg, delivered at a continuous rate of 6 mL/hour. In Group IB, the same drug combination (total volume 50 mL) was administered as intermittent epidural boluses of 6 mL every 60 minutes. In both groups, epidural analgesia was initiated when the patient reported pain or when the visual analogue scale (VAS) score exceeded 4. In case of inadequate analgesia, a supplemental epidural bolus of 4 mL was administered with a lockout interval of 30 minutes. Intravenous tramadol 50 mg was provided as rescue analgesia if required.

Patients were closely monitored for hemodynamic parameters including heart rate and blood pressure, as well as for adverse effects such as hypotension, nausea, vomiting, pruritus, respiratory depression, and gastric irritation. Hypotension, if encountered, was managed by temporarily stopping the infusion or bolus and administering intravenous ephedrine 3 mg when necessary. Pain was assessed using a 10 cm visual analogue scale (VAS), where 0 indicated no pain and 10 represented the worst imaginable pain. Assessments were performed at regular intervals of 30 minutes initially and subsequently at 12 and 24 hours postoperatively. Any occurrence of respiratory discomfort was noted and managed appropriately.

Data were entered and analyzed using appropriate statistical software. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Comparison between the two groups was performed using the independent Student’s t-test for continuous variables and the Chi-square test or Fisher’s exact test for categorical variables. A p value of less than 0.05 was considered statistically significant.

Result:

Table1:Comparison of studyvariablesbetweenGroupCIandGroupIB

Parameters	CI			IB			P-Values
Age	60.07	±	8.40	60.47	±	7.78	0.001**
Gender(M:F)	9:6			7:8			-
Height	159.67	±	0.001*	165.60	±	9.12	0.001**
Weight	66.60	±	0.001*	73.60	±	8.02	0.001**
BMI	24.35	±	0.001*	22.70	±	2.22	0.001**
ASA	2.13	±	0.001*	2.33	±	0.49	0.001**

Table 1 shows the comparison of study variables between group CI and group IB. The age, height, weight, BMI and ASA showed a significant difference between the group CI and group IB, respectively, the P value is 0.001*.

Table2:Comparisonof study variablesbetween 12thand 24thhrofgroupCI

Parameters	CI						P-Values
	12thHr			24thHr			
VAS	4.47	±	0.99	3.53	±	0.74	0.001**
SBP	131.33	±	19.22	123.33	±	9.76	0.219
DBP	74.67	±	9.90	76.00	±	9.86	0.422
HR	83.07	±	15.69	77.67	±	9.79	0.596

Table 2 illustrate the comparison of studyvariables between 12th and 24th hr of group CI. The VAS showed a significant difference between the 12th and 24th hr of group CI. Additionally, the systolic and diastolic blood pressure and heart rate does not show anysignificant between the 12th and 24th hr of group CI.

Table3:Comparisonofstudy variablesbetween 12thand 24thhrof IB

Parameters	IB						P-Values
	12thHr			24thHr			
VAS	2.93	±	0.88	2.47	±	0.74	0.001*

SBP	122.00	±	11.46	124.00	±	9.86	0.219
DBP	117.47	±	167.40	76.13	±	5.21	0.422
HR	79.53	±	8.97	79.93	±	7.27	0.596

Table3 illustrate the comparison ofstudyvariablesbetween 12th and 24th hrof group IB. The VAS showed a significant between the 12th and 24th hr of group IB (P=0.001**). Additionally, the systolic and diastolic blood pressure and heart rate does not show any significant between the 12th and 24th hr of group CI.

Table4:Correlation of study variablesbetweenCIand IB

Parameter	ASA		VAS	
	r- value	P-value	r- value	P-value
Age	0.102	0.59	0.305	0.10
Height	0.297	0.11	0.277	0.13
Weight	0.098	0.60	0.078	0.68
BMI	0.007	0.97	0.102	0.59
SBP	0.348	0.05*	0.286	0.02*
DBP	0.104	0.58	0.027	0.83
HR	0.297	0.111	0.157	0.230

Table 4 shows the correlation of study variables between group CI and group IB. There is no significant correlation between ASA, VAS and age, Height, Weight, BMI, DBP and HR. There was a significant positive correlation between the ASA, VAS and systolic blood pressure, the P value is 0.02*.

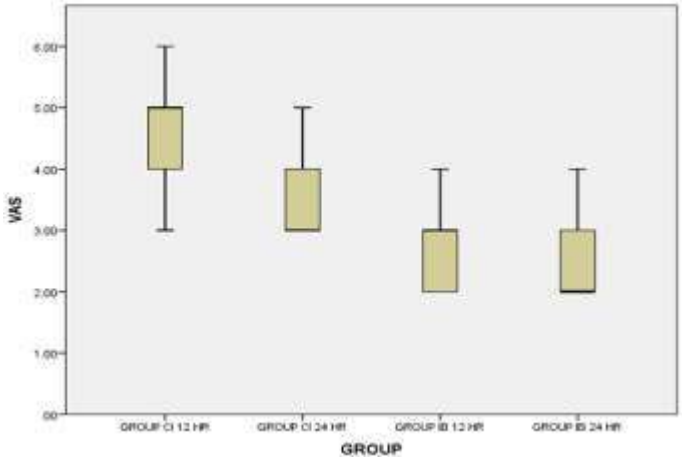

Figure1: Showsthe boxplot between visualanaloguescaleand study subjects

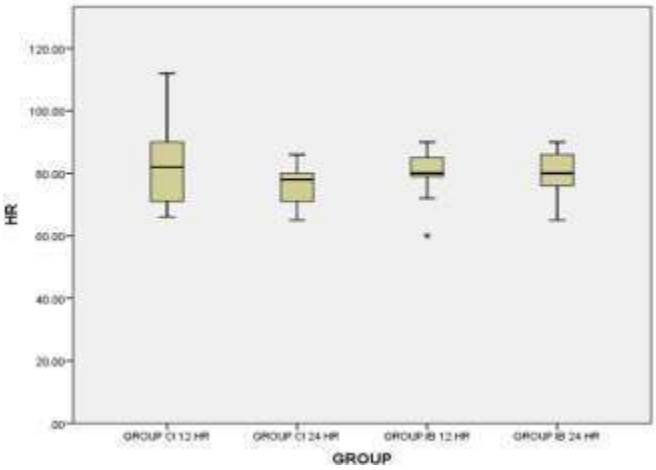

Figure2:Shows thebox plotbetween heartrateandstudy subjects

Comparedto0.1%mlofplainropivacaine,spinalanesthesiawithhyperbaricropivacaine0.1

% ml led to a considerably faster recovery of both motor and sensory block, as well as a shorter time to first voluntary micturition and home-readiness (17-18). Many studies have been done to find the suitable dose of morphine or defining the dose of intrathecal morphine in patients undergoing hip and knee arthroplasty which provide good analgesia and less side effects (19-20). The use of ropivacaine and morphine for intrathecal anesthesia in the lower abdominal and lower limb surgeries provided an adequate level of block for the surgery with faster onset of sensory and motor blockade, lesser duration of motor blockade with good analgesia and stable

hemodynamics. The studies have reported ropivacaine produced a faster onset, greater success rate of analgesia at the level of T10 dermatome, and faster recovery of the block.

Discussion:

Effective postoperative pain management plays a crucial role in enhancing recovery, promoting early ambulation, and reducing postoperative complications in patients undergoing lower limb surgeries. In the present study, epidural administration of ropivacaine combined with morphine using intermittent bolus (IB) and continuous infusion (CI) techniques was compared to evaluate analgesic efficacy, hemodynamic stability, and safety outcomes.Ropivacaine, a long-acting amide local anesthetic, is widely preferred in neuraxial anesthesia due to its favorable safety profile and differential sensory-motor blockade. Compared to bupivacaine, ropivacaine is associated with reduced cardiotoxicity and faster recovery of motor function, making it particularly suitable for orthopedic procedures requiring early mobilization (11,12). Previous studies have demonstrated that ropivacaine provides adequate sensory blockade with quicker regression of motor block, thereby improving postoperative recovery parameters such as early ambulation and return of bladder function (11).

The addition of morphine, a hydrophilic opioid, enhances the quality and duration of analgesia when used in neuraxial techniques. Its high affinity for spinal opioid receptors results in prolonged analgesic effects with minimal systemic absorption (13). Several studies have evaluated the optimal dosing of intrathecal and epidural morphine in orthopedic surgeries, showing effective pain relief with acceptable side effect profiles (14). In this study, the combination of ropivacaine and morphine provided satisfactory analgesia with minimal adverse effects in both groups.

A key finding of the present study is that patients in the intermittent bolus group (IB) exhibited significantly lower VAS scores at both 12 and 24 hours compared to the continuous infusion group (CI). This suggests that intermittent bolus administration provides superior analgesic efficacy. The improved pain control may be attributed to better spread of the anesthetic solution within the epidural space during bolus administration, resulting in more uniform dermatomal coverage. Similar findings have been reported in earlier studies, where intermittent bolus techniques were associated with improved analgesia and reduced drug requirements compared to continuous infusion (15,16).

Hemodynamic parameters, including systolic blood pressure, diastolic blood pressure, and heart rate, remained stable in both groups, with no statistically significant differences observed between 12 and 24 hours. This indicates that both techniques are hemodynamically safe. Although a statistically significant correlation was observed between systolic blood pressure and VAS scores, this may reflect the physiological response to pain rather than a direct effect of the analgesic technique.

Baseline demographic variables such as age, height, weight, BMI, and ASA classification showed statistical differences between the groups. However, these differences are unlikely to have significantly influenced the primary outcomes, as previous studies suggest that minor baseline variations do not substantially affect analgesic efficacy in randomized trials (17).

Furthermore, no major adverse effects such as severe hypotension or respiratory depression were observed in either group. Minor side effects, if present, were transient and manageable. This is consistent with existing literature demonstrating the safety of epidural ropivacaine combined with morphine for postoperative analgesia (18).

Overall, the findings of this study suggest that while both intermittent bolus and continuous infusion techniques are effective for postoperative epidural analgesia, the intermittent bolus technique offers superior pain relief without compromising safety or hemodynamic stability. Therefore, intermittent bolus administration may be considered a preferable method in patients undergoing lower limb surgeries.

Conclusion:

Intermittent epidural bolus of ropivacaine with morphine provided superior postoperative analgesia compared to continuous infusion, with lower VAS scores and comparable hemodynamic stability. Both techniques were safe with minimal adverse effects; however, intermittent bolus demonstrated better pain control, supporting its preference for postoperative analgesia in lower limb surgeries.

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