Original Research

COMPARATIVE EVALUATION OF DEXMEDETOMIDINE AND CLONIDINE AS EPIDURAL ADJUVANTS TO BUPIVACAINE IN LOWER LIMB SURGERIES

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ABSTRACT

Background: Epidural anaesthesia is commonly used for lower limb surgeries because it provides effective intraoperative anaesthesia, prolonged postoperative analgesia, and stable haemodynamics.
Alpha-2 adrenergic agonists such as dexmedetomidine and clonidine are frequently used as adjuvants to local anaesthetics to improve the quality and duration of epidural blockade.
Methodology: This prospective randomized comparative study was conducted in the Department of Anaesthesiology, Sree Mookambika Institute of Medical Sciences, Kulasekharam, from March 2025 to April 2026. Patients aged 20–60 years belonging to ASA physical status I and II undergoing elective lower limb surgeries under epidural anaesthesia were included in the study. Patients were randomly allocated into two groups. Group D received dexmedetomidine with 0.5% bupivacaine, while Group C received clonidine with 0.5% bupivacaine.
Haemodynamic parameters, sedation scores, postoperative pain scores, duration of analgesia, and adverse effects were assessed and compared.
Results: Both groups showed stable haemodynamic profiles throughout the study period. However, dexmedetomidine produced a greater reduction in heart rate and mean arterial pressure compared to clonidine while remaining within safe clinical limits. Ramsay Sedation Scores were significantly higher in the dexmedetomidine group at all observed intervals ($p<0.05$).
Visual Analog Scale scores for postoperative pain were significantly lower in Group D at 120, 240, and 360 minutes, indicating prolonged analgesia. Bradycardia and hypotension were slightly more common in the dexmedetomidine group but were effectively managed.
Conclusion: Dexmedetomidine was found to be a superior adjuvant to epidural bupivacaine compared to clonidine due to better sedation, prolonged postoperative analgesia, and effective haemodynamic stability with manageable adverse effects.

Keywords: Dexmedetomidine, Clonidine, Epidural Anaesthesia, Bupivacaine, Lower Limb Surgery, Postoperative Analgesia.

INTRODUCTION

Epidural anaesthesia is widely utilized for lower limb surgeries because of its ability to provide effective intraoperative anaesthesia, prolonged postoperative analgesia, and stable haemodynamic conditions.[1]

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Regional anaesthetic techniques have gained increasing popularity in orthopaedic procedures due to advantages such as reduced stress response, lower incidence of thromboembolic complications, early mobilization, shorter hospital stay, and improved patient satisfaction.2 However, the duration and quality of analgesia achieved with local anaesthetics alone may sometimes be inadequate for prolonged surgical procedures and postoperative pain management. Therefore, the use of adjuvants with epidural local anaesthetics has become a common practice to enhance the efficacy of regional blocks.3 Bupivacaine is one of the most commonly used long-acting local anaesthetic agents for epidural anaesthesia because of its prolonged duration of action and excellent sensory blockade. 4 Despite its effectiveness, the search for an ideal adjuvant

continues with the aim of accelerating onset of blockade, prolonging duration of analgesia, improving block quality, reducing local anaesthetic requirements, and minimizing adverse effects. 5 Various adjuvants such as opioids, ketamine, and alpha-2 adrenergic agonists have been investigated for this purpose. Among them, alpha-2 adrenergic agonists have emerged as promising agents because of their sedative, analgesic, and sympatholytic properties Dexmedetomidine is a highly selective alpha-2 adrenergic receptor agonist with a selectivity nearly eight times greater than clonidine. 7 It produces analgesia by acting on alpha-2 receptors in the dorsal horn of the spinal cord and inhibits release of nociceptive neurotransmitters. Dexmedetomidine also provides sedation, anxiolysis, and sympatholysis without causing significant respiratory depression, which makes it particularly useful as a adjuvant in regional anaesthesia. 8 Several studies have demonstrated that addition of dexmedetomidine to epidural local anaesthetics prolongs sensory and motor blockade, improves postoperative analgesia, and enhances patient comfort during surgery. 9 Clonidine is another alpha-2 adrenergic agonist that has been extensively used as an adjuvant in epidural and spinal anaesthesia for many years.[10] It acts mainly through stimulation of pre-synaptic alpha-2 receptors, leading to inhibition of norepinephrine release and suppression of sympathetic activity. Clonidine prolongs the duration of sensory and motor blockade, enhances analgesia, and provides sedation.[11] However, side effects such as hypotension, bradycardia, and dry mouth may occur, particularly at higher doses.[12] Both dexmedetomidine and clonidine have demonstrated efficacy in improving the quality and duration of epidural anaesthesia when combined with bupivacaine.[13] Although numerous studies have evaluated each drug separately against local anaesthetics alone, there are relatively limited studies directly comparing dexmedetomidine and clonidine as epidural adjuvants in lower limb surgeries. Comparative evaluation of these agents is important to determine the superior adjuvant in terms of onset and duration of blockade, haemodynamic stability, sedation quality, postoperative analgesia, and incidence of adverse effects. Lower limb orthopaedic surgeries often require prolonged anaesthesia and effective postoperative pain management to facilitate early mobilization and rehabilitation. Hence, identifying an ideal epidural adjuvant is of considerable clinical importance. The present study was therefore undertaken to compare the efficacy of dexmedetomidine and clonidine when added to 0.5% bupivacaine for epidural anaesthesia in lower limb surgeries. The study aimed to evaluate the block characteristics, haemodynamic stability, sedation levels, duration of postoperative analgesia, and associated side effects of these two agents.

Aim

To compare the efficacy of dexmedetomidine and clonidine as adjuvants to 0.5% bupivacaine in epidural anaesthesia for lower limb surgeries.

Objectives

- To compare the onset time of sensory blockade between dexmedetomidine and clonidine groups.
- To evaluate and compare the onset and duration of motor blockade in both groups.
- To assess intraoperative haemodynamic parameters such as heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure.

MATERIALS AND METHOD

This prospective randomized comparative study was conducted in the Department ofAnaesthesiology at Sree Mookambika Institute of Medical Sciences, Kulasekharam, from March 2025 to April 2026 after obtaining approval from the Institutional Ethics Committee and written informed consent from all patients. Patients belonging to American Society ofAnesthesiologists (ASA) physical status I and II, aged between 20 and 60 years, who were scheduled for elective lower limb surgeries under epidural anaesthesia were included in the study. Patients with contraindications to regional anaesthesia such as coagulopathy, local infection at the puncture site, neurological disorders, severe cardiovascular, hepatic, or renal diseases were excluded from the study. Patients with a history of allergy to the study drugs, those receiving long-term sedatives or antihypertensive medications, and patients unwilling to participate were also excluded. All patients underwent detailed pre-anaesthetic evaluation including clinical examination and routine laboratory investigations. Patients received oral ranitidine 150 mg and alprazolam 0.25 mg as premedication on the night before surgery. On arrival to the operation theatre, standard monitoring including electrocardiography (ECG), non- invasive blood pressure (NIBP), and pulse oximetry (SpO2) was instituted. Baseline haemodynamic parameters such as heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure were recorded. Intravenous access was secured and all patients were preloaded with Ringer lactate solution 10 mL/kg prior to the procedure.

Under strict aseptic precautions, epidural anaesthesia was administered in the sitting position at the L3–L4 intervertebral space using an 18-gauge Tuohy needle. After identification of the epidural space by loss of resistance technique, an epidural catheter was inserted and secured appropriately. A

test dose of 3 mL of 2% lignocaine with adrenaline 1:200000 was administered to confirm proper placement of the epidural catheter and to exclude inadvertent intrathecal or intravascular injection.

Following confirmation of correct catheter placement, patients were randomly allocated into two study groups. One group received 0.5% bupivacaine with dexmedetomidine, while the other group received 0.5% bupivacaine with clonidine as an epidural adjuvant. The onset and duration of sensory and motor blockade, haemodynamic parameters, sedation level, and duration of postoperative analgesia were assessed and compared between the groups. Sensory blockade was assessed using the pinprick method, while motor blockade was evaluated using the Modified Bromage Scale. Heart rate and mean arterial pressure were recorded at baseline and subsequently at 5, 10, 20, 30, 45, and 60 minutes after administration of the block and thereafter hourly until regression of the block.

Sedation was assessed using the Ramsay Sedation Scale, and postoperative pain was evaluated using the Visual Analog Scale (VAS). The time to first rescue analgesic requirement was recorded. Any adverse effects such as bradycardia, hypotension, nausea, vomiting, respiratory depression, and excessive sedation were also noted and managed appropriately.

The collected data were entered into Microsoft Excel and analysed using Statistical Package for Social Sciences (SPSS) software version 22.0. Continuous variables such as onset and duration of sensory and motor blockade were expressed as mean ± standard deviation and analysed using the independent Student's t-test. Categorical variables such as incidence of side effects were expressed as frequency and percentage and compared using the Chi-square test or Fisher's exact test wherever appropriate. A p-value of less than 0.05 was considered statistically significant.

RESULT

Table 1: Comparison of Hemodynamic Parameters (Heart Rate And Mean Arterial Pressure) Between Group D and Group C

Time (Minutes)	Heart Rate (bpm) - Group D	Heart Rate (bpm) – Grou C	MAP (mmHg) - Group D	MAP (mmHg) - Group C
Baseline	84.3 ± 6.7	85.1 ± 7.2	98.6 ± 5.3	99.2 ± 4.8
10 min	82.1 ± 5.8	83.5 ± 6.1	96.2 ± 4.9	97.8 ± 5.2
30 min	79.4 ± 6.0	81.2 ± 5.7	94.1 ± 5.0	96.7 ± 4.9
60 min	78.0 ± 5.5	80.5 ± 5.2	92.8 ± 4.6	95.4 ± 5.1
90 min	76.5 ± 5.2	78.9 ± 5.4	91.3 ± 5.0	94.1 ± 4.8

Heart rate and mean arterial pressure were recorded at different time intervals. The baseline heart rate was almost similar in both groups. Over time, heart rate reduced more in the dexmedetomidine group compared to the clonidine group. At 90 minutes, the heart rate in Group D was 76.5 ± 5.2 bpm while in Group C it was 78.9 ± 5.4 bpm. The difference became more significant as time progressed. Mean arterial pressure also followed a similar pattern. At baseline both groups had comparable MAP values but after drug administration, Group D showed a greater reduction compared to Group C. At 90 minutes the MAP was 91.3 ± 5.0 mmHg in Group D and 94.1 ± 4.8 mmHg in Group C. The hemodynamic changes were within safe limits in both groups, though dexmedetomidine caused a slightly greater decrease in heart rate and blood pressure.

Table 2: Ramsay Sedation Scores at Different Time Intervals in Group D and Group C

Time (Minutes)	Group D (Dexmedetomidine)	Group C (Clonidine)	p-value
10 min	2.3 ± 0.5	1.8 ± 0.4	< 0.05
30 min	2.8 ± 0.6	2.2 ± 0.5	< 0.05
60 min	3.0 ± 0.7	2.5 ± 0.6	< 0.05
90 min	2.9 ± 0.6	2.3 ± 0.5	< 0.05

Sedation was assessed using the Ramsay Sedation Scale at multiple time points. The sedation score in Group D was consistently higher compared to Group C. At 10 minutes Group D had

a score of2.3 ± 0.5 while Group C had 1.8 ± 0.4. Group D achieved a mean score of 3.0 ± 0.7 at 60 minutes while Group C got a score of2.5 ± 0.6. The discrepancy grew at 30 and 60 minutes. The dexmedetomidine group continued to have a higher level of sedation even after 90 minutes. For every time interval exhibiting statistical significance the p-value was< 0.05. This implies that compared to clonidine, dexmedetomidine produces a deeper level of sedation, which could help lessen surgical anxiety and discomfort.

Table 3: Visualanalog Scale (VAS) Scores for Postoperative Pain and Duration of analgesia

Time (Minutes)	VAS Score - Group D	VAS Score - Group C	p-value
30 min	1.1 ± 0.3	1.4 ± 0.5	0.08
120 min	1.5 ± 0.4	2.0 ± 0.5	< 0.05
240 min	2.2 ± 0.6	3.1 ± 0.7	< 0.05
360 min	3.8 ± 0.8	5.0 ± 1.0	< 0.05

Pain intensity was evaluated using the Visual Analog Scale at different postoperative intervals. The VAS score was lower in Group D at all time points indicating better pain relief. At 30 minutes, the score in Group D was 1.1 ± 0.3 while in Group C it was 1.4 ± 0.5 though the difference was not statistically significant. By 120 minutes Group D had a significantly lower pain score of 1.5 ± 0.4 compared to 2.0 ± 0.5 in Group C. The gap widened at 240 and 360 minutes with Group D scoring 3.8 ± 0.8 at 360 minutes while Group C had 5.0 ± 1.0. The difference was statistically significant. These results indicate that dexmedetomidine provides longer pain relief compared to clonidine, reducing the need for early rescue analgesia.

Table 4: Incidence of Adverse Effects Observed in Group D and Group C

Adverse Effect	Group D (%)	Group C (%)	p-value
Bradycardia	15%	8%	< 0.05
Hypotension	12%	6%	< 0.05
Nausea/Vomiting	5%	3%	0.12
Respiratory Depression	0%	0%	-

The incidence of adverse effects was recorded in both groups. Bradycardia was observed in 15 percent ofpatients in Group D compared to 8 percent in Group C, with a p-value of less than 0.05. Hypotension was seen in 12 percent ofpatients in Group D and 6 percent in Group C, also statistically significant. Nausea and vomiting occurred in 5 percent of patients in Group D and 3 percent in Group C, but the difference was not statistically significant. No cases of respiratory depression were surgeries with respect to haemodynamic parameters, sedation profile, postoperative analgesia, and adverse effects. Both drugs provided effective epidural anaesthesia with adequate intraoperative stability and postoperative pain relief. However, dexmedetomidine demonstrated superior analgesic efficacy and sedation when compared to clonidine. Haemodynamic stability is an important consideration during epidural anaesthesia because sympathetic blockade may result in hypotension and bradycardia. In the present study, both groups showed a gradual reduction in heart rate and mean arterial pressure following epidural administration. However, the reduction was more pronounced in the dexmedetomidine group. At 90 minutes, Group D reported in either group. Although dexmedetomidine led to a slightly higher occurrence of bradycardia and hypotension, both side effects were managed effectively without complications.

DISCUSSION

The present study compared dexmedetomidine and clonidine as adjuvants to epidural bupivacaine in lower limb

showed a heart rate of 76.5 ± 5.2 bpm compared to 78.9 ± 5.4 bpm in Group C. Similarly, mean arterial pressure at 90 minutes was 91.3 ± 5.0 mmHg in Group D and 94.1 ± 4.8 mmHg in Group C. Although dexmedetomidine produced a greater fall in heart rate and blood pressure, the values remained within clinically acceptable limits and were managed effectively without major complications. Similar findings were reported by Bajwa et al., who observed better haemodynamic stability with dexmedetomidine compared to clonidine in epidural anaesthesia. I4 The sympatholytic action of dexmedetomidine through highly selective alpha-2 receptor stimulation contributes to attenuation of stress response and reduction in catecholamine

release.I5 Sedation is another desirable property during regional anaesthesia because it reduces patient anxiety and improves surgical comfort. In the present study, Ramsay Sedation Scores were significantly higher in the dexmedetomidine group at all measured intervals ($p<0.05$). At 60 minutes, Group D achieved a sedation score of 3.0 ± 0.7 compared to 2.5 ± 0.6 in Group C. These findings suggest that dexmedetomidine provides deeper yet arousable sedation compared to clonidine. Similar observations were made by El-Hennawy et al., who demonstrated enhanced sedation and patient comfort with dexmedetomidine as an epidural adjuvant.I6 Dexmedetomidine-induced sedation resembles natural sleep and is associated with minimal respiratory depression, making it particularly advantageous in regional anaesthesia.I7 Postoperative pain relief is a major determinant of patient satisfaction and early rehabilitation following lower limb surgeries. In the present study, Visual Analog Scale scores were consistently lower in Group D at all postoperative intervals, indicating superior analgesia with dexmedetomidine. At 360 minutes postoperatively, the VAS score in Group D was 3.8 ± 0.8 compared to 5.0 ± 1.0 in Group C, which was statistically significant. These findings indicate prolonged duration of analgesia and delayed requirement for rescue analgesics in the dexmedetomidine group. Similar results were observed by Gupta et al., who reported prolonged sensory blockade and superior postoperative analgesia with dexmedetomidine compared to clonidine.[18] The enhanced analgesic action may be due to inhibition of substance P release and suppression of nociceptive transmission in the dorsal horn of the spinal cord.[19]

The incidence of adverse effects was slightly higher in the dexmedetomidine group. Bradycardia and hypotension were observed in 15% and 12% ofpatients respectively in Group D compared to 8% and 6% in Group C. The differences were statistically significant; however, all episodes were mild and managed successfully with standard treatment. No respiratory depression was noted in either group, supporting the safety of alpha-2 agonists in epidural anaesthesia. Similar findings were reported in previous studies where dexmedetomidine produced more pronounced haemodynamic effects than clonidine but without serious complications.2 Overall, the present study demonstrates that dexmedetomidine is a more effective epidural adjuvant than clonidine in lower limb surgeries due to its superior sedation profile, prolonged postoperative analgesia, and acceptable haemodynamic stability despite a slightly higher. incidence of manageable adverse effects.

CONCLUSION

Both dexmedetomidine and clonidine were effective adjuvants to epidural bupivacaine in lower limb surgeries, providing satisfactory intraoperative anaesthesia and postoperative analgesia. Dexmedetomidine demonstrated superior efficacy by producing better sedation, prolonged postoperative analgesia, and lower postoperative pain scores compared to clonidine. Although dexmedetomidine was associated with a slightly higher incidence of bradycardia and hypotension, these adverse effects were mild and manageable. Therefore, dexmedetomidine may be considered a more effective epidural adjuvant than clonidine for lower limb surgeries due to its enhanced analgesic and sedative properties with acceptable haemodynamic stability.

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