



CLINICAL EVALUATION OF THREE DIFFERENT DOSES OF CLONIDINE (0.5,1,1.5MCG/KG) AS AN ADJUVANT TO 20ML OF ROPIVACAINE (0.375%) IN ULTRASOUND GUIDED CAUDAL EPIDURAL BLOCK IN ADULT PATIENTS UNDERGOING LUMBOSACRAL SPINE SURGERIES - AN OBSERVATIONAL STUDY

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ABSTRACT

BACKGROUND: Caudal epidural analgesia is an effective technique for intraoperative and postoperative pain management in lumbosacral spine fixation surgeries. When combined with general anesthesia, it reduces anesthetic requirements, improves recovery, and enhances postoperative analgesia. Ropivacaine, a long-acting amide local anesthetic, offers prolonged sensory blockade with minimal motor effects and reduced toxicity. Clonidine, an α -2 adrenergic agonist, enhances the effects of local anesthetics through spinal receptor modulation and contributes to hemodynamic stability.

AIM: The study aimed to observe and evaluate the duration and quality of analgesia of three different doses of clonidine (0.5, 1.0, and 1.5 mcg/kg) as an adjuvant to 20ml of 0.375% Ropivacaine in ultrasound guided caudal epidural block in adult patients undergoing Lumbosacral spine fixation surgeries.

MATERIALS AND METHODS:

Study Design: A prospective, hospital-based observational study.

Study Setting: Conducted at Narayana Medical College, Nellore. Total cases of 90 patients undergoing elective lumbosacral spine fixation surgeries.

Group A: Ropivacaine 0.375% + Clonidine 0.5 mcg/kg

Group B: Ropivacaine 0.375% + Clonidine 1.0 mcg/kg

Group C: Ropivacaine 0.375% + Clonidine 1.5 mcg/kg

To assess quality and duration analgesia, vas score, hemodynamic parameters (HR, BP, SpO₂), patient satisfaction, time to first rescue analgesia, side effects and the number of paracetamol/tramadol doses within the first 24 hours.

RESULTS: Group C showed the longest duration of analgesia and the maximum delay in requirement of first rescue analgesia (23.36 ± 0.99 hrs) but was associated with increased sedation and mild hypotension. This group also required the least number of rescue tramadol doses during the first 24 hours postoperatively (0.13 ± 0.33), indicating superior analgesic efficacy. In contrast, Group A had the shortest duration of analgesia with earlier need for rescue analgesia (7.66 ± 0.54 hrs) and the highest requirement for additional rescue analgesic doses, with maximum tramadol consumption in the first 24 hours (2.76 ± 0.66). Group B provided an optimal balance with prolonged analgesia and delayed rescue analgesia requirement (18.33 ± 1.49 hrs), while maintaining stable hemodynamic parameters. The tramadol requirement in this group was significantly lower (1.36 ± 0.49), compared to Group A, reflecting effective postoperative analgesia with fewer adverse effects. Patient satisfaction scores were highest in Group B, followed by Group C and Group A.

CONCLUSION: Clonidine effectively enhances ropivacaine analgesia in caudal epidural blocks. Among the doses studied, 1.0 mcg/kg is the most appropriate, offering prolonged analgesia, maintain hemodynamics stable and better patient outcomes. It is a safe and effective choice for adult lumbosacral spine fixation surgeries

Key words: Caudal epidural analgesia; Ultrasound-guided caudal block; Ropivacaine; Clonidine; Lumbosacral spine fixation surgery; Postoperative analgesia; Rescue analgesia; Visual Analog Scale (VAS)

Introduction

Caudal epidural anaesthesia is a regional anaesthetic technique that has gained increasing application in adult spine fixation surgeries. The introduction of ultrasound guidance has further improved the accuracy, safety, and success rate of caudal epidural block by enabling real-time visualization of the sacral hiatus, sacral cornua, and needle placement, thereby reducing technical failure and procedure-related complications. Lumbosacral spine fixation surgeries performed under general anaesthesia are commonly associated with significant postoperative pain due to extensive paraspinal muscle dissection, manipulation of the vertebrae, intervertebral discs, facet joints, ligaments, instrumentation, bone drilling, and nerve root handling. Adequate postoperative pain management is essential to facilitate early mobilization, improve functional recovery, reduce hospital stay, and enhance patient satisfaction.

Postoperative pain following spine fixation surgery is commonly managed using systemic analgesics such as opioids and non-steroidal anti-inflammatory drugs. However, opioid-based analgesia is frequently associated with adverse effects including nausea, vomiting, sedation, respiratory depression, pruritus, and delayed recovery. Inadequate pain control may also increase the stress response, delay ambulation, and prolong hospitalization. Therefore, regional anaesthesia techniques have become an important component of multimodal analgesia in spine surgeries.

Caudal epidural block involves the administration of local anaesthetic agents into the epidural space through the sacral hiatus, producing blockade of the sacral and lower lumbar nerve roots. When combined with general anaesthesia in adult patients undergoing lumbosacral spine fixation surgeries, caudal epidural analgesia provides effective intraoperative and postoperative pain relief while reducing systemic opioid requirements. This regional anaesthetic technique forms an important component of multimodal analgesia, which combines different analgesic modalities acting through various mechanisms to achieve superior pain control while minimizing opioid consumption and opioid-related adverse effects. By providing effective afferent neural blockade, caudal epidural analgesia complements systemic analgesics such as paracetamol, non-steroidal anti-inflammatory drugs (NSAIDs), and low-dose opioids, thereby enhancing analgesic efficacy, facilitating early mobilization, and improving postoperative recovery. The technique is relatively simple, safe, and associated with a lower risk of accidental dural puncture compared to lumbar epidural approaches.

The sacral hiatus, formed by the failure of fusion of the laminae of the fifth sacral vertebra, serves as the entry point for caudal epidural injection. Following administration into the epidural space, local anaesthetic agents spread cephalad and block neural transmission by inhibiting sodium channel conduction in spinal nerve roots. The extent and duration of analgesia depend on the volume and concentration of the local anaesthetic as well as the use of adjuvant drugs.

Ropivacaine is a long-acting amide local anesthetic; chemical name is s-(-)- propyl-2,6 pipercoloxylide hydrochloride monohydrate. Ropivacaine acts by blocking voltage-gated sodium channels, thereby inhibiting nerve impulse conduction. It provides differential sensory blockade with minimal motor blockade, which is advantageous in facilitating early postoperative neurological assessment and early ambulation after spine fixation surgery.

Clonidine is a selective partial α_2 -adrenergic agonist (an aniline derivative) that produces sympatholysis, sedation, and analgesia by reducing central sympathetic outflow. It acts by stimulating presynaptic α_2 receptors, inhibiting norepinephrine release, and directly suppressing spinal sympathetic neurons, leading to increased vagal tone. Major effects include hypotension, bradycardia, sedation, and analgesia. Common adverse effects are drowsiness, dry mouth, constipation, bradycardia, hypotension, and rebound hypertension after abrupt withdrawal of high doses. It is metabolized in the liver, excreted mainly by the kidneys, and should be used cautiously in neonates, severe renal impairment (GFR <10 mL/min), and liver disease.

The addition of clonidine to ropivacaine has been shown to prolong postoperative analgesia, decrease analgesic consumption, and improve patient comfort without causing significant respiratory depression.

Recent advances in perioperative pain management and enhanced recovery protocols have increased interest in optimizing caudal epidural techniques in spine fixation surgeries. Evaluation of different doses of clonidine as an adjuvant to ropivacaine may help determine the optimal balance between analgesic efficacy and adverse effects such as hypotension, bradycardia, and sedation.

Therefore, the present study was undertaken to evaluate the clinical efficacy and safety of different doses of clonidine as an adjuvant to ropivacaine in ultrasound-guided caudal epidural block administered along with general anaesthesia in adult patients undergoing lumbosacral spine fixation surgeries.

AIM: To observe and evaluate the duration and quality of analgesia of three different doses of clonidine (0.5, 1.0, and 1.5 mcg/kg) as an adjuvant to 20ml of 0.375% Ropivacaine in ultrasound guided caudal epidural block in adult patients undergoing Lumbosacral spine fixation surgeries.

Objectives Of The Study:

Primary Objectives:

- 1.To assess the duration and quality of analgesia among the three groups using the Numeric Rating Scale (NRS) score.
- 2.To compare the hemodynamic parameters, including heart rate (HR) and mean arterial pressure (MAP), among the three groups.

Secondary Objectives:

- 3.To assess patient satisfaction scores.
- 4.To determine the time to first rescue analgesia.
- 5.To compare the number of doses of tramadol required during the first 24 hours postoperatively.
- 6.To evaluate complications such as nausea, vomiting, sedation, breathlessness, bradycardia, and hypotension.

Materials And Methods:

Ethics committee approval & informed written consent from patient obtained

Study Design: A prospective, Hospital-based observational study.

Study Setting and Duration: 4 months study duration Conducted at Narayana medical college,

Nellore.

Groups Observed: number of patients: 90 patients undergoing elective lumbosacral spine surgeries.

Group A: 20ml of Ropivacaine 0.375% + Clonidine 0.5 mcg/kg

Group B: 20ml of Ropivacaine 0.375% + Clonidine 1.0 mcg/kg

Group C: 20ml of Ropivacaine 0.375% + Clonidine 1.5 mcg/kg

Inclusion Criteria	Exclusion Criteria
Adults aged 20-80 years ASA Physical status II and III Scheduled for elective lumbosacral spine fixation surgeries Consent for caudal epidural analgesia	Patient refusal Allergy to study drug Coagulopathy Local infection at the injection site Preexisting neurological or psychiatric conditions Chronic opioid use

Sample Size:

Total of 90 patients, 30 patients in each group, total three groups.

$$n_0 = [2 * (Z_{1-\alpha/2} + Z_{1-\beta})^2 * \sigma^2] / \Delta^2$$

Data Analysis:

The statistical procedures were performed using the statistical package IBM SPSS Statistics version 20.

- Statistical analysis was performed using One-Way Analysis of Variance (ANOVA) for comparison of continuous variables among the three groups, and Chi-square tests for categorical variables. A p-value of <0.05 was considered statistically significant.

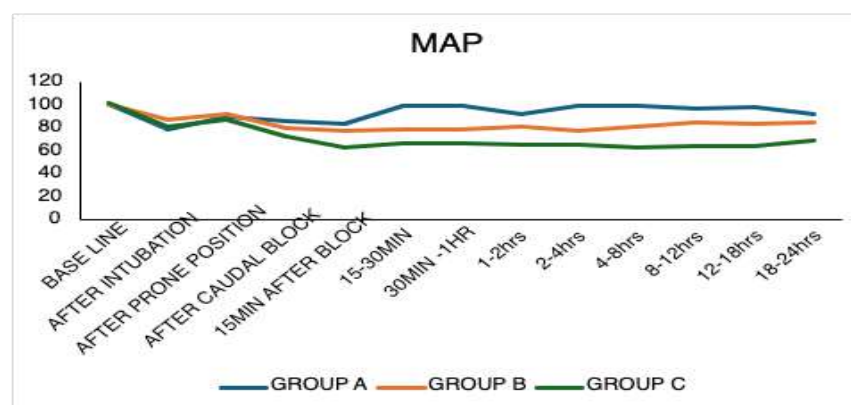
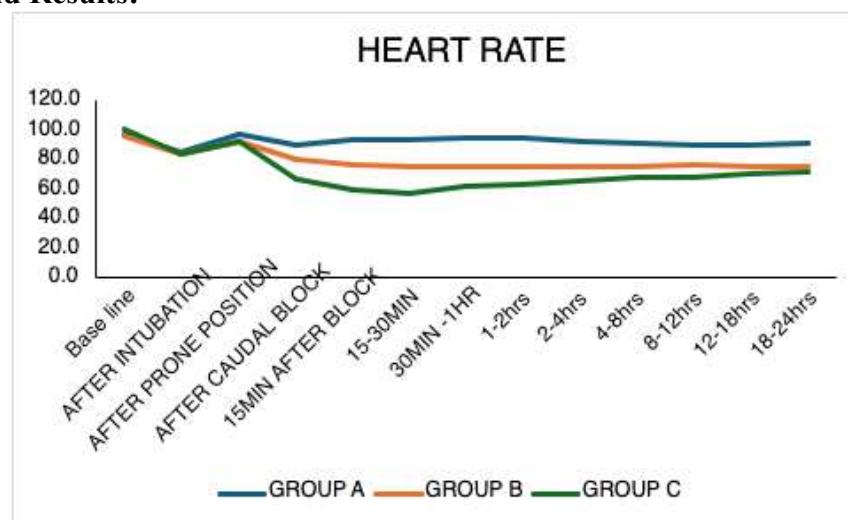
Methodology:

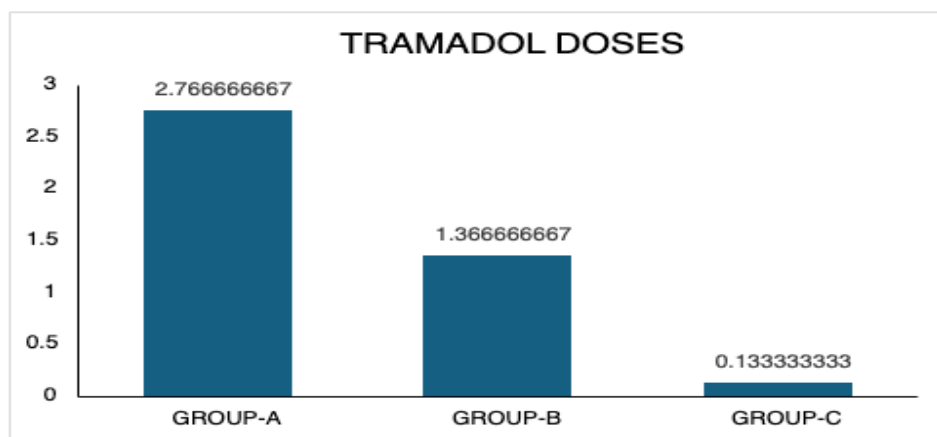
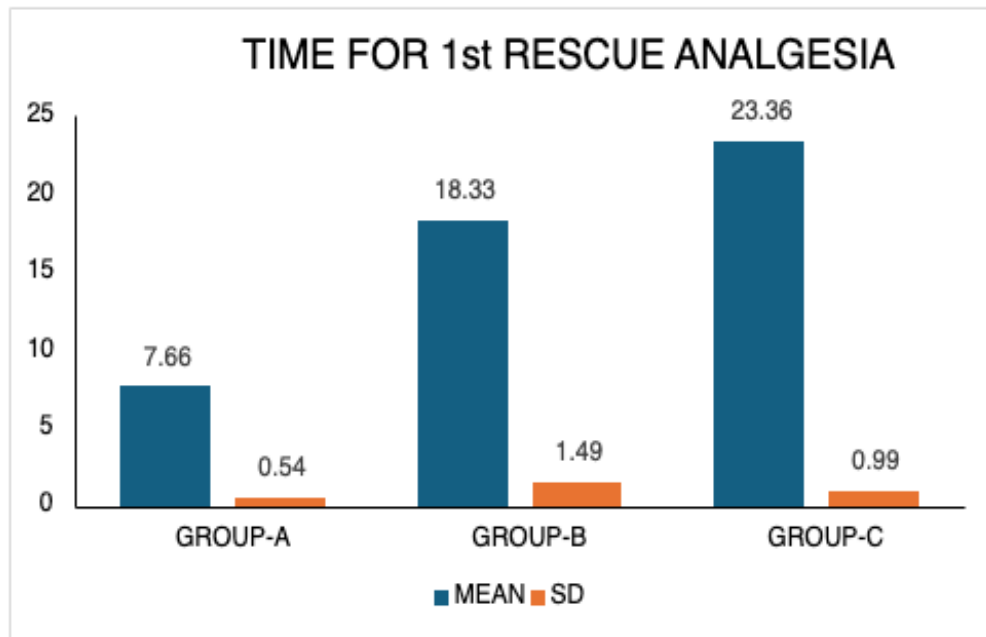
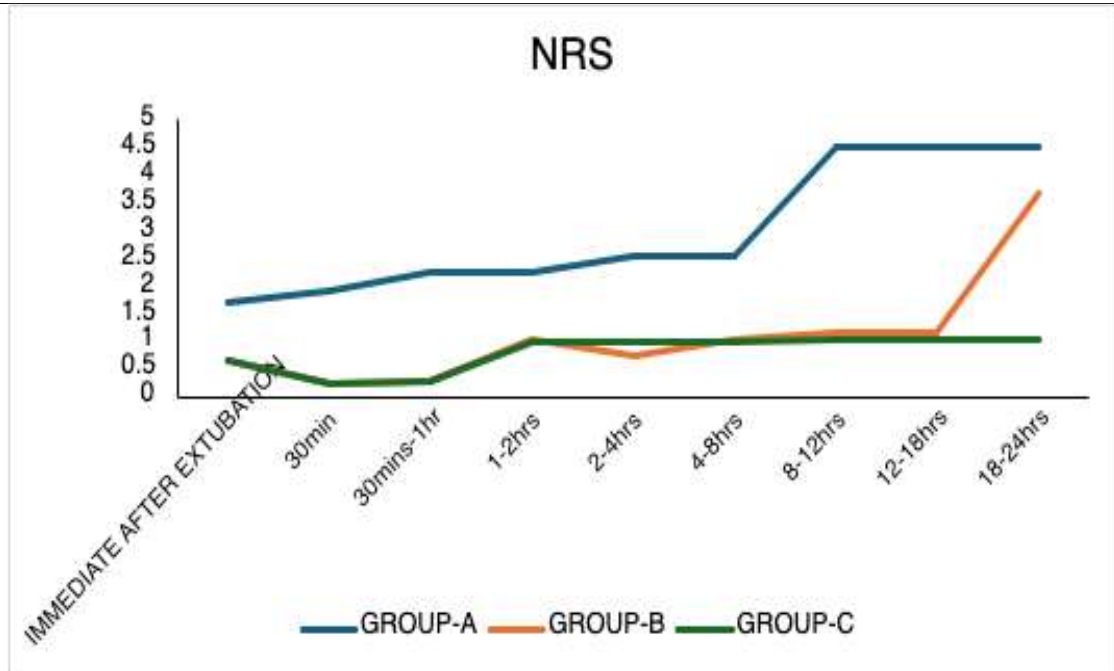
Caudal epidural block was performed after induction of general anesthesia. Patients were premedicated based on hemodynamics with glycopyrrolate 10mcg/kg and midazolam 0.05mg/kg intravenously. Induction of anesthesia was achieved using fentanyl 2mcg/kg, lignocaine (Loxicard) 1.5mg/kg, propofol 2mg/kg, and cisatracurium 0.2 mg/kg to facilitate endotracheal intubation. The anaesthesia was maintained with intermittent positive pressure ventilation using O₂ + AIR + sevoflurane & intermittent bolus of cisatracurium.

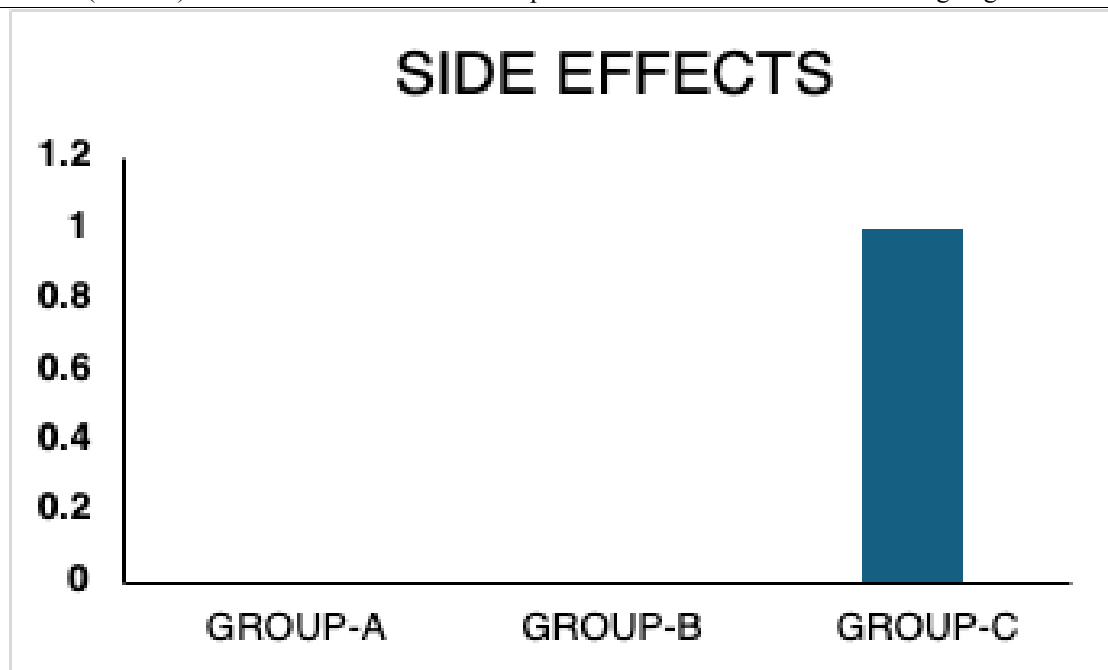
Following induction, the patient was placed in the prone position with a pillow under the pelvis to facilitate access to the sacral hiatus. Under strict aseptic precautions, the sacral hiatus was palpated between the sacral cornua at the lower end of the sacrum. A high-frequency linear ultrasound probe was placed in transverse or longitudinal orientation over the sacral hiatus to visualize important anatomical landmarks including the sacrococcygeal ligament, sacral cornua, and sacral canal. A 23G spinal needle was inserted at an angle of 30–45° through the sacrococcygeal ligament under real-time ultrasound guidance. Correct needle placement was confirmed by visualization of the needle entering the caudal epidural space and by negative aspiration for blood or cerebrospinal fluid. After confirmation, the study drug solution was injected slowly, and the spread of drug within the caudal epidural space was visualized on ultrasound as separation of tissues.



Observation And Results:







Discussion:

Lumbosacral spine fixation surgeries are among the most painful orthopaedic and neurosurgical procedures because they involve extensive dissection of multiple pain-sensitive tissues. The surgical procedure typically includes a long midline skin incision followed by subperiosteal stripping of the paraspinal muscles from the vertebral laminae and spinous processes followed by insertion of pedicle screws and rods to stabilize the affected spinal segments. Throughout the procedure, there is continuous manipulation of muscles, ligaments, vertebral periosteum, facet joints, intervertebral discs, and nerve roots, all of which contribute to significant nociceptive stimulation. The prolonged duration of surgery, extensive tissue trauma, and inflammatory response further intensify postoperative pain.

Postoperative pain following lumbar spine fixation surgery is multifactorial and includes both somatic and neuropathic components. Somatic pain arises from skin incision, muscle dissection, fascial stretching, periosteal injury, and bony instrumentation, whereas neuropathic pain may result from nerve root manipulation or pre-existing nerve compression. If inadequately managed, severe postoperative pain activates the sympathetic nervous system, leading to tachycardia, hypertension, increased myocardial oxygen consumption, impaired pulmonary function due to shallow breathing, delayed ambulation, prolonged hospital stays, increased opioid requirements, and reduced patient satisfaction. Therefore, effective perioperative analgesia is essential not only for patient comfort but also for promoting early recovery and minimizing postoperative complications.

Multimodal analgesia has become the cornerstone of postoperative pain management in spine surgery. The concept of multimodal analgesia involves the use of different analgesic techniques and medications acting through complementary mechanisms to achieve superior pain relief while reducing opioid consumption and associated adverse effects. Patients undergoing lumbosacral spine surgery commonly receive a combination of systemic analgesics such as paracetamol, non-steroidal anti-inflammatory drugs or selective COX-2 inhibitors when appropriate, gabapentinoids, and opioids, along with regional anaesthetic techniques. Regional analgesia, particularly caudal epidural block, plays a significant role in multimodal analgesia by providing effective afferent nociceptive blockade before the onset of central sensitization. The incorporation of regional anaesthesia into multimodal analgesic protocols has been shown to improve postoperative pain control, facilitate early mobilization, reduce opioid-related side effects, shorten hospital stay, and enhance overall patient recovery.

Among the available regional analgesic techniques, caudal epidural block has emerged as a valuable option in adult lumbosacral spine surgeries. Although traditionally considered a paediatric regional

technique, advances in ultrasound technology have expanded its application in adults. The caudal approach allows access to the epidural space through the sacral hiatus, enabling cephalad spread of local anaesthetic to the sacral and lower lumbar nerve roots involved in transmitting postoperative pain following lumbosacral spine surgery. Compared with lumbar epidural catheterization, caudal epidural block is technically simpler, avoids interference with the surgical field, carries a lower risk of accidental dural puncture, and is particularly useful in patients with altered lumbar anatomy or spinal instrumentation. Ultrasound guidance further enhances the accuracy and safety of the procedure by facilitating visualization of the sacral hiatus, sacrococcygeal ligament, needle placement, and spread of the injectate, thereby increasing block success and reducing complications. Ropivacaine was selected as the local anaesthetic in the present study because of its favourable pharmacological profile. It is a long-acting amide local anaesthetic with reduced cardiotoxicity and neurotoxicity compared with bupivacaine. Ropivacaine exhibits greater sensory-motor differentiation, producing effective sensory analgesia while causing less motor blockade. This characteristic is particularly advantageous following spine surgery, where early neurological assessment and prompt mobilization are important components of postoperative care. The concentration of 0.375% ropivacaine provides adequate sensory blockade with minimal motor impairment, making it an appropriate choice for caudal epidural analgesia in adult spine surgeries.

Although ropivacaine provides satisfactory postoperative analgesia, its duration of action is limited when used alone. Consequently, several neuraxial adjuvants have been investigated to prolong analgesia and reduce postoperative opioid requirements.

Clonidine has gained widespread acceptance as an epidural adjuvant because of its analgesic efficacy, opioid-sparing effect, and favourable safety profile. Clonidine is a selective α_2 -adrenergic receptor agonist that produces analgesia primarily through activation of α_2 receptors in the substantia gelatinosa of the dorsal horn of the spinal cord. Activation of these receptors inhibits presynaptic release of substance P and glutamate while producing postsynaptic hyperpolarization of dorsal horn neurons, thereby suppressing transmission of nociceptive impulses. In addition, clonidine enhances the action of local anaesthetics by increasing potassium conductance and augmenting neuronal hyperpolarization, resulting in prolonged sensory blockade.

The analgesic benefits of clonidine extend beyond prolongation of local anaesthetic action. By reducing central sympathetic outflow, clonidine attenuates the neuroendocrine stress response to surgery, provides mild sedation without clinically significant respiratory depression, decreases postoperative shivering, and reduces perioperative opioid consumption. Unlike neuraxial opioids, clonidine is associated with a lower incidence of respiratory depression, nausea, vomiting, pruritus, and urinary retention, making it an attractive alternative adjuvant for caudal epidural analgesia in spine fixation surgery.

In the present study, Group C (clonidine 1.5 mcg/kg) showed the longest duration of analgesia and the maximum delay in requirement of first rescue analgesia (23.36 ± 0.99 hrs) when compared with Groups A and B. However, this higher dose was associated with increased sedation and mild hypotension. This group also required the least number of rescue tramadol doses during the first 24 hours postoperatively (0.13 ± 0.33), indicating superior analgesic efficacy. These findings suggest that although higher doses of clonidine enhance analgesic efficacy, they may also increase the incidence of dose-related adverse effects.

Group A (clonidine 0.5 mcg/kg) demonstrated the shortest duration of analgesia with earlier requirement of first rescue analgesia (7.66 ± 0.54 hrs) and required more rescue analgesic doses during the postoperative period. Patients in this group showed the highest tramadol consumption in the first 24 hours (2.76 ± 0.66), suggesting comparatively inadequate prolonged postoperative pain relief. Although this lower dose maintained stable hemodynamic parameters with minimal side effects, the analgesic efficacy was comparatively inadequate for prolonged postoperative pain control following spine surgeries.

Group B (clonidine 1.0 mcg/kg) provides an optimal balance between analgesic efficacy and safety. Patients in this group experienced prolonged analgesia with delayed requirement of first rescue analgesia (18.33 ± 1.49 hrs), while maintaining stable hemodynamic parameters and minimal

sedation. The tramadol requirement in this group was significantly lower (1.36 ± 0.49) compared to Group A, reflecting effective postoperative analgesia with fewer adverse effects. Patient satisfaction scores were highest in Group B, followed by Group C and Group A, indicating better overall perioperative comfort and recovery profile. Thus, the intermediate dose appeared to provide the best balance between prolonged analgesia and reduced adverse effects.

Hemodynamic parameters including heart rate and mean arterial pressure remained clinically acceptable in all groups, although mild hypotension and sedation were more commonly observed in Group C. No major complications such as respiratory depression or severe bradycardia were observed, indicating that clonidine can be used safely as an adjuvant in caudal epidural blocks when administered in carefully titrated doses.

Ultrasound guidance in caudal epidural block also contributed to accurate needle placement and drug administration, thereby improving the success rate and safety of the procedure. Visualization of the sacral hiatus, sacrococcygeal ligament, and epidural spread of local anesthetic minimized technical difficulties and potential complications associated with blind techniques.

Overall, the findings of the present study support the use of clonidine as an effective adjuvant to ropivacaine in ultrasound-guided caudal epidural block for adult lumbosacral spine fixation surgeries. Among the doses studied, clonidine 1.0 mcg/kg was found to be the most appropriate dose as it provided effective and prolonged postoperative analgesia with hemodynamic stable and better patient satisfaction.

The present study was comparable with those of Dave et al. (2024), who reported significantly lower VAS scores during the first 12 postoperative hours and prolonged analgesia in the clonidine group without significant hemodynamic changes or sedation. Similarly, Group B (clonidine 1.0 $\mu\text{g/kg}$) in the present study showed prolonged analgesia (18.33 ± 1.49 hours), lower tramadol consumption (1.36 ± 0.49), and stable hemodynamics with minimal sedation. However, Group C (clonidine 1.5 $\mu\text{g/kg}$) produced the longest duration of analgesia (23.36 ± 0.99 hours) with the lowest rescue tramadol requirement (0.13 ± 0.33). Unlike Dave et al., this higher dose was associated with increased sedation and mild hypotension. These findings indicate that 1.0 $\mu\text{g/kg}$ offers an optimal balance between analgesic efficacy and safety, whereas 1.5 $\mu\text{g/kg}$ provides superior analgesia at the expense of dose-related adverse effects.

Swathi et al. (2021) found that caudal 0.2% ropivacaine and 0.2% bupivacaine with fentanyl produced comparable postoperative analgesia, with no significant difference in VAS scores, time to first rescue analgesia, or 24-hour analgesic consumption, although bradycardia was significantly higher with bupivacaine (30% vs. 4% intraoperatively and 16% vs. 0% postoperatively; $P < 0.01$). In contrast, the present study demonstrated a dose-dependent improvement in analgesia with clonidine. Group C (1.5 mcg/kg) showed the longest duration of analgesia (23.36 ± 0.99 h) and the lowest tramadol requirement (0.13 ± 0.33), but with increased sedation and mild hypotension. Group B (1.0 mcg/kg) provided prolonged analgesia (18.33 ± 1.49 h) with stable hemodynamics, minimal adverse effects, and the highest patient satisfaction. Therefore, the present study suggests that clonidine 1.0 mcg/kg offers the best balance between prolonged postoperative analgesia and safety following spine surgery.

the present study were comparable with by Urvashi Yadav et al. (2020), who demonstrated that the addition of dexmedetomidine to bupivacaine for wound instillation in lumbar laminectomy significantly prolonged the duration of analgesia (19.93 ± 3.2 h vs. 12.13 ± 1.8 h) and reduced rescue analgesic requirement (62.51 ± 39.13 mg vs. 95.68 ± 33.5 mg). Similarly, in the present study, Group C (clonidine 1.5 $\mu\text{g/kg}$) showed the longest duration of analgesia (23.36 ± 0.99 h) and the lowest tramadol requirement (0.13 ± 0.33 doses). Both studies demonstrated that the addition of an α_2 -adrenergic agonist significantly improved postoperative analgesia and reduced analgesic consumption. However, unlike the study by Urvashi Yadav et al., the higher clonidine dose in the present study was associated with increased sedation and mild hypotension, suggesting dose-related adverse effects.

Conclusion:

Clonidine enhances the analgesic effect of 0.375% ropivacaine in caudal epidural blocks. Among the doses, 1 µg/kg provided the most balanced outcome with prolonged pain relief and intraoperative hemodynamics stability. The 1.5 µg/kg dose caused mild hypotension and bradycardia, while 0.5 µg/kg was less effective.

References

1. Woolf CJ. Recent advances in the pathophysiology of acute pain. *BJA: British Journal of Anaesthesia*. 1989 Aug 1;63(2):139-46.
2. Woolf CJ, Chong MS. Preemptive analgesia—treating postoperative pain by preventing the establishment of central sensitization. *Anesthesia & Analgesia*. 1993 Aug 1;77(2):362-79.
3. Dave R, Purohit M, Purohit S, Sharma N, Meena S. Analgesic efficacy of clonidine as an adjuvant with ropivacaine in a caudal epidural block in lumbar spine surgery: a randomized double-blind interventional study. *Int J Pharm Clin Res*. 2024;16(8):411-418.
4. Swathi G, Chalam KS, Sai Kiran NA, Furtado SV. Preemptive analgesic efficacy of caudal ropivacaine vs bupivacaine: A randomized study in patients undergoing single level lumbar discectomy. *Narayana Medical Journal* 2021; 10:10-15.
5. Yadav U, Srivastava S, Srivastav D. Postoperative analgesic effect of bupivacaine alone and with dexmedetomidine in wound instillation for lumbar laminectomy: A randomized control trial. *Anesthesia Essays and Researches*. 2020 Jan 1;14(1):149-53.
6. Nagappa S, Kalappa S, Sridhara RB. Clonidine as an adjuvant to caudal epidural ropivacaine for lumbosacral spine surgeries. *Anesthesia Essays and Research*. 2018 Jan 1;12(1):240-5.
7. SAAL JS, FRANSON RC, DOBROW R, SAAL JA, WHITE AH, GOLDTHWAITE N. High levels of inflammatory phospholipase A2 activity in lumbar disc herniations. *Spine*. 1990 Jul 1;15(7):674-8.
8. Hurley RW, Wu CL. Acute postoperative pain. *Miller's anesthesia*. 2010:2757-81.
9. DeLoach LJ, Higgins MS, Caplan AB, Stiff JL. The visual analog scale in the immediate postoperative period: intrasubject variability and correlation with a numeric scale. *Anesthesia & Analgesia*. 1998 Jan 1;86(1):102-6.