Original Article

Comparison of Levobupivacaine and Bupivacaine in Caudal Epidural by Ultrasound for Postoperative Analgesia in Children

Damisetti Sumedha[1], Madhan Pandian[2], Bharat C A[3]

[1]DNB Resident, Department of Anaesthesiology, Indira Gandhi Government General Hospital and Post Graduate Institute, Pondicherry, India.
[2]Specialist Grade 1, Department of Anaesthesiology, Indira Gandhi Government General Hospital and Post Graduate Institute, Pondicherry, India.
[3]DNB Resident, Department of Anaesthesiology, Indira Gandhi Government General Hospital and Post Graduate Institute, Pondicherry, India.

Abstract

Background: Effective post-operative pain management is critical in pediatric patients following infraumbilical surgeries. While landmark-guided caudal blocks are common, ultrasound guidance enhances safety and precision. This hospital-based, prospective, randomized, double-blinded study compares the duration of analgesia, hemodynamic stability, and motor recovery of 0.25% bupivacaine versus 0.25% levobupivacaine in pediatric caudal epidurals. Ninety-two children (ASA I-II, aged 2–8 years) undergoing elective infraumbilical surgeries were allocated into two equal groups (n=46) to receive either 0.25% bupivacaine or 0.25% levobupivacaine under ultrasound guidance. The primary outcome assessed was the duration of analgesia, while secondary outcomes included hemodynamic parameters, FLACC pain scores, and the time to motor recovery as assessed by the Modified Bromage Scale. The mean duration of analgesia was significantly longer in the bupivacaine group (329.28 ± 22.69 mins) compared to the levobupivacaine group (286.85 ± 13.96 mins) ($p < 0.001$). Conversely, motor recovery was significantly faster with levobupivacaine (3.20 ± 0.66 hours) than with bupivacaine (4.07 ± 0.85 hours) ($p < 0.001$). Intraoperative heart rates were slightly lower in the bupivacaine group, but postoperative hemodynamics and adverse effects were minimal and comparable across both groups. While levobupivacaine offers faster motor recovery, bupivacaine provides a significantly longer duration of postoperative analgesia. When performed under ultrasound guidance, which effectively mitigates the risk of inadvertent intravascular injection, bupivacaine remains an excellent, safe choice for maximizing the pain-free window in pediatric day-care surgeries.

Keywords: Bupivacaine; Caudal epidural; Levobupivacaine; Paediatric analgesia; Ultrasound guidance.

Received: 15 July 2026 **Revised: 01 August 2026** **Accepted: 18 August 2026** **Published: 12 September 2026**

Introduction

The caudal epidural block is a widely utilized and reliable regional anaesthesia technique that minimizes systemic anaesthetic requirements and attenuates the surgical stress response, encouraging a smoother recovery.[1]Traditionally, caudal blocks in children have relied on a landmark-based technique, which is limited by anatomical variability and carries an inherent risk of inaccurate needle placement or inadvertent intravascular injection. To overcome these limitations, the integration of high-frequency ultrasound guidance has become increasingly prevalent, allowing for the real-time visualization of sacral anatomy and precise confirmation of local anaesthetic spread, significantly enhancing both block success and overall patient safety.[2,3]

The clinical efficacy and safety of the caudal block heavily depend on the chosen local anaesthetic. Bupivacaine is a potent, long-acting amide local anaesthetic that provides excellent prolonged analgesia; however, its strong binding affinity to myocardial sodium channels, particularly its R-enantiomer, is associated with significant cardiovascular toxicity in the event of systemic absorption.[5] To mitigate this risk, levobupivacaine, the pure S-enantiomer of bupivacaine, was developed to offer an improved cardiovascular and central nervous system safety profile while maintaining comparable clinical efficacy.[4]

Aims and objectives: The primary aim of this study is to compare post-operative analgesia and hemodynamic changes between 0.25% bupivacaine and 0.25% levobupivacaine in pediatric patients undergoing infra umbilical surgeries under caudal epidural.

The primary objective is to compare the duration of analgesia between the two agents. The secondary objectives are to compare the hemodynamic parameters and to compare the incidence of adverse effects between 0.25% bupivacaine and 0.25% levobupivacaine in pediatric caudal epidural.

Materials and Methods

Study design and study setting: After obtaining approval from the Institutional Scientific Committee and the Ethics Committee, informed consent was obtained from the patient's parents. This hospital-based, prospective, randomised, double-

Address for correspondence: Dr. Damisetti Sumedha, DNB Resident, Department of Anaesthesiology, Indira Gandhi Government General Hospital and Post Graduate Institute, Pondicherry, India
E-mail: sumedharao3179@gmail.com

DOI:
10.21276/amit.2026.v13.i3.1030

How to cite this article: Sumedha D, Pandian M, Bharat CA.Comparison of Levobupivacaine and Bupivacaine in Caudal Epidural by Ultrasound for Postoperative Analgesia in Children. Acta Med Int. 2026;13(3):127-131.

blinded study was conducted over a duration of 24 months at the Indira Gandhi government general hospital and post graduate institute, Puducherry.

The inclusion criteria were defined as patients aged between 2 to 8 years, of both genders, with ASA physical status 1 and 2, who were scheduled for elective infraumbilical surgeries. The exclusion criteria included emergency surgeries, ASA physical status 3 and 4, known hypersensitivity to amide local anaesthetics, history of active neurological, cardiac, respiratory and renal diseases, local site infection, anatomical malformation of the spine and the patient's parents refuse to participate in the study.

Methodology: Pre-anaesthetic evaluations were performed 24 hours prior to surgery. Standard preoperative fasting guidelines were strictly enforced in accordance with the American Society of Anaesthesiologists (ASA) protocols.[6]In the operating room, standard ASA monitors were attached and baseline vitals were recorded. Following intravenous premedication with glycopyrrolate 0.01 mg/kg, midazolam 0.05 mg/kg, and ondansetron 0.1 mg/kg, general anaesthesia was induced using ketamine 2 mg/kg or propofol 2 mg/kg alongside fentanyl 2 mcg/kg. An appropriate-sized LMA was inserted and connected to a Jackson Rees circuit. Anaesthesia was maintained with sevoflurane and a 1:1 mixture of nitrous oxide and oxygen.

After securing the airway, patients were positioned laterally. Under strict aseptic precautions, the caudal epidural was performed under ultrasound guidance using a 23G short-bevelled, 1.5-inch hypodermic needle. An Esaote X8 high-frequency (3–15 MHz) linear ultrasound transducer with a musculoskeletal preset and a depth of 3 cm was utilized. Initially, using a transverse imaging plane, the sacral cornua were visualized as distinct hypoechoic structures resembling the ‘eyes of a frog’. Between the two cornua, an upper hyperechoic line representing the sacrococcygeal membrane and an inferior hyperechoic line representing the dorsal surface of the sacrum were identified. The hypoechoic space between these two structures indicates the sacral hiatus.[11]

The transducer was then rotated to obtain a longitudinal view, capturing the sacrococcygeal membrane as a relatively thick, linear hyperechoic band sloping caudally. The needle was inserted in-plane under this longitudinal view, allowing for optimal, continuous visualization of the needle shaft and tip. Upon entry into the epidural space, the dispersion of the local anaesthetic into the caudal space was observed in real time. This spread was confirmed by the appearance of a single dominant colour and localized turbulence on colour Doppler imaging. The assigned drug (either 0.25% bupivacaine or 0.25% levobupivacaine) was administered at a precise volume calculated according to the modified Armitage formula: 0.5 ml/kg for a sacral block, 1 ml/kg for a lower thoracic block.

Intraoperative vitals (heart rate, SpO2, and respiratory rate) were recorded at 5-minute intervals for the first 30 minutes, and subsequently every 15 minutes. Postoperatively, pain was assessed using the FLACC scale (Face, Legs, Activity, Cry, Consolability). A FLACC score greater than 4 indicated significant pain, triggering the administration of intravenous paracetamol (20 mg/kg) as rescue analgesia; this duration was recorded to determine the duration of analgesia.[7] Motor recovery was assessed using the Modified Bromage Scale to objectively assess the resolution of the motor blockade.

Sample Size Calculation: Sample size was calculated using the formula for two independent proportions based on a study by Jadhav et al.[7] Patients were randomized into Group B (Bupivacaine) and Group L (Levobupivacaine) using sealed envelopes.

Results

A total of 92 paediatric patients undergoing elective infraumbilical surgeries were enrolled and randomly assigned to either the 0.25% bupivacaine group (n=46) or the 0.25% levobupivacaine group (n=46) and the following results were noted.

Demographic and Baseline Clinical Characteristics: The baseline demographic profiles, including age, weight, and gender distribution, were homogeneous and statistically comparable between the two cohorts prior to the intervention. The study population was predominantly male children (84 out of total 92 children) and the types of surgical procedures—primarily circumcision and herniotomy—were evenly distributed across both groups ($p = 0.388$). Furthermore, the mean duration of surgery did not differ significantly between the bupivacaine (47.07 ± 19.74 minutes) and levobupivacaine (43.89 ± 17.87 minutes) groups ($p = 0.471$). A comprehensive summary of the baseline demographic and clinical characteristics is provided in [Table 1].

Hemodynamics: Baseline intraoperative heart rates were comparable between the bupivacaine and levobupivacaine groups, but patients receiving bupivacaine exhibited a statistically significant reduction in heart rate at 25, 45, and 60 minutes intraoperatively ($p < 0.05$). Conversely, during the postoperative period, both cohorts maintained excellent and comparable hemodynamic stability with no significant differences in pulse rates up to 8 hours. Oxygen saturation also remained consistently above 98% throughout the entire study. A detailed comparison of the significant intraoperative heart rate trends is provided in Graph 1.[10]

Postoperative analgesia and FLACC scale: The primary outcome, mean time to first rescue analgesia, was significantly prolonged in the bupivacaine group (329.28 ± 22.69 minutes) compared to the levobupivacaine group (286.85 ± 13.96 minutes) ($p < 0.001$). Postoperative pain was assessed using the FLACC scale, with scores remaining low and statistically comparable between both cohorts for the first 4 hours postoperatively. By the 8-hour mark, FLACC scores became significantly higher in the bupivacaine group (4.66 ± 1.54) than in the levobupivacaine group (3.88 ± 1.58) ($p = 0.019$), likely reflecting the earlier administration of rescue analgesia in the levobupivacaine cohort. The comprehensive data for postoperative analgesia and pain scores are summarized in Graph 2.

Duration of motor blockade and modified Bromage scores

Motor recovery was significantly faster in the levobupivacaine group compared to the bupivacaine group ($p < 0.001$). The mean duration of motor blockade was 4.07 ± 0.85 hours for

patients receiving bupivacaine, compared to only 3.20 ± 0.66 hours for those receiving levobupivacaine. Correspondingly, Modified Bromage scores were significantly lower in the levobupivacaine cohort at 0.5, 1, 2, and 4 hours postoperatively, indicating a more rapid return of full motor function. By 8 hours, all patients in both groups had achieved complete motor recovery with no residual blockade. These motor recovery outcomes are detailed in Graph 3.

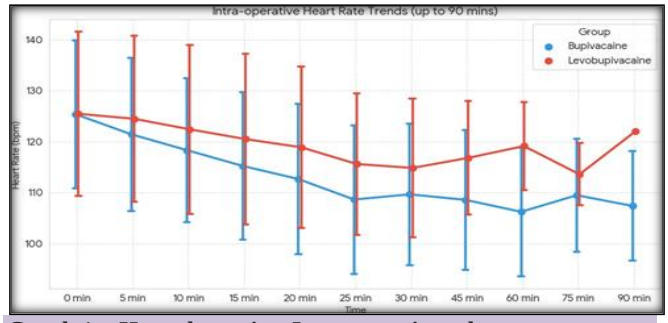
Complications: Both study drugs demonstrated excellent safety profiles with a minimal and statistically comparable incidence of minor complications, such as postoperative nausea and vomiting (PONV) (p = 0.695). Crucially, no severe adverse events—including respiratory depression, hemodynamic instability, or local anaesthetic systemic toxicity (LAST)—occurred in either cohort. The detailed incidence of these postoperative complications is summarized in [Table 2].

Table 1: Demographic and Baseline Clinical Characteristics

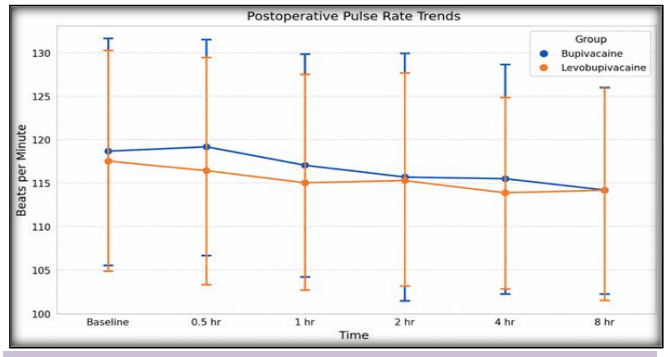
Parameter	Group B (Bupivacaine) (n=46)	Group L (Levobupivacaine) (n=46)	P-value
Age (years), Mean ± SD	4.34 ± 2.18	4.41 ± 2.02	0.690
Weight (kg), Mean ± SD	14.68 ± 4.51	15.28 ± 3.97	0.450
Gender (Male/Female), n	43 / 3	41 / 5	0.714
Duration of Surgery (min), Mean ± SD	47.07 ± 19.74	43.89 ± 17.87	0.471

Table 2: Incidence of Postoperative Complications

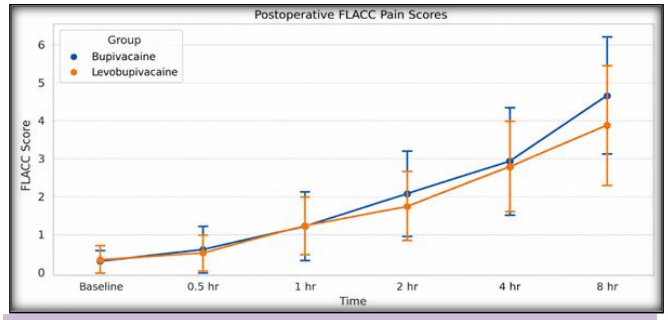
Complication	Group B (Bupivacaine) (n=46)	Group L (Levobupivacaine) (n=46)	P-value
Postoperative Nausea and Vomiting (PONV)	4	3	0.695
Urinary Retention	1	1	1.000



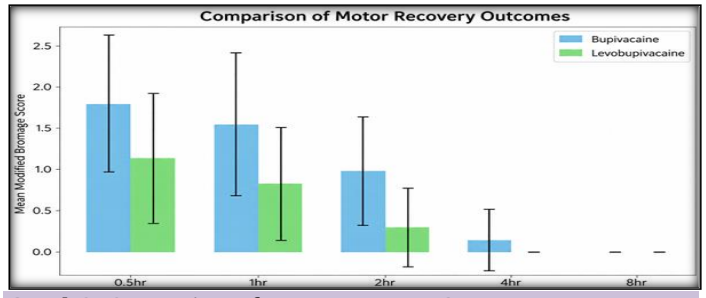
Graph 1a: Hemodynamics- Intraoperativepulserate



Graph 1b: Hemodynamics – Postoperative Pulse rate



Graph 2: Postoperative Analgesia and FLACC Pain Scores



Graph 3: Comparison of Motor Recovery Outcomes

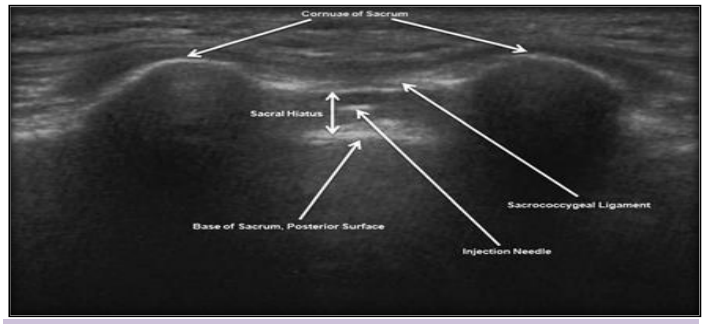


Figure 1: Transverse Ultrasound View of the Sacral Hiatus and Caudal Epidural Space

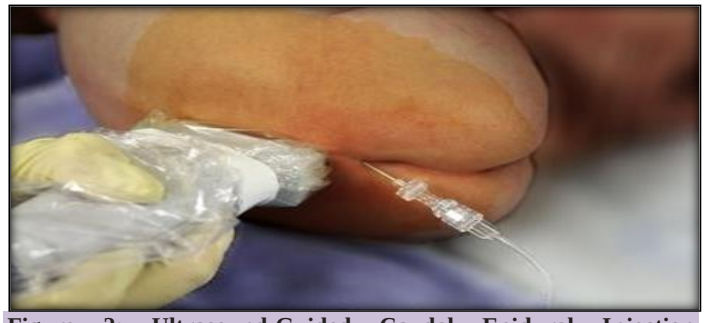


Figure 2: Ultrasound-Guided Caudal Epidural Injection Technique – Positioning

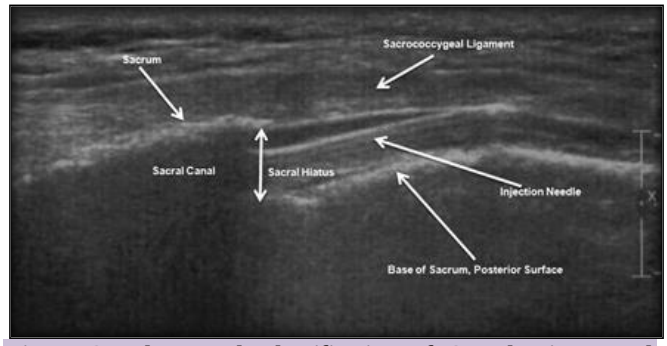


Figure 3: Ultrasound Identification of Sacral Hiatus and Caudal Epidural Space

Discussion

Effective postoperative analgesia in pediatric infraumbilical surgeries is paramount for minimizing physiological stress and ensuring a smooth recovery.[8,9]The primary objective of this prospective, randomized, double-blinded study was to compare the duration of analgesia, motor recovery and safety profiles of 0.25% bupivacaine and 0.25% levobupivacaine in pediatric caudal epidurals. Our findings demonstrate a distinct clinical trade-off: bupivacaine provides a significantly longer duration of postoperative analgesia, while levobupivacaine offers a faster return of motor function.

Efficacy and Duration of Analgesia: The most important finding in our study was the significantly prolonged duration of analgesia in the bupivacaine group (329.28 ± 22.69 mins) compared to the levobupivacaine group (286.85 ± 13.96 mins). This aligns with previous literature comparing these and related local anaesthetic agents in pediatric caudal blocks.[14,17-20] Postoperative FLACC scores were uniformly low and comparable between the cohorts for the first 4 hours, indicating that both agents are highly effective for early postoperative pain control. The significant divergence in FLACC scores at 8 hours does not indicate late-stage block failure, but rather reflects the expected earlier administration of rescue analgesia in the levobupivacaine cohort.

Motor Blockade and Recovery: In pediatric ambulatory and day-care surgeries, early ambulation is highly desirable. Our data showed that levobupivacaine resulted in a significantly faster resolution of motor blockade (3.20 ± 0.66 hours) compared to bupivacaine (4.07 ± 0.85 hours). This is consistent with published pediatric caudal studies evaluating motor blockade and postoperative analgesia.[15-17]

Hemodynamic Stability and Safety Profile: Both agents maintained excellent postoperative hemodynamic stability with minimal adverse effects like postoperative nausea and vomiting (PONV). Intraoperatively, however, the bupivacaine group exhibited a statistically significant reduction in heart rate at 25, 45, and 60 minutes compared to the levobupivacaine group. This can be attributed to bupivacaine's more profound sympathetic blockade.[10] Historically, the primary concern with bupivacaine has been the cardiotoxic potential of its R-enantiomer in the event of accidental systemic absorption, leading many clinicians to prefer levobupivacaine for its wider therapeutic index in pediatricpatients.[5]

The Ultrasound Advantage: The traditional preference for levobupivacaine was largely established during the era of landmark-guided "blind" caudal blocks, where the risk of inadvertent intravascular injection was a constant threat. In our study, the integration of high-frequency ultrasound fundamentally altered this risk profile. Real-time ultrasonography allowed for direct visualization of the sacral anatomy, precise needle tip placement and confirmation of epidural spread via color Doppler, effectively mitigating the risk of intravascular injection.[11,12,13,21] Therefore, we propose that when caudal blocks are performed under ultrasound guidance, the primary safety risk of bupivacaine is neutralized, allowing clinicians to safely harness its superior duration of analgesia for pediatricpatients.[22]

Conclusion

While both agents are safe and effective for paediatric caudal epidural analgesia, 0.25% bupivacaine provides a significantly longer duration of postoperative pain relief compared to 0.25% levobupivacaine. In our study, real-time ultrasound guidance completely prevented intravascular injections and cardiotoxicity, proving to be a highly effective, radiation-free alternative to the gold standard fluoroscopy. Because ultrasound neutralizes the primary safety concerns associated with bupivacaine, its theoretical cardiotoxic risks are clinically negligible in this setting. Therefore, prioritizing the extended duration of analgesia it provides, ultrasound-guided 0.25% bupivacaine remains the preferred choice for maximizing the postoperative pain-free period in pediatric day-care surgeries.

References

1. Lönnqvist PA, Morton NS. Postoperative analgesia in infants and children. Br J Anaesth. 2005;95(1):59-68. doi:10.1093/bja/aei065.
2. Wiegele M, Marhofer P, Lönnqvist PA. Caudal epidural blocks in paediatric patients: a review and practical considerations. Br J Anaesth. 2019;122(4):509-517. doi:10.1016/j.bja.2018.11.030.
3. Suresh S, Long J, Birmingham PK, De Oliveira GS Jr. Are caudal blocks for pain control safe in children? An analysis of 18,650 caudal blocks from the Pediatric Regional Anesthesia Network (PRAN) database. Anesth Analg. 2015;120(1):151-156. doi:10.1213/ANE.0000000000000446.
4. Heppolette CAA, Brunnen D, Bampoe S, Odor PM. Clinical pharmacokinetics and pharmacodynamics of levobupivacaine. Clin Pharmacokinet. 2020;59(6):715-745. doi:10.1007/s40262-020-00868-0.
5. Baştutcu Saka Ö, Balcı C, Savacı RG. Comparison of the effects of the toxic dosages of bupivacaine, levobupivacaine and ropivacaine on cardiovascular system in an experimental animal model. J Turk Anaesth Int Care. 2012;40(2):91-98.
6. American Society of Anesthesiologists Task Force on Preoperative Fasting. Practice guidelines for preoperative fasting and the use of pharmacologic agents to reduce the risk of pulmonary aspiration: application to healthy patients undergoing elective procedures: an updated report. Anesthesiology. 2017;126(3):376-393. doi:10.1097/ALN.0000000000001452.
7. Jadhav PA, Malde AD. Comparison of levobupivacaine 0.25% and bupivacaine 0.25% for caudal analgesia in children undergoing herniotomy. PediatrAnesth Crit Care J. 2017;5(2):66-73.

8. Bosenberg A. Benefits of regional anesthesia in children. Paediatr Anaesth. 2012;22(1):10-18. doi:10.1111/j.1460-9592.2011.03691.x.
9. Wolf AR. Effects of regional analgesia on stress responses to pediatric surgery. Paediatr Anaesth. 2012;22(1):19-24. doi:10.1111/j.1460-9592.2011.03714.x.
10. Stoelting RK, Hillier SC, Syal K, Flood P, editors. Stoelting's pharmacology and physiology in anesthetic practice. 1st South Asia ed. New Delhi: Wolters Kluwer India; 2022.
11. Chen CPC, Tang SFT, Hsu TC, Tsai WC, Liu HP, Chen MJL, et al. Ultrasound guidance in caudal epidural needle placement. Anesthesiology. 2004;101(1):181-184. doi:10.1097/00000542-200407000-00028.
12. Ahiskalioglu A, Yayik AM, Ahiskalioglu EO, Ekinci M, Gölboyu BE, Celik EC, et al. Ultrasound-guided versus conventional injection for caudal block in children: a prospective randomized clinical study. J Clin Anesth. 2018;44:91-96.
13. Kil HK. Caudal and epidural blocks in infants and small children: historical perspective and ultrasound-guided approaches. Korean J Anesthesiol. 2018;71(6):427-434.
14. Sharma J, Gupta R, Kumari A, Mahajan L, Singh J. A comparative study of 0.25% levobupivacaine, 0.25% ropivacaine, and 0.25% bupivacaine in paediatric single shot caudal block. Anesthesiol Res Pract. 2018;2018:1486261. doi:10.1155/2018/1486261.
15. Praveen P, Remadevi R, Pratheeba N. Caudal epidural analgesia in pediatric patients: comparison of 0.25% levobupivacaine and 0.25% ropivacaine in terms of motor blockade and postoperative analgesia. Anesth Essays Res. 2017;11(1):223-227. doi:10.4103/0259-1162.200231.
16. Marjanovic V, Budic I, Stevic M, Simic D. A comparison of three different volumes of levobupivacaine for caudal block in children undergoing orchidopexy and inguinal hernia repair. Med Princ Pract. 2017;26(4):331-336. doi:10.1159/000475936.
17. Kaya Z, Süren M, Arici S, Karaman S, Tapar H, Erdemir F. Prospective, randomized, double-blinded comparison of the effects of caudally administered levobupivacaine 0.25% and bupivacaine 0.25% on pain and motor block in children undergoing circumcision surgery. Eur Rev Med Pharmacol Sci. 2012;16(14):2014-2020.
18. Locatelli B, Ingelmo P, Sonzogni V, Zanella A, Gatti V, Spotti A, et al. Randomized, double-blind, phase III, controlled trial comparing levobupivacaine 0.25%, ropivacaine 0.25% and bupivacaine 0.25% by the caudal route in children. Br J Anaesth. 2005;94(3):366-371. doi:10.1093/bja/aei059.
19. Ray M, Mondal SK, Biswas A. Caudal analgesia in paediatric patients: comparison between bupivacaine and ropivacaine. Indian J Anaesth. 2003;47(4):275-278.
20. Das HK, Behera S, Mohapatra J, Dash L. A comparative study between ropivacaine and bupivacaine in pediatric caudal block for postoperative analgesia. Ann Med Med Sci. 2025;4:209-215.
21. Klocke R, Jenkinson T, Glew D. Sonographically guided caudal epidural steroid injections. J Ultrasound Med. 2003;22(11):1229-1232. doi:10.7863/jum.2003.22.11.1229.
22. Jain D, Hussain SY, Ayub A. Comparative evaluation of landmark technique and ultrasound-guided caudal epidural injection in pediatric population: a systematic review and meta-analysis. Paediatr Anaesth. 2022;32(1):35-42. doi:10.1111/pan.14332.