https://doi.org/10.29309/TPMJ/2026.33.02.10013 www.theprofesional.com

ORIGINAL ARTICLE

Comparison of effectiveness of pediatric caudal block with ultrasound guidance versus landmark technique.

Sana Malik[1], Mohsin Riaz Askri[2], Shumyala Maqbool[3], Waleed Manzoor[4], Sana Fatima[5], Hasan Talal[6]

ABSTRACT… Objective: To compare the efficacy of ultrasound guidance versus landmark technique for performing caudal block in children undergoing infraumbilical surgery. **Study Design:** Non Randomized Controlled Trial. **Setting:** Institute of Child Health and Children Hospital, Faisalabad. **Period:** January 2025 – April 2025. **Methods:** After institutional ethical approval, 240 children aged 2 to 10 years were randomly assigned to two equal groups: Group USG (ultrasound-guided) and Group LM (landmark technique). Caudal block was administered under general anesthesia in both groups. Primary outcome was success on first attempt; secondary outcomes included performance time, incidence of tachycardia (defined as ≥10% rise in heart rate during skin incision), and number of needle punctures. Data were analyzed using SPSS version 23. **Results:** No significant difference was found between the groups in terms of age, weight, and gender. The USG group showed a significantly higher success rate on the first attempt (95% vs. 70.83%, p = 0.000) and a lower incidence of tachycardia (10% vs. 32%, p = 0.000). However, time taken was significantly longer in the USG group (110.88 ± 16.11 sec vs. 63.62 ± 13.10 sec, p = 0.000). **Conclusion:** Ultrasound guidance significantly increases the success rate of pediatric caudal block compared to landmark technique, although it requires more time to perform.

Key words: Caudal Block, Landmark Technique, Pediatric Anesthesia, Sacral Hiatus, Ultrasound Guidance.

Article Citation: Malik S, Askri MR, Maqbool S, Manzoor W, Fatima S, Talal H. Comparison of effectiveness of pediatric caudal block with ultrasound guidance versus landmark technique. Professional Med J 2026; 33(02):332-335. https://doi.org/10.29309/TPMJ/2026.33.02.10013

INTRODUCTION

Painful stimuli from surgery evoke significant stress responses in pediatric patients, which can result in complications such as tachycardia, hypertension, and delayed recovery.[1] Caudal block is a popular and effective regional anesthetic technique in children, often used in infraumbilical surgeries to provide both intraoperative and postoperative analgesia.[2] Its use minimizes the requirement for systemic opioids and inhalational anesthetics, leading to fewer side effects like nausea, ileus, and respiratory depression.[3]

Despite its popularity, the landmark (LM) technique for caudal block relies heavily on palpation of anatomical structures such as sacral hiatus and cornu, which may vary significantly in pediatric populations.[4] In certain cases, especially in infants and young children, identifying these structures accurately becomes challenging due to immature bone development and soft tissue coverage. These variations may lead to multiple punctures, failed blocks, or inadvertent injury.[5]

Ultrasound guidance (USG) has emerged as a safer and more accurate technique for performing regional blocks, including caudal block.[6] It allows real-time visualization of anatomical structures, verification of needle position, and monitoring of local anesthetic spread.[7] This technique is non-invasive, easily teachable, and avoids radiation exposure unlike fluoroscopy.[8]

Multiple international studies have demonstrated that ultrasound-guided caudal blocks improve accuracy and safety, reduce failure rates, and increase patient comfort.[9] However, data from Pakistani pediatric populations remain sparse. Limited local studies have addressed whether the use of ultrasound truly confers a measurable clinical advantage over conventional landmark-based methods.[10]

This study was designed to compare the effectiveness of ultrasound-guided versus landmark-guided caudal blocks in children undergoing infraumbilical surgeries.

1. MBBS, Postgraduate Resident Anesthesia, Children Hospital, & The Institute of Child Health, Faisalabad.
2. MBBS, FCPS, Assistant Professor Anesthesia, Children Hospital, & The Institute of Child Health, Faisalabad.
3. MBBS, FCPS, Senior Registrar Anesthesia, Allied Hospital/ Faisalabad Medical University, Faisalabad.
4. MBBS, FCPS, Senior Registrar Anesthesia & ICU, Aladan Hospital, Kuwait.
5. MBBS, Postgraduate Resident, Children Hospital, Faisalabad.
6. Health Manager, MNCH, Bhowana.

Correspondence Address:
Dr. Mohsin Riaz Askri
Department of Anesthesia, Children Hospital, & The Institute of Child Health, Faisalabad.
mohsinriazaskri@gmail.com

Article received on:
04/08/2025
Accepted for publication:
15/10/2025

By quantifying block success rate, performance time, and hemodynamic response, we aim to validate the use of ultrasound as a superior alternative in pediatric anesthesia practice.

METHODS

This study was a non-randomized controlled trial conducted at the Institute of Child Health and Children Hospital, Faisalabad, from January 2025 to April 2025. Ethical Approval: Approved by the Institutional Ethical Review Committee (Ref#: 31/CH & ICH/FSD; Date: 07/01/2025).

A total of 240 children aged 2 to 10 years, scheduled for elective infraumbilical surgeries under general anesthesia, were enrolled after obtaining written informed consent from parents or guardians. Patients were divided into two equal groups based on the technique used for caudal block: Group USG (ultrasound-guided) and Group LM (landmark technique).

Inclusion Criteria

- Children aged 2–10 years
- ASA Physical Status I or II
- Undergoing elective infraumbilical surgeries under general anesthesia

Exclusion Criteria

- Age below 2 or above 10 years
- ASA III or IV
- Emergency surgery
- Coagulopathy
- Spinal deformity or infection at injection site
- Allergy to local anesthetics

All patients received general anesthesia with sevoflurane (6–8%) via facemask followed by IV access and airway secured with an I-gel or LMA. Standard monitoring (SpO_2, ECG, NIBP) was applied throughout. In Group LM (Landmark technique), the sacral hiatus was palpated and a 22G hypodermic needle was inserted. After confirming negative aspiration for blood or CSF, 1 mL/kg of 0.125% bupivacaine was injected slowly. In Group USG (Ultrasound-guided technique), the sacral hiatus was identified using a high-frequency linear ultrasound probe. The needle was advanced in-plane under real-time ultrasound guidance, and the same dose of bupivacaine was administered after confirming correct spread in the caudal canal. A waiting period of 10 minutes was allowed post-injection before surgical incision.

First-attempt success rate (defined as successful caudal block with no blood, CSF, resistance, or subcutaneous swelling) were our primary outcomes whereas Incidence of tachycardia (≥10% increase in HR during skin incision), Performance time (in seconds), Number of needle punctures were secondary outcomes.

Data were analyzed using SPSS version 23. Continuous variables were expressed as mean ± standard deviation and compared using Student's t-test. Categorical variables were analyzed using Chi-square test. A p-value < 0.05 was considered statistically significant.

RESULTS

A total of 240 children meeting the inclusion criteria were enrolled in this study and divided equally into two groups: Group USG (ultrasound-guided) and Group LM (landmark technique). Both groups were comparable in baseline characteristics, including age, gender, and weight. The mean age in the ultrasound group was 5.52 ± 2.16 years, while in the landmark group, it was 5.45 ± 2.08 years (p = 0.76). Mean body weight in Group USG was 16.83 ± 4.21 kg and in Group LM was 16.54 ± 3.98 kg (p = 0.54). There was no statistically significant difference between the groups in terms of gender distribution, with males representing 60% of Group USG and 57.5% of Group LM (p = 0.69).

TABLE-I

Demographic characteristics

Parameter	Group USG (n=120)	Group LM (n=120)	P-Value
Age (years)	5.52 ± 2.16	5.45 ± 2.08	0.76
Weight (kg)	16.83 ± 4.21	16.54 ± 3.98	0.54
Male (%)	72 (60%)	69 (57.5%)	0.69
Female (%)	48 (40%)	51 (42.5%)	0.69

Age and weight were compared using the independent samples t-test. Gender distribution was analyzed using the Chi-square test.

The clinical performance of caudal blocks varied significantly between the two groups. First-attempt success was achieved in 114 patients (95%) in the ultrasound-guided group, compared to only 85 patients (70.83%) in the landmark group ($p < 0.001$). This indicates a significantly higher reliability and precision with ultrasound guidance.

The mean performance time, defined as the interval from positioning the patient to successful administration of local anesthetic, was considerably longer in Group USG (110.88 ± 16.11 seconds) as compared to Group LM (63.62 ± 13.10 seconds), with a p-value of <0.001. Though the USG technique required more time, its improved accuracy and lower complication rates were evident.

A marked difference was also observed in hemodynamic responses. In Group USG, only 10% of children developed tachycardia (≥10% rise in heart rate during incision), whereas in Group LM, 32% exhibited this sympathetic response ($p < 0.001$), indicating less effective analgesia in the landmark group.

TABLE-II

Clinical outcomes

Outcome	Group USG (n=120)	Group LM (n=120)	P-Value
First-attempt success (%)	114 (95%)	85 (70.83%)	<0.001
Performance time (sec)	110.88 ± 16.11	63.62 ± 13.10	<0.001
Tachycardia during incision (%)	12 (10%)	38 (32%)	<0.001

First-attempt success and tachycardia were compared using the Chi-square test. Performance time was analyzed using the independent samples t-test.

DISCUSSION

The findings of this study underscore the clinical superiority of ultrasound-guided caudal blocks over the traditional landmark technique in pediatric patients. Our results show that ultrasound guidance significantly improves first-attempt success rates and reduces the incidence of tachycardia during surgical incision — a proxy for intraoperative pain. These outcomes are critical in pediatric anesthesia, where minimizing both procedural trauma and physiological stress is paramount.

The increased success rate of 95% in the ultrasound group aligns with several international studies reporting high efficacy when real-time imaging is used to guide needle placement.[6] This is likely due to enhanced visualization of anatomical landmarks, which is especially useful in children whose sacral anatomy can vary due to age-related differences in ossification.[4] Conversely, the 70.83% success rate in the landmark group reflects the common challenge of blind insertion, as palpation may be difficult in obese, anxious, or very young children.[5]

One important trade-off noted in this study was the longer performance time associated with ultrasound guidance. This increase, while statistically significant, is not clinically alarming, particularly given the safety and accuracy benefits. Other studies support this observation, noting that with experience and frequent use, the ultrasound-guided technique becomes more efficient over time.[7]

The significantly lower incidence of tachycardia in Group USG (10% vs. 32%) further emphasizes the effectiveness of this approach. Tachycardia during surgical incision typically reflects an inadequate block or incomplete analgesia, which was more common in the landmark group. This finding is consistent with prior research demonstrating better spread of anesthetic and block confirmation when ultrasound is used.[8,9]

The ultrasound technique also minimizes risks such as intravascular injection, dural puncture, and multiple needle attempts — complications that, while rare, can have serious consequences in pediatric patients. This study did not encounter these adverse events, likely due to the skill level of the anesthesiologists involved and the small sample size.

The non-randomized design of the study is a limitation, as it may introduce selection bias. However, both groups were well matched in demographics and baseline characteristics. Also, the same volume and concentration of local anesthetic were used, and

experienced providers carried out all procedures, which helped standardize interventions.

This research contributes valuable data from a local pediatric population, addressing the existing gap in region-specific evidence. While international studies support the role of ultrasound in improving regional block techniques, this study reinforces its application in resource-limited settings, demonstrating that it is not only feasible but also highly beneficial.

CONCLUSION

In conclusion, ultrasound guidance significantly improves the efficacy and safety profile of pediatric caudal blocks compared to the landmark technique. While it requires additional time and equipment, the benefits — including higher success rates, better intraoperative stability, and reduced procedural discomfort — make it a superior choice for infraumbilical surgeries in children. Based on these results, ultrasound-guided caudal blocks should be encouraged as a standard of care in pediatric anesthesia, particularly when expertise and resources allow.

Future studies should aim to further validate these findings across diverse surgical types, age groups, and clinical environments. Randomized multicenter trials may provide stronger evidence and help formulate guidelines for routine use of ultrasound in pediatric regional anesthesia.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

SOURCE OF FUNDING

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

REFERENCES

1. Hafeman M, Greenspan S, Rakhamimova E, Jin Z, Moore RP, Al Bizri E. **Caudal block vs. transversus abdominis plane block for pediatric surgery: A systematic review and meta-analysis.** Front Pediatr. 2023; 11.
2. Benka AU, Pandurov M, Galambos IF, Rakić G, Vrsajkov V, Drašković B. **Effects of caudal block in pediatric surgical patients: A randomized clinical trial.** Braz J Anesthesiol. 2020; 70(2):97-103.
3. Desai N, Chan E, El-Boghdadly K, Albrecht E. **Caudal analgesia versus abdominal wall blocks for pediatric genitourinary surgery: Systematic review and meta-analysis.** Reg Anesth Pain Med. 2020; 45(11):924-33.
4. Sanghvi C, Dua A. **Caudal anesthesia. In: StatPearls.** Treasure Island (FL): StatPearls Publishing; 2024. Available from: https://www.ncbi.nlm.nih.gov/books/NBK551693/
5. Jalapati DH, Narayanan MK, Thota RS, Prakash S, Natarajan S. **Caudal block in pediatric patients: Clinical profile.** Eur J Mol Clin Med. 2022; 9(2):133-39.
6. Choi JH, Lee T, Kwon HH, You SK, Kang JW. **Outcome of ultrasonographic imaging in infants with sacral dimple.** Korean J Pediatr. 2018; 61(6):194-99.
7. 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.** Pediatr Anesth. 2022; 32(1):35-42.
8. Lufler RS, Davis ML, Afifi LM, Willson RF, Croft PE. **Bringing anatomy to life: Evaluating a novel ultrasound curriculum in the anatomy laboratory.** Anat Sci Educ. 2022; 15(3):609-19.
9. Nanjundaswamy N, Nagappa S, Shridhara R, Kalappa S. **A comparative study of ultrasound-guided caudal block versus anatomical landmark-based caudal block in pediatric surgical cases.** Indian Anaesth Forum. 2020; 21(1):10.
10. Royer DF, Buenting Gritton CA. **The use of ultrasound in the teaching and learning of anatomy. In: Chan LK, Pawlina W, editors. Teaching Anatomy: A practical guide.** Cham: Springer. 2020; 367-77.
11. Chen WT, Kang YN, Wang TC, Lin CW, Cheng CY, Suk FM, et al. **Does ultrasound education improve anatomy learning? Effects of the Parallel Ultrasound Hands-on (PUSH) undergraduate medicine course.** BMC Med Educ. 2022; 22(1):207.

AUTHORSHIP AND CONTRIBUTION DECLARATION	
1	**Sana Malik:** Manuscript writing.
2	**Mohsin Riaz Askri:** Literature search, study design, conceptualization.
3	**Shumyala Maqbool:** Data analysis, interpretation.
4	**Waleed Manzoor:** Data collection, Proof reading.
5	**Sana Fatima:** Statistical analysis, proof reading.
6	**Hasan Talal:** Endnote, references.