Section: Anaesthesiology

Original Research Article

A COMPARATIVE ANALYSIS OF CAUDAL BLOCK GIVEN VIA ULTRASOUND VERSUS CONVENTIONAL TECHNIQUE IN CHILDREN REQUIRING MINOR LOWER ABDOMINAL SURGERY

Limina Titus T[1], A. Govishkamal[1], S. Kesavalakshmi[1], Lokesh R[1]

[1]Assistant Professor, Department of Anaesthesiology, Govt. Stanley Medical College & Hospital, Tamilnadu, India

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Corresponding Author:
Dr. Lokesh R,
Email: lokey1991@gmail.com

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Abstract

Background: Pain management is a vital aspect of paediatric surgery, as surgical procedures elicit a significant stress response. Caudal block, a regional anaesthesia technique, is commonly used in paediatric lower abdominal surgeries. Our study aimed to compare the success rate, complications, and procedural characteristics of ultrasound-guided versus conventional landmark-guided caudal block in paediatric patients undergoing minor lower abdominal surgery. **Materials and Methods:** This randomised comparative study included 60 ASA PS I and II children at Government Stanley Medical College and Hospital from March to August 2021. Participants were assigned to Group A (ultrasound-guided caudal block, n=30) and Group B (landmark technique, n=30). The primary outcomes included the success rate, number of attempts, first-attempt success, and complications. Secondary outcomes included procedure time and haemodynamic stability. **Result:** Both techniques achieved a 100% success rate, with no complications. However, the first-attempt success rate was significantly higher in the ultrasound group (96.7%) than in the landmark group (73.3%) (p=0.040). The number of attempts was also significantly lower in the ultrasound group (p=0.040). The time taken to perform the block was significantly shorter in the ultrasound group (5.0±0.5 min) than in the landmark group (5.5±0.9 min) (p=0.009). Regarding complications, only one case of blood tap was observed in the landmark group, which was not statistically significant (p=1.000). No cases of dural puncture, rectal perforation, or subcutaneous bulging were reported in either group. **Conclusion:** Ultrasound-guided caudal block showed significantly higher first-attempt success rate and reduced procedural time than the landmark technique. Both methods had comparable overall success rates and similar safety profiles.

INTRODUCTION

Pain stimuli associated with surgical procedures elicit a stress response. Pharmacological measures to relieve pain can have multiple issues in the paediatric population due to immature hepatic and renal systems. Regional anaesthetic techniques can effectively prevent this stress response. Caudal blockade is one of the most commonly used regional anaesthetic techniques in the paediatric age group. Caudal block is a type of central neuraxial blockade that is most commonly used in paediatrics to provide analgesia for surgeries up to the umbilicus.[1] When caudal blockade is used along with general anaesthesia, it alleviates the need for opioids and inhalational anaesthesia.

The sacral hiatus serves as the access point for caudal epidural injections, but its anatomical variations can impact the success of the procedure.[2,3] Various techniques, such as the 'whoosh' test and nerve stimulation have been described to confirm proper needle placement.[4,5] However, ultrasonography has gained importance in the paediatric age group, even in infants under one year of age, especially in cases with sacral dimples.[6] The importance of ultrasonography has been recognised mainly due to anatomical landmark variations. Ultrasound before the procedure helps to visualise the sacral hiatus, sacrococcygeal ligament, duramater and epidural space. Ultrasonography has proven helpful in preventing complications by allowing real-time visualisation of the needle tip entering the sacral hiatus.

Aim

Our study aims to compare the success and complications of ultrasound and conventional methods for caudal block in children requiring minor lower abdominal surgery.

MATERIALS AND METHODS

This prospective randomised comparative study included 60 children who underwent abdominal or lower limb surgery in the Department of Paediatric Surgery at Government Stanley Medical College and Hospital between March 2021 and August 2021. Following approval from the Institutional Ethics Committee, informed written consent was obtained from the parents of the children.

Inclusion Criteria

Children aged 6 months to 6 years, weighing <20 kg, and classified as American Society of Anesthesiologists (ASA) physical status I and II, undergoing abdominal or lower limb surgery were included.

Exclusion Criteria

Children with severe systemic diseases, neurological or spinal abnormalities, coagulation abnormalities, or local infections were excluded from the study.

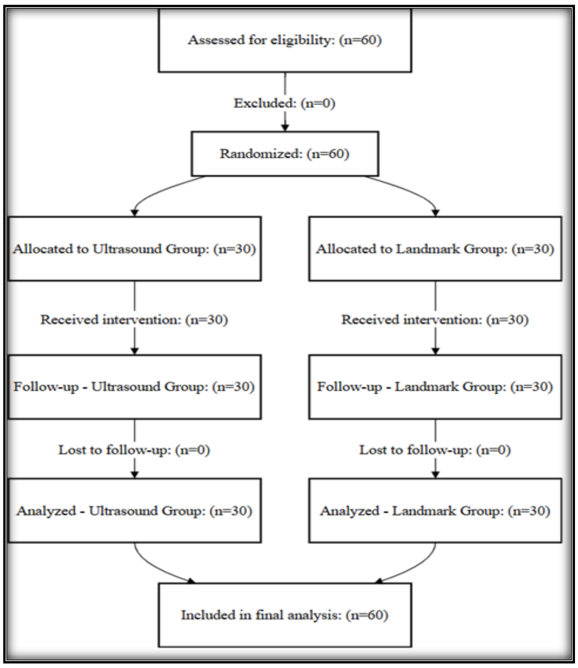
Methods: Children were randomly allocated into two groups using a computerised random number system, with group assignment determined in the operating theatre just before anaesthesia administration. Group A comprised 30 children who received a caudal block under ultrasound guidance using 0.25% bupivacaine, prepared according to the modified Armitage formula. Group B comprised 30 children who received a caudal block using the landmark technique with the same anaesthetic formulation. The procedure was performed by an anaesthesiologist who was not involved in the study.

Upon arrival in the operating room, standard monitoring devices were applied, that includes electrocardiography, peripheral oxygen saturation measurement, and non-invasive blood pressure monitoring. The baseline values were recorded. Intravenous access was secured using a 22G needle. Premedication included atropine (10 µg/kg/min), midazolam (50 µg/kg/min), and fentanyl (2 µg/kg/min). Anaesthesia was induced via a facemask with propofol (2 mg/kg/min) and maintained using spontaneous respiration with 2% sevoflurane in a 50% oxygen and 50% nitrous oxide mixture. The child was positioned laterally for the caudal block, and the caudal solution was prepared using the modified Armitage formula.

In Group A, caudal block was performed under ultrasound guidance, following strict aseptic precautions. A sterile plastic cover was placed on the ultrasound probe. The sacral hiatus was identified at the level of the sacral cornua using a linear transducer with optimal clarity. Initially, the probe was placed transversely over the coccyx and moved superiorly to locate the sacral cornua, which appeared as the "frog eye sign." At the same time, the sacrococcygeal ligament was visualised as the "hump." The probe was then rotated in the sagittal plane to identify the sacrococcygeal ligament, sacral canal, and vertebrae. The needle was advanced under direct vision in the sagittal plane with continuous ultrasound monitoring. Needle placement was confirmed by observing sacral canal distension in both the sagittal and transverse planes. Once confirmed, 0.25% bupivacaine was administered. The sacral cornua, needle tip, and visible bulge were observed during the injection.

In Group B, caudal block was performed using the landmark technique. The posterior superior iliac spines, sacral cornua, and sacral hiatus were identified by palpating the skin. A 22G needle was inserted at the apex of the hiatus at a 60–90° angle. A distinct "pop" sensation or loss of resistance indicated penetration into the sacral canal. The needle was then redirected at a 20–30° angle to the skin and advanced 2–3 mm inside the sacral hiatus. The correct needle position was confirmed using the "swoosh" test. After confirmation, 0.25% bupivacaine was administered according to the modified Armitage formula. The key parameters recorded included visibility of landmarks, palpability of the sacral cornua, identification of the hiatus, number of attempts, results of the swoosh test, visual observation of the bulge, and procedure duration.

All study participants were monitored for complications such as dural puncture, blood taps, subcutaneous bulging, and rectal perforation. Haemodynamic parameters including heart rate and blood pressure were recorded during surgery. The primary outcome measured were the success rate of the caudal block and the associated complications. The secondary outcomes included block performance time and first-attempt success rate. The success of the block was defined as the absence of an increase in the heart rate and blood pressure upon surgical incision. Block time was measured from positioning and disinfection to the completion of local anaesthetic administration. First-attempt success was defined as successful entry into the sacral canal or hiatus with a single needle orientation on the first puncture without withdrawal from the skin.



CONSORT Flowchart

Statistical Analysis: Data are presented as mean, standard deviation, frequency, and percentage. Continuous variables were compared using the independent-sample t-test. Categorical variables were compared using Pearson's chi-square test. If the expected cell frequency was less than 5 in 2×2 tables, then Fisher's exact test significance was defined by p-values < 0.05 using a two-tailed test. Data analysis was performed using IBM SPSS version 23.0.

RESULTS

The comparison of sex distribution between the groups was not significant (p=1.000). Similarly, there was no significant difference in ASA classification between groups (p=0.347). Both groups achieved a 100% success rate with no failures. However, the number of attempts required for success differed significantly between the groups (p=0.040).
Success on the first attempt was significantly higher in the ultrasound group (96.7%)(p=0.040). The incidence of blood taps did not differ significantly between the groups (p=1.000) [Table 1].

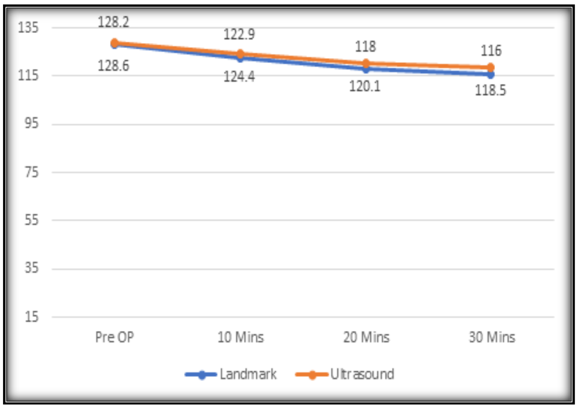


Figure 1: Comparison of HR between the groups

The comparison of HR among the preoperative, 10-, 20-, and 30-mins groups shows no significant difference (p>0.05) [Figure 1].

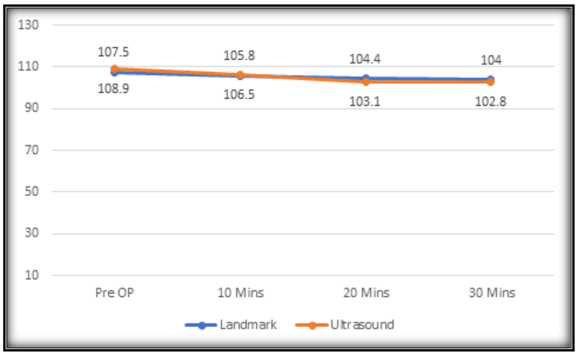


Figure 2: Comparison of SBP between the groups

The comparison of SBP among Groups Pre-OP, 10-, 20-, and 30-mins showed no significant difference (p>0.05) [Figure 2].

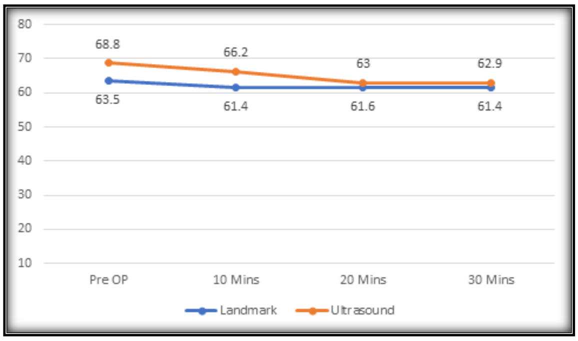


Figure 3: Comparison of DBP between the groups

The comparison of DBP between the groups at 20 and 30 min showed no significant difference (p>0.05), whereas in the preoperative period at 10 min, there was a significant difference (p<0.05) [Figure 3].

Table 1: Comparison of demographic and procedural variables between groups.

		Group N (%)		P-value
		Landmark	**Ultrasound**	
Gender	Female	1 (3.3%)	2 (6.7%)	1.000
	Male	29 (96.7%)	28 (93.3%)	
ASA PS	I	22 (73.3%)	25 (83.3%)	0.347
	II	8 (26.7%)	5 (16.7%)	
Number of Attempts	1	22 (73.3%)	29 (96.7%)	0.040
	2	7 (23.3%)	1 (3.3%)	
	3	1 (3.3%)	0	
Success at the first attempt	Yes	22 (73.3%)	29 (96.7%)	0.040
Blood Tap	No	29 (96.7%)	30 (100%)	1.000
	Yes	1 (3.3%)	0	

The comparison of age and weight between the groups showed no significant difference (p=0.173) and (p=0.604, respectively). However, the time required to perform the block was significantly shorter in the ultrasound group (5.0±0.5 min) (p=0.009) [Table 2].

Table 2: Comparison of baseline characteristics and procedure time

	Group (Mean±SD)		P-value
	Landmark	**Ultrasound**	
Age (years)	4.4±1.5	3.9±1.5	0.173
Weight (kg)	13.5±2.6	13.1±2.9	0.604
Time to perform block (mins)	5.5±0.9	5.0±0.5	0.009

DISCUSSION

The use of ultrasound has gained popularity worldwide as a safer and more effective alternative to landmark techniques. High-resolution ultrasound machines enhance precision and improve procedural outcomes. In our study, ultrasound was chosen because of its several advantages, including a shorter procedure duration, reduced number of needle pricks, and lower risk of accidental dural puncture.

In our study, there was no significant difference between the two groups in terms of age, sex, weight, and ASA-PS status. This finding is consistent with the study conducted by Riaz et al., who also reported similar results in their comparison between the ultrasound-guided and landmark techniques for paediatric caudal block.[7] Abukawa et al. also found that ultrasound guidance allowed for accurate identification of the sacral hiatus and epidural space, further supporting the reliability of ultrasound in paediatric patients.[8]

We noted that both techniques had a high success rate for the block, with a significant reduction in heart rate and blood pressure. Jain et al. also found no significant difference in the overall success rate between the two groups in their systematic review and meta-analysis.[9] However, Nanjundaswamy et al. observed a significant difference, with the ultrasound group demonstrating a higher success rate.[10] Similar findings were reported by Wang et al., where the success rate was slightly higher in the ultrasound group compared to the landmark technique.[11]

In our study, no complications, such as subcutaneous swelling, rectal perforation, or dural puncture, were observed in either group, except for a single blood tap in the landmark group, which was not statistically significant (p=0.173). This aligns with findings by Ahiskalioglu et al., who reported that vascular puncture and subcutaneous swelling rates were significantly higher in the landmark group compared to the ultrasound group.[12] Similarly, Nanjundaswamy et al. found a higher incidence of complications in the landmark group, with blood tap occurring in 23.8% of cases, compared to only 3% in the ultrasound group.[10] Karaca et al. and Rajesh et al. also reported higher complication rates in the landmark group, with increased incidences of needle punctures, subcutaneous bulging, and blood aspiration.[13,14]

The number of attempts between the ultrasound and landmark groups was significantly different, with a higher number of attempts in the landmark group. This finding is corroborated byKaraca et al., who also observed a higher number of attempts in the landmark group compared to the ultrasound group.[13] Additionally, Wang et al. demonstrated similar results, highlighting that ultrasound guidance led to a higher first-attempt success rate.[11] Ahiskalioglu et al. found a significantly lower number of punctures in the ultrasound group, emphasising the benefits of ultrasound guidance.[12]

In our study, the time required to perform the block was significantly shorter (p=0.001) in the ultrasound group than in the landmark group requiring less time. This result is consistent with findings from Wang et al., who also demonstrated that ultrasound-guided blocks required significantly less time to perform compared to the landmark technique.[11] However, Riaz et al. reported a longer block performance time in the ultrasound group compared to the landmark group, which contrasts with our findings.[7] Similarly, Rajesh et al. found that ultrasound-guided blocks took more time compared to the landmark technique.[14]

The success rate of our study on the first attempt was significantly different between the ultrasound and landmark techniques (p=0.40), with a higher first-attempt success rate in the ultrasound group. This conclusion aligns with the findings of Riaz et al., who also demonstrated a higher success rate on the first attempt with ultrasound guidance compared to the landmark technique.[7] Additionally, Karaca et al. and Ahiskalioglu et al. reported similar results, with a significantly higher first-attempt success rate in the ultrasound group.[12,13] Jain et al. confirmed in their meta-analysis that ultrasound significantly improves first puncture success rates while reducing complications.[9,13] Furthermore, Marjanovic et al. examined different volumes of levobupivacaine for the caudal block. They found that while the anaesthetic volume did not significantly influence postoperative analgesia duration, using ultrasound could optimise precision and safety during the procedure.[15]

CONCLUSION

The ultrasound-guided caudal block resulted in a comparable success rate between the two groups, with no significant complications observed. Ultrasound use reduced the number of attempts required, decreased block performance time, and improved first-attempt success. Given these advantages, the routine use of ultrasound for caudal block placement is recommended to enhance procedural efficiency and success rates. Further studies with larger sample sizes are required to validate these findings.

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