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Original Research Article

Ultrasound-Guided Versus Conventional Technique Comparison for Caudal Block in Pediatric Patients

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Abstract:

Background and Aim: Perioperative pain in children is a significant consideration, and caudal block is a safe and effective method for managing pain in paediatric patients. When combined with general anaesthesia, it can lead to reduced need for other medications, improved postoperative pain relief, and quicker extubation. Our main goal was to evaluate the two methods by looking at the effectiveness of pain relief, as shown by the intra-operative hemodynamic parameters. We aimed to compare the two techniques by analysing the number of post-operative complications, need for rescue analgesia, puncture count, and duration of each block.

Material and Methods: An investigation was carried out on 100 patients aged between 6 months to 5 years, who were split into two groups (Group A and Group B) of 50 patients each, undergoing elective lower gastrointestinal and genito-urinary tract surgeries over a two-year period in a tertiary care hospital.

Results: On average, it took 11.45 ± 8.50 minutes to complete the block procedure. Most patients experienced mild discomfort in both study groups within the first hour after surgery. By the sixth hour, most patients were calm and at ease. At the 12th and 24th hour, most patients were relaxed and comfortable, with similar results in both groups. In group A, 48% of patients needed rescue analgesia, while 52% of patients in group U did not require it. However, this difference was not statistically significant.

Conclusion: The caudal block is a commonly used regional anaesthesia technique in children. Using the traditional landmark-based method is simpler and quicker than the more modern ultrasound-guided approach, which requires specialised skills.

Keywords: Caudal block, Pediatric, Rescue Analgesia, Ultrasound-guided.

Introduction

Regional anaesthetic methods like caudal epidural anaesthesia help reduce the need for inhaled anaesthetics, lessen the body's stress during surgery, promote a gentle recovery, and offer effective immediate pain relief after surgery while reducing the need for systemic pain medications. [1] The caudal epidural block is a commonly utilised regional anaesthetic method, particularly in paediatric surgery.

This method is secure, dependable, simple to carry out, and proves highly efficient for children, particularly in surgeries below the navel when paired with general anaesthesia. This technique is widely utilized in paediatric anaesthesia for pain management during and after surgery. Providing pain relief during and after surgeries below the navel is an effective method. It reduces the body's stress hormone reaction to surgical procedures. [2]

These blocks are commonly used for surgical procedures below the umbilicus, such as inguinal hernia repair, circumcision, anal atresia treatment, and intussusception treatment, orthopaedic procedures involving the pelvic girdle, and casting to immobilize newborns with hip dysplasia. [3] There has been a rise in the use of these procedures in paediatric cases due to their simplicity, low complication rates, and applicability in elective surgeries. [4]

Children often experience stronger physical and emotional responses to pain compared to adults. It is essential to provide sufficient pain relief to avoid short-term and long-term negative consequences. For the best perioperative pain relief in children, it's important to include local anaesthetics in the initial pain management plan. This can be achieved by selecting a regional anaesthetic technique like neuraxial blockade, peripheral nerve blockade, or local wound infiltration in combination with general anaesthesia or sedation. [5-7]

Performing caudal block in children is a safe and effective way to reduce pain scores. When combined with general anaesthesia, it can decrease the need for volatile agents and opioids, leading to better postoperative pain management and quicker extubation. During surgery in children, a caudal block is done from the lower back to the middle of the chest to manage expected significant pain before and after the procedure. [8,9] Conventional methods for nerve localization involve using landmarks and neuro-stimulation techniques, but they often have high rates of failure. The effectiveness of pain relief from epidural anaesthesia relies on how far the solution spreads within the epidural space, influenced by the amount injected. [10,11]

Reports indicate that this technique has been used as the only anaesthetic in children who are not eligible for general anaesthesia, such as those with muscular dystrophies and suspected malignant hyperthermia. The block is considered very safe, with a very low incidence of harmful effects. The most serious issues are block failure and urinary retention. [12] Combining caudal epidural blocks with general anaesthesia is typically done to ensure effective post-operative pain relief. It also decreases the need for opioids and inhalational agents during surgery.

According to reports, the conventional caudal anaesthesia method has a success rate of 75% in paediatric patients, possibly because of differences in sacral anatomy. Ultrasonography offers detailed anatomical information for conducting neuraxial blocks, especially in caudal blocks. [13,14] It aids in visualising the sacral hiatus, sacrococcygeal ligament, dura mater, epidural space, and the distribution of local anesthetic within the epidural space. It remains uncertain whether ultrasonography enhances the effectiveness of caudal blocks in children. In this study, our goal was to compare two methods of giving caudal block in children. Our main goal was to evaluate the two methods by looking at how well they provided pain relief, as shown by the intra-operative haemodynamic parameters. We aimed to compare the two techniques by analyzing post-operative complications, need for rescue analgesia, puncture count, and duration of each block.

Material and Methods

Conducted was a study on 100 patients aged between 6 months to 5 years, split into two groups (Group A and Group B) of 50 patients each, undergoing elective lower abdominal and genitourinary tract surgeries. The patients belonged to ASA class I/II and were enrolled after institutional ethics committee approval at a Tertiary care Hospital over a span of two years. Excluded from the study were children with abnormal coagulation profiles, infections on the back, spinal abnormalities, and pre-existing neurological deficits.

For comparative study design we have at 95% confidence level and statistical power of 80% with effect size 0.7 with mean (SD) 2.16 (1.85) and 2.87 (2.41) for group 1 and group 2 respectively in the study done by Erbuyun et al. [3] We needed a sample size of 100 for our study.

Following enrollment, the groups were assigned using a computer-generated number sequence to prevent any bias in selection. All patients underwent a thorough pre-anesthetic examination. The anaesthetic procedure was described to the parent/guardian of the patients preparing for lower abdominal or genitourinary surgery, and written informed consent was obtained. No medication was administered before the surgery. After confirming the patient had fasted sufficiently, they were transferred to the operating room. Following the setup of standard ASA monitors (ECG, Non-invasive blood pressure, oxygen saturation probe), the patient was induced with 7-8% Sevoflurane through inhalation. Intravenous access was then established, and the airway was secured using either a Supraglottic airway device or Endotracheal tubes of suitable size. Following the airway was secured, the anaesthesia was sustained by utilising a mixture of oxygen and nitrous oxide (1:1) along with sevoflurane.

Performing caudal block using the traditional method - The patients were positioned on their side with their hips and knees bent. Following proper skin sterilisation with chlorhexidine solution, the two sacral cornua were located along the line of the spinous process at the level of the sacrococcygeal joint. Following the examination of the sacral cornua and hiatus, a 21G BD needle was inserted into the skin at a 60-80 degree angle until the sacrococcygeal ligament was punctured, which was confirmed by a popping sensation. After successfully piercing the ligament to enter the sacral canal, the angle of the needle was decreased to 20-30 degrees and the depth of insertion was increased to 2 mm. After confirming the lack of blood or Cerebrospinal fluid in the aspirate, administer over one minute using the 'single shot technique' while under continuous hemodynamic monitoring. The patient's skin was properly sterilised.

Hemodynamic parameters were monitored throughout the surgery, from before administering anaesthesia to the end of the procedure, at specific intervals. The study recorded the number of needle punctures needed for accurate needle placement and local anaesthetic injection. The duration from preparing and covering the site until administering the local anaesthetic agent was considered as the

time required completing the block. A successful block was characterised by no more than a 15% increase in Mean Arterial Pressure or Heart Rate as measured 5 minutes after skin incision. If the block failed, 0.5 mcg/kg of Fentanyl was given intra-operatively as needed. Every patient was given Paracetamol injection at a dose of 10 mg/kg intravenously during surgery, regardless of the caudal block technique used. Following the surgery, the patients received appropriate medication to reverse the effects, were then removed from the ventilator, and transferred to the post-anesthesia care unit for monitoring. The PACU staff conducted post-operative pain assessments using the FLACC scale at regular intervals. They were provided with a pain assessment chart and briefed about the procedure. Patients with a score of 4 or higher received rescue analgesia with Tramadol 1 mg/kg and Ondansetron 100 mcg/kg intravenously.

Statistical Analysis

The data was compiled and input into a spreadsheet using Microsoft Excel 2007, and then transferred to the data editor page of SPSS version 15 (SPSS Inc., Chicago, Illinois, USA). Quantitative data was presented using means and standard deviations or median and interquartile range, depending on their distribution. The qualitative data was displayed in terms of counts and percentages. Confidence level and level of significance were both set at 95% and 5% for all tests.

Results

100 individuals took part in the study. The age, weight, gender, and ASA class were similar in both groups and not statistically significant ($p > 0.05$). Table 1 the average duration to complete the task was 11.45 ± 8.50 minutes. In Group A, the average block performing time was 6.7 minutes, while in Group B, it was 14.5 minutes. Refer to Table 2 for more details.

They also compared the number of punctures needed to perform the caudal block in the two groups. The success rate of the blocks was similar in both groups, with a p-value greater than 0.05. The number of needle punctures needed to access the caudal canal was similar and did not show statistical significance ($p>0.05$). The success rate at the initial puncture was similar in both groups ($p>0.05$). The patients' haemodynamic parameters were regularly monitored and found to be similar in both groups.

The assessment of post-operative pain was conducted using the FLACC score. Most patients experienced slight discomfort in both study groups within the first hour after surgery. By the sixth hour, most patients were calm and at ease. By the 12th and 24th hour, most patients in both groups were calm and at ease, with similar outcomes. Comparing the need for rescue analgesia between the two groups, it was found that 48% of patients in group A and 52% of patients in group U did not need additional pain relief. However, this difference was not statistically significant ($p>0.05$) (Table 3). A comparison was made between the occurrences of complications linked to caudal block in the two groups.

Table 1: Demographics of study participants

Variable	Group A (n=50)	Group B (n=50)	P value
Age (years)	2.03±0.31	2.24±0.48	0.10
Gender (M/F)	24/26	25/25	0.09
ASA class (I/II)	45/5	49/1	0.23

*Indicate statistically significance at $p \leq 0.05$

Table 2: Comparative analysis of caudal block between the two groups Group C Group

Variable	Group A (n=50)	Group B (n=50)	P value
Block performing time	6.7 (4.23)	14.5 (5.5)	0.001*
Block success rate	88.1%	88.1%	0.5
Success at first puncture	52.9%	47.6%	0.23

*Indicate statistically significance at $p \leq 0.05$

Table 3: Comparison of rescue analgesia between study groups

Rescue Analgesia	Group A (%)	Group B (%)	P value
Yes	53	47	0.07
No	48	52	

Statistically significance at $p \leq 0.05$

Discussion

Several techniques can be used to identify the caudal epidural space, such as palpation, the whoosh test, fluoroscopy, and ultrasonography. One common technique involves using palpation to detect a distinct 'pop' sensation when the needle penetrates the sacrococcygeal ligament. Yet, relying solely on the palpation method may not always suffice, as confirmation typically occurs once the clinical effects of the injected drug

become apparent. [15,16] Once the coccyx is palpated, you can locate the sacral hiatus by detecting a depression in the skin while moving upwards. Performing this technique can be challenging when dealing with overweight children or those with unclear anatomical features. One technique involves locating the posterior superior iliac spine and the sacral hiatus to form an equiangular triangle. Kim et al highlighted that it might not be appropriate, particularly in children under 6 years old, due to the lack of equiangular triangle formation. [17]

Performing the block based on landmarks has been a traditional practice, but newer techniques like ultrasound and fluoroscopy have presented challenges to this approach. Studies have shown that the traditional landmark-based method is linked to failure rates of 10-20%. Ultrasonography is considered a crucial tool for guiding central neuraxial and peripheral nerve blocks, as highlighted in various studies. Ultrasound-guided techniques offer benefits such as real-time visualisation of the needle, avoiding crucial structures like vessels during drug administration, and observing the spread of local anaesthetic. It can also help pinpoint and locate the sacral hiatus for precise needle placement in the sacral/caudal canal, particularly in situations where anatomical variations in the sacrum and hiatus pose challenges for the standard technique. [18-20]

In comparing the two groups, the average age of the patients was 2.03 years in Group A and 2.24 years in Group B. With a calculated p-value of 0.95, it indicates that the two groups did not show significant differences, demonstrating comparability.

Out of the total participants, 49 were male and 51 were female. From our research, 54.5% of the patients received inguinal hernia repair. The average duration for performing the caudal block was 11.45 ± 8.50 minutes. In contrast, Ahiskalioglu et al [21] conducted a study showing that the mean block performing time was 103.1 ± 45.1 seconds using the conventional technique and 109.9 ± 49.7 seconds with the ultrasound guided technique, resulting in a p-value of 0.463. There was no statistically significant time difference in performing the block using the two techniques in the study conducted by Karaca et al. [22]

The procedure was carried out with a single puncture in 74% of patients, two punctures in 21% of patients, and three punctures in 5% of patients. The findings were similar to a study conducted by Ahiskalioglu et al. [21], which reported a first puncture success rate of 80% with ultrasound guidance compared to 63% with the conventional method. In a study by Karaca et al. [22], the first puncture success rate was 90.2% with ultrasound guidance and 66.2% with conventional block. In a study by Erbuyun et al [4], they compared the number of needle punctures. It was found that 1.06 ± 0.25 punctures were needed in the ultrasound-guided group, while 1.10 ± 0.3 punctures were required in the landmark-based technique. The p-value was 0.579.

According to our research, 88.1% of the patients experienced a successful caudal block. The success rate of the block was consistent across all the groups. In Group A, the success rate at first puncture was 52.9%, while in Group B it was 47.6%. With a p-value of 0.23, the results were not statistically significant. In their study, Karaca and colleagues found that the success rate of the block was similar in both groups. In a study by Wang et al, they compared conventional methods and sacral hiatus using ultrasound guidance for paediatric caudal block. The study showed that the first puncture success rate was higher, and the durations of block were shorter in Group H compared to Group C. [23]

Non-invasive procedures Comparisons were made between the blood pressure and heart rate of both groups at regular intervals before and after administering the caudal block, with similar values observed in both groups. In a study by Adler et al [24], the effectiveness of ultrasonography in caudal blocks was examined in 98 patients. It was noted that 94 patients did not experience any change in heart rate during incision. In a study conducted by Nanjundaswamy et al [25], similar findings were observed.

After the procedure, the pain levels were regularly assessed using the FLACC scale for both groups. It was noted that most patients in both groups felt calm and at ease, 6 hours after surgery, 47% of patients in Group A and 53% of patients in Group B were feeling calm and at ease. 57.5% of patients in Group A experienced mild discomfort, compared to 42.5% of patients in Group B. By the twelfth hour, half of the patients in each group were feeling relaxed and comfortable, while the others experienced mild discomfort. Patients with a pain score above 4 received rescue analgesia, and it was noted that the need was consistent in both Group A and Group B. The Wong-Baker FACES pain rating scale was used by Erbuyun et al [4] to evaluate postoperative pain up to 6 hours after surgery. Statistically significant reductions in pain levels were observed at the 90th minute in the ultrasound-guided group, while the need for rescue analgesia was consistent in both groups.

The occurrence of intravascular puncture was the same in both groups, while only the conventional group showed soft tissue bulge. In their study, Ahiskaligo et al [21] found that most complications, such as dural puncture and

subcutaneous bulging, occurred in the conventional group. No instances of intravascular puncture or LAST were reported in the study. In a study by Wang et al [23], they found that the conventional group had a higher incidence of intravascular puncture. Additionally, soft tissue bulge was observed in 7.1% of patients in the conventional group, but none in the ultrasound guided group. There are a few drawbacks to this study. It's important to note that the study did not take into account the length of motor block and how effective the local anaesthetic was for pain relief after surgery. Additionally, we only evaluated the in-plane technique; upcoming research should contrast the in-plane and out-plane methods.

Conclusion

The caudal block is a commonly used regional anaesthesia technique in children. Using the traditional landmark-based method is simpler and quicker than the more modern ultrasound-guided approach, which requires a higher level of skill from the practitioner. Both techniques offer similar levels of pain relief. Complications linked to the block are less frequent with the ultrasound-guided method. Ultrasonography is often preferred, particularly when identifying sacral anatomy and landmarks proves challenging. More research is necessary to determine the significance of ultrasonography in administering caudal block.

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