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Original Research Article

Ultrasound-Guided Vs. Conventional Approach for Caudal Block in Pediatric Patients: A Comparative Study

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Abstract:

Background and Aim: Surgical procedures below the umbilicus have typically been recommended to utilize caudal blocks. Their popularity has grown in pediatric cases due to their simplicity and low risk of complications. Some sources have mentioned the use of this technique as the only form of anesthesia in children who may not be suitable for general anesthesia. Our objective was to compare two different methods of administering caudal block in paediatric patients.

Material and Methods: A study was conducted on 100 patients between 6 months to 5 years of age, who were divided into two groups (Group A and Group B) of 50 patients each. Comparisons were made between both groups in terms of intra-operative analgesia, haemodynamic parameters, time required to perform the block, and demand for rescue analgesia.

Results: The intra-operative haemodynamic parameters were similar in both groups. Group B took significantly longer to perform the block compared to Group A. The statistical significance level was found to be less than or equal to 0.05. In Group A, the success rate at first puncture was 52%, while in Group B it was 48%. Most patients reported feeling calm and at ease during the first hour after their surgery. The need for additional pain relief after surgery was similar in both groups.

Conclusion: the caudal block is a commonly used regional anesthesia technique in the pediatric population. The conventional technique is known for being easier and less time consuming compared to the ultrasound-guided technique, which is relatively new and requires expertise from the practitioner.

Keywords: Caudal Block, Paediatric, Haemodynamic Parameters, Ultrasound.

Introduction

This procedure is frequently carried out in children. It provides effective pain relief without the negative effects of intravenous opioid medications, such as nausea, sedation, and respiratory depression. Typically, caudal blocks are administered to children once general anesthesia has been induced. In traditional teaching, operators rely on their subjective sensation of feeling a "give" or "pop" as they advance the needle through the sacrococcygeal ligament and the absence of resistance when injecting the local anesthetic.

First documented in 1933, caudal block can serve as a standalone technique for surgical anesthesia or be combined with general anesthesia to ensure effective postoperative pain relief. [1-3] when it comes to surgical anesthesia, caudal block offers some great benefits. It allows for the avoidance of volatile anesthetic agents and neuromuscular blockers, while also preserving spontaneous ventilation and promoting early recovery. When used alongside general anesthesia, it can help reduce the need for volatile anesthetic agents and neuromuscular blockers, while also providing excellent pain relief. During surgery under caudal anesthesia, the levels of adrenocorticotropic hormone (ACTH), beta-endorphin, antidiuretic hormone (ADH), cortisol, prolactin, and glucose are found to be less affected compared to general anesthesia. [4,5]

There has been a rise in the use of caudal epidural blocks in paediatric cases due to their simplicity, low risk of complications, and suitability for elective surgeries. [6] Typically, it is combined with General Anaesthesia to ensure effective pain relief after surgery. Additionally, it decreases the need for opioids and inhalational agents during

surgery. [7] There has been a rise in cases of systemic toxicity associated with the use of local anaesthetics, which can be linked to the growing popularity and utilization of caudal anaesthesia. [8] The traditional method is typically carried out with the patient lying on their side or stomach. You can easily locate the two sacral cornu by palpating around the area of the sacrococcygeal joint. The block is administered using a technique known as the 'single shot technique'. There is a potential for dural or vascular puncture, which should be taken into consideration. The ultrasound guided block is carried out by visualizing the sacral cornu and hiatus, and then injecting the medication into the sacral canal under direct vision. [9] Ultrasonography-guided caudal blocks have gained popularity among paediatric anesthesiologists due to their ability to enhance safety and reduce complication rates. [10] According to reports, the success rate of the conventional caudal anaesthesia method in paediatric patients is 75%. This variation in success is believed to be caused by differences in sacral anatomy. [11] Ultrasonography is a valuable tool for obtaining detailed anatomical information, particularly when performing neuraxial blocks, especially caudal blocks. [12] This technique allows for clear visualization of important anatomical structures such as the sacral hiatus, sacrococcygeal ligament, dura mater, epidural space, and the distribution of local anesthetic within the epidural space. The effectiveness of ultrasonography in improving the success rates of caudal blocks in children is currently uncertain. Performing the traditional single-shot caudal block by inserting the needle into the sacral canal through the sacral hiatus carries a potential risk of inadvertent dural or vascular puncture. Ultrasound has emerged as a valuable tool in regional anesthesia, providing the ability to visualize nerves and nearby structures in real-time. By visualizing the injectate entering the precise plane, the success rate of achieving a block of over 95% is significantly improved. [13] Our objective was to compare the two methods of administering caudal block in paediatric patients.

Material and Methods

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

Group assignment was conducted using a computer-generated number sequence after enrollment to ensure impartial selection. A thorough pre-anesthetic examination was conducted for all patients. The parent/guardian of the patients undergoing lower abdominal or genitourinary surgery received a detailed explanation of the anesthetic procedure and provided written informed consent. There was no premedication administered on the day of surgery. The patient was taken to the operating room after confirming that they had fasted sufficiently. Standard ASA monitors (ECG, Non-invasive blood pressure, oxygen saturation probe) were applied and inhalational induction was performed using 7-8% Sevoflurane. Intravenous access was established, and the airway was secured using either a Supraglottic airway device or appropriately sized endotracheal tubes. Following the establishment of the airway, the anesthesia was sustained using a combination of oxygen and nitrous oxide in equal proportions, along with sevoflurane.

Administering caudal blocks using the conventional technique

The patients were positioned on their side with their hips and knees bent. Following proper sterilization of the skin with chlorhexidine solution, the two sacral cornua were located by palpating 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 carefully inserted into the skin at a 60-80 degree angle. The needle was advanced until it punctured the sacrococcygeal ligament, which was confirmed by a distinct popping sensation. After successfully piercing the ligament to enter the sacral canal, the angle of the needle was then adjusted to 20-30 degrees and the depth of insertion increased to 2 mm. After confirming the absence of blood or cerebrospinal fluid in the aspirate, the procedure is performed using the 'single shot technique' while continuously monitoring the patient's hemodynamics for one minute. The patient's skin was properly sterilized.

The intra-operative hemodynamic parameters were measured throughout the surgery, from before the start of anesthesia until its completion, at regular intervals. The study recorded the number of needle punctures needed to accurately position the needle and administer the local anesthetic. The duration from preparing the site to administering the local anesthetic was considered as the time required completing the block. In order to determine a successful block, the medical team looked for any signs of an increase in Mean Arterial Pressure or Heart Rate of more than 15% within 5 minutes after the skin incision. During the operation, if the block failed, Fentanyl was given as needed at a

dose of 0.5 mcg/kg. Regardless of the technique used for caudal block, all patients were administered an intravenous infusion of Paracetamol at a dosage of 10 mg/kg during the operation.

Following the surgery, the patients were given appropriate medication (Neostigmine 0.05 mg/kg and Glycopyrrolate 0.2 mg for every 1 mg of Neostigmine) to reverse the effects, and then they were taken off the ventilator and moved to the post-anaesthesia care unit for close monitoring and observation. The PACU staff conducted post-operative pain assessments at regular intervals using the FLACC scale. They were provided with a pain assessment chart and given a thorough explanation of the procedure. Patients with a score of 4 or higher received rescue analgesia with an injection. Administer Tramadol at a dose of 1 mg/kg along with Ondansetron at a dose of 100 mcg/kg intravenously.

Statistical analysis

The recorded data was organized and inputted into a spreadsheet computer program (Microsoft Excel 2019) before being transferred to the data editor page of SPSS version 15 (SPSS Inc., Chicago, Illinois, USA). The quantitative variables were reported using either means and standard deviations or median and interquartile range, depending on their distribution. The presentation of qualitative variables was in the form of counts and percentages. Confidence level and level of significance were set at 95% and 5% respectively for all tests.

Results

The study included a total of 100 participants. The median age, mean weight, and gender were similar in both groups and did not show any significant differences ($p > 0.05$). Here is Table 1. The average duration of the block procedure was 11.06 ± 8.40 minutes. In Group A, the median block performing time was 6.4(4.25) minutes, while in Group B it was 15.5(6) minutes. The p-value was found to be statistically significant ($p < 0.05$).

In Table 2, the numbers of punctures needed to perform the caudal block were compared between the two groups. The block success rate was similar in both groups, with no statistically significant difference ($p>0.05$). The number of needle punctures needed to enter the caudal canal was similar and did not show any statistical significance ($p>0.05$). The success rate at initial puncture was similar in both groups.

The haemodynamic parameters of the patients were regularly monitored and found to be similar in both groups. The post-operative pain assessment was conducted using the FLACC score. Most patients experienced mild discomfort in both study groups within the first hour after surgery. By the sixth hour, the majority of patients were feeling relaxed and comfortable. At the 12th and 24th hour, most patients reported feeling relaxed and comfortable, and the results were similar in both groups. The study analyzed the need for rescue analgesia in two groups. It was found that 49% of patients in group A and 51% of patients in group B did not require rescue analgesia. However, this difference was not statistically significant ($p>0.05$) (Table 3). Complications associated with caudal block were compared between the two groups.

Table 1: Demographics of study participants

Variable	Group A (n=50)	Group B (n=50)	P value
Age (years)	2 (3.11)	2.24(3.05)	0.23
Weight (kg)	11.4 ± 5.4	12.10 ± 5.2	0.17
Gender (M/F)	24/26	25/25	0.09

Statistically significance at p≤0.05

Table 2: Number of needle punctures required to perform block in each group

Punctures	Group A (n=50)	Group B (n=50)	P value
1	52%	48%	0.06
2	42	58	
3	34	66	

Statistically significance at p≤0.05

Table 3: Comparison of rescue analgesia between study groups

Rescue Analgesia	Group A (n=50)	Group B (n=50)	P value
Yes	52	48	0.23
No	49	51	

Statistically significance at p≤0.05

Discussion

The caudal block has been a well-known procedure for over 80 years, with its associated complications also being widely recognized. These complications include dural puncture, intravascular injection, rectal penetration, drug overdose, and morphine apnea.

Various methods have been explored to determine the correct positioning of the caudal needle in the epidural space. These techniques include nerve stimulation, ultrasound imaging, the whoosh test, and the modified swoosh test. [14,15] New application techniques are constantly being developed to reduce complication rates. While it is true that aspiration and the return of blood or liquor can be considered as strong evidence for needle misplacement, it is important to note that a negative aspiration may not be sensitive enough to completely rule out these complications. One way to detect accidental systemic injection is by using a "test dose" with epinephrine, although it may not be very effective in detecting intrathecal misplacement. [16,17]

Ultrasonography is widely recognized as a crucial tool for guiding central neuraxial and peripheral nerve blocks, according to various sources in the medical field. One of the benefits of using the ultrasound guided technique is the ability to see the needle in real-time, which helps avoid important structures like vessels when administering the drug. Additionally, it allows for a better understanding of how the local anesthetic spreads. [18] Additionally, it has the ability to accurately identify and locate the sacral hiatus, which is particularly useful in cases where anatomical variations in the sacrum and hiatus pose challenges for conventional techniques. [19]

The average age of the patients in our study was 2 years. The patients in Group A had a median age of 2 (3.11) years, while those in Group B had a median age of 2.24 (3.05) years. With a calculated p-value of 0.23, it can be concluded that there is no significant difference between the two groups, indicating comparability. Our study found that 49% of the patients were male, while 51% were female. In Group A, there were 24 males, accounting for 48% of the total, while Group U had 25 males, making up 50% of the group. In Group A, there were 26 females, accounting for 52% of the total, while in Group B, there were 25 females, making up 50% of the total.

In Group A, the median block performing time was 6.4(4.25) minutes, while in Group B it was 15.5(6) minutes. The results were statistically significant ($P < 0.05$). In the study conducted by Karaca et al [20], no significant difference in the time taken to perform the block was observed between the two techniques. In a study conducted by Kollipara et al [21], it was found that the average time it took to perform a block was 30.34 ± 7.34 seconds using the conventional technique, while it took 53.19 ± 10.97 seconds using the ultrasound-guided technique. This difference in time was found to be statistically significant. In a study conducted by Nanjundaswamy et al [22], they found that the block performing time was significantly higher when using the ultrasound guided technique. A majority of patients (74%) underwent the block with just one puncture, while 21% required two punctures and the remaining 5% needed three punctures. In both groups, the block was performed with a single puncture. This method was used in 52% of patients in group A and 48% of patients in group B. In group A, 42% of patients required two punctures, while in group B, this number was 58%. The number of punctures needed differed between the two groups, with 34% of patients in group A requiring three punctures compared to 66% of patients in group B.

However, this difference was not found to be statistically significant. Just like a health journalist, Wang et al conducted a study comparing conventional methods and sacral hiatus using ultrasound guidance for pediatric caudal block. They found that Group H had a higher first puncture success rate and shorter block durations compared to Group C. [23] In a study conducted by Ahiskalioglu A et al, they compared caudal blocks performed using ultrasound and conventional methods. The results showed that the first puncture success rate was higher in the ultrasound group compared to the conventional group. [24] In a study conducted by Karaca et al [20], it was observed that the block was successfully achieved in 98 (73.7%) patients using the conventional technique and in 130 (97.7%) patients using the ultrasound-guided technique. This highlights the effectiveness of the ultrasound-guided technique in improving the success rate of the block. In a study by Erbuyun et al [7], they compared the number of needle punctures and found that the ultrasound-guided group required an average of 1.06 ± 0.25 punctures, while the landmark-based technique required an average of 1.10 ± 0.3 punctures.

According to our study, a significant majority of patients (88%) experienced a successful caudal block. The success rate of the blocks was the same in all of the groups. In Group A, the success rate at first puncture was 52%, while in Group B it was 48%. However, these results were not statistically significant. In the study conducted by Ahiskalioglu et al [9], it was found that the first puncture success rate was higher in Group B compared to Group A. However, the block success rates were similar in both groups. In a study conducted by Singh Mahima et al., they found that the success rate of US Guided caudal block was 94%, compared to 78% in the conventional caudal block group. Ultrasound is a valuable tool for accurately guiding the placement of the epidural needle, enhancing technique, improving patient acceptance, and reducing failure rates.

Both groups were regularly monitored before and after receiving the caudal block to compare their non-invasive blood pressure and heart rate. The

values were found to be similar in both groups. In a study conducted by Adler et al [7], the effectiveness of ultrasonography in caudal blocks was examined in a group of 98 patients. The researchers found that in 94 of these patients, there was no noticeable change in heart rate when the incision was made. In a study conducted by Nanjundaswamy et al [22], they found similar results. Both groups showed a significant reduction in heart rate from the baseline value.

However, the landmark-based group had a greater reduction in mean arterial pressure (MAP) compared to the ultrasound-guided group. The heart rate response is a reliable indicator of successful needle placement. Within the context of our study, this result was obtained under general anesthesia with isoflurane in 50% nitrous oxide after midazolam premedication and thiopentone sodium induction.

After the procedure, the pain experienced by the patients in both groups was assessed using the FLACC scale at regular intervals. The results showed that the majority of patients in both groups reported feeling relaxed and comfortable. After 6 hours following the operation, a significant number of patients in Group C (45%) and Group U (55%) reported feeling relaxed and comfortable. Incorporating the Wong-Baker FACES pain rating scale, Erbuyun et al [6] assessed postoperative pain for 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 remained unchanged in both groups.

A small percentage of the study population experienced dural puncture during the administration of the block, while an even smaller percentage had intravascular puncture and soft tissue bulging. In their study, Ahiskaligo et al [9] found that most complications occurred in the conventional group, specifically dural puncture. And the appearance of bulging under the skin In a study by Karaca et al [20], the researchers compared the occurrence of complications in two groups and found that 10.5% of patients in the conventional group experienced intravascular puncture, while none of the patients in the ultrasound-guided group had this complication. No complications were observed in the group that received ultrasound guidance.

There are a few limitations to consider in this study. It is important to note that the study did not take into account the duration of motor block and analgesic efficacy of local anesthesia in the postoperative period.

It is important to note that our assessment focused solely on the in-plane technique. However, it would be beneficial for future studies to compare both the in-plane and out-plane methods.

Conclusion

Caudal block is one of the most widely practiced regional anaesthesia technique in paediatric population. The conventional landmark-based technique is easier and less time consuming as compared to the ultrasound-guided technique, which is newer and the practitioner needs expertise. The quality of analgesia provided by both the techniques is comparable.

References

1. Beyaz SG, Tokgöz O, Tüfek A: Caudal epidural block in children and infants: retrospective analysis of 2088 cases. Ann Saudi Med. 2011; 31:494-497.
2. Hoelzle M, Weiss M, Dillier C, Gerber A: Comparison of awake spinal with awake caudal anesthesia in preterm and ex-preterm infants for herniotomy. Pediatr Anesth. 2010; 20:620- 624.
3. Brenner L, Kettner SC, Marhofer P, et al.: Caudal anaesthesia under sedation: a prospective analysis of 512 infants and children. Br J Anaesth. 2010; 104:751-755.
4. Somri M, Gaitini LA, Vaida SJ, et al.: Effect of ilioinguinal nerve block on the catecholamine plasma levels in orchidopexy: comparison with caudal epidural block. Paediatr Anaesth. 2002; 12:791-797. 10.
5. Solak M, Ulusoy H, Sarihan H: Effects of caudal block on cortisol and prolactin responses to postoperative pain in children. Eur J Pediatr Surg. 2000, 10:219-223.
6. Koray E, Barı¸s A, Gülay O, Ömer Y, Gökhan T, ˙Idil T, et al. The role of ultrasound guidance in pediatric caudal block. Saudi Med J. 2016; 37(2):147–50.
7. Adler AC, Schwartz DA, Begley A, Friderici J, Connelly NR. Heart rate response to a caudal block in children anesthetized with sevoflurane after ultrasound confirmation of placement. Paediatr Anaesth. 2015; 25(12):1274–9.
8. Tobias JD. Caudal epidural block: a review of test dosing and recognition of systemic injection in children. Anesth Analg. 2001; 93(5):1156–61.
9. Ahiskalioglu A, Yayik AM, Ahiskalioglu EO, Ekinci M, Gölboyu BE, Celik EC. Ultrasound-guided versus conventional injection for caudal block in children: A prospective randomized clinical study. J Clin Anesth. 2018; 44:91–6.
10. Chen CP, Tang SF, Hsu TC, Tsai WC, Liu HP, Chen MJ. Ultrasound guidance in caudal epidural needle placement. Anesthesiology. 2004; 101(1):181–4.
11. Singh Mahima, Bamba Charu comparison of caudal epidural block using ultrasound guid-

ance versus the conventional technique in adult patients global Journal for Research Analysis. 2019; 8: 9-11.
12. Kil HK. Caudal and epidural blocks in infants and small children: historical perspective and ultrasound-guided approaches. Korean J Anesthesiol. 2018; 71(6):430–9.
13. Tsui BC, Tarkkila P, Gupta S, Kearney R: Confirmation of caudal needle placement using nerve stimulation. Anesthesiology. 1999, 91:374-378.
14. Roberts SA, Guruswamy V, Galvez I: Caudal injectate can be reliably imaged using portable ultrasound-a preliminary study. Paediatr Anaesth. 2005, 15:948-952.
15. Talwar V, Tyagi R, Mullick P, Gogia AR: Comparison of 'whoosh' and modified 'swoosh' test for identification of the caudal epidural space in children. Paediatr Anaesth. 2006, 16:134-139.
16. Wang LZ, Hu XX, Zhang YF, Chang XY: A randomized comparison of caudal block by sacral hiatus injection under ultrasound guidance with traditional sacral canal injection in children. Paediatr Anaesth. 2013, 23:395-400.
17. Tobias JD: Caudal epidural block: a review of test dosing and recognition of systemic injection in children. Anesth Analg. 2001; 93:1156-1161
18. Gregori T, Viscasillas J, Benigni L. Ultrasonographic anatomy of the sacrococcygeal region and ultrasound-guided epidural injection at the sacrococcygeal space in dogs. Vet Rec. 2014; 175(3):68.
19. Nikooseresht M, Hashemi M, Mohajerani SA, Shahandeh F, Agah M. Ultrasound as a screening tool for performing caudal epidural injections. Iran J Radiol. 2014; 11(2):e13262.
20. Karaca O, Pinar HU, Gokmen Z, Dogan R. Ultrasound-Guided versus Conventional Caudal Block in Children: A Prospective Randomized Study. Eur J Pediatr Surg. 2019; 29(6): 533–8.
21. Kollipara N, Kodali VRK, Parameswari A. A randomized double-blinded controlled trial comparing ultrasound-guided versus conventional injection for caudal block in children undergoing infraumbilical surgeries. J Anaesthesiol Clin Pharmacol. 2021; 37(2):249– 54.
22. Nanjundaswamy NH, Nagappa S, Shridhara RB, Kalappa S. A comparative study of ultrasound-guided caudal block versus anatomical landmark-based caudal block in pediatric surgical cases. Indian Anaesth Forum. 2020; 21:10–5.
23. Wang LZ, Hu XX, Zhang YF, Chang XY. A randomized comparison of caudal block by sacral hiatus injection under ultrasound guidance with traditional sacral canal injection inchildren. Paediatr Anaesth. 2013; 23(5):395-400.