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Use of Ultrasound in Pediatric Caudal Anesthesia: A Randomized Comparative Study

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Abstract

Objective: The aim of this comparative study was to evaluate the efficacy and safety of ultrasound-guided caudal anesthesia compared to blind caudal anesthesia for subumbilical surgery in pediatric patients.

Methods: This prospective study included pediatric patients undergoing subumbilical surgery in the Department of Pediatric Surgery. Patients were divided into two groups: the ultrasound-guided caudal anesthesia group and the blind caudal anesthesia group. Primary outcomes assessed included the success rate of block placement, onset and duration of sensory and motor blockade, analgesic requirements, and perioperative complications.

Results: A total of 40 patients were included in the study, with 20 patients in the ultrasound-guided group and 20 patients in the blind group. The success rate of block placement was significantly higher in the ultrasound-guided group compared to the blind group ($p < 0.001$). The

ultrasound-guided group also demonstrated faster onset of sensory and motor blockade ($p < 0.05$) and longer duration of analgesia ($p < 0.05$) compared to the blind group. Postoperative analgesic requirements were significantly lower in the ultrasound-guided group ($p < 0.001$). No significant differences in perioperative complications were observed between the two groups.

Conclusion: Ultrasound-guided caudal anesthesia was found to be more effective and reliable than blind caudal anesthesia for subumbilical surgery in pediatric patients. It provided a higher success rate of block placement, faster onset and longer duration of sensory and motor blockade, reduced postoperative analgesic requirements, and comparable safety profile. Ultrasound guidance should be considered as the preferred technique for caudal anesthesia in this patient population.

Keywords: Ultrasound-Guided Caudal Anesthesia, Blind Caudal Anesthesia, Subumbilical Surgery, Pediatric Patients, Efficacy, Safety

Introduction

Caudal anesthesia is a widely employed technique in pediatric anesthesia; however, the full evaluation of its use in conjunction with ultrasound remains limited^[1-3]. The primary objective of this study is to assess the impact of ultrasound guidance on various aspects of caudal anesthesia, including postoperative pain, incidence of complications, hemodynamic stability, and needle visualization^[4-6].

By incorporating ultrasound into the caudal anesthesia procedure, it is hypothesized that there will be improved visualization and confirmation of the needle's correct placement within the sacral canal, resulting in a reduction in incidents and enhanced patient safety^[4-6]. Additionally, the real-time visualization provided by ultrasound can facilitate accurate assessment of the sacral region's anatomy prior to needle puncture, potentially minimizing the risk of complications^[4-6].

Furthermore, the use of ultrasound guidance may contribute to better postoperative pain management by ensuring the precise delivery of the local anesthetic solution to the target area, leading to reduced pain intensity and improved patient satisfaction^[4-6]. Hemodynamic stability is another crucial aspect to be evaluated, as the incidence of intraoperative tachycardia and other hemodynamic disturbances can provide insights into the effectiveness of the anesthesia^[4-6].

This study aims to contribute to the existing literature by providing a comprehensive assessment of the use of ultrasound in caudal anesthesia. By evaluating multiple outcome measures and incorporating a larger sample size, the findings of this study can potentially enhance our understanding of the role of ultrasound in optimizing the safety and efficacy of caudal anesthesia in pediatric patients^[4-6].

Materials and Methods

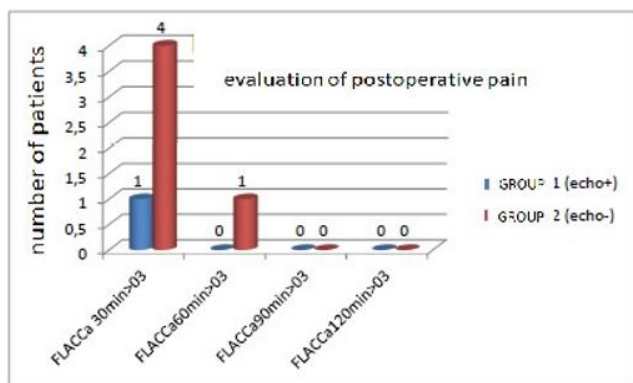
This randomized comparative study involved forty children meeting the inclusion criteria of being ASA I or II level children scheduled for umbilical surgery and weighing less than 20 kg. Exclusion criteria included coagulation disorders, site infections, and spina bifida. After general anesthesia or sedation, caudal anesthesia was performed using a mixture of 0.25% bupivacaine and 0.1% lidocaine. The participants were divided into two groups: Group 1 (echo+) underwent caudal anesthesia performed under ultrasound guidance using a 7 MHz linear probe, while Group 2 (echo-) underwent blind caudal anesthesia. The evaluation included postoperative pain assessed using the FLACC scale at 30 minutes, 60 minutes, 90 minutes, and 120 minutes. Incidents, intraoperative hemodynamic stability, and needle visualization were assessed for the echo+ group. Intraoperative monitoring included non-invasive blood pressure measurement, ECG, oxygen saturation, and capnography. Statistical analysis was performed using Epi Info 6 software.

Results

The study population consisted of a male-to-female ratio of 7:3. Postoperative pain was assessed at different time intervals. At 30 minutes, the echo- group had four cases of pain (score > 3), while the echo+ group had only one case. At 60 minutes, no cases of pain were observed in the echo+ group, while one case was present in the echo- group. At 90 minutes, the echo+ group had no cases of pain (FLACC score = 0), while three patients had FLACC scores between 1 and 3. At 120 minutes, no cases of pain (FLACC score = 0) were observed in both groups. Two incidents occurred during the block procedure in the echo- group, while no incidents were observed in the echo+ group. One case of hemodynamic instability in the form of tachycardia was observed in the echo- group. In the echo+ group, the needle was not visualized in two cases.

Pain progression table

	echo+	echo-
FLACC>03 à 30min	01	04
FLACC>03 à 60min	00	01
FLACC>03 à 90min	00	00
FLACC>03 à 120min	00	00
Les incidents	00	02
Stabilité HDM peropératoire	00	00



Discussion

The higher incidence of postoperative pain in the echo- group may be attributed to factors such as incomplete or inadequate block due to the inability to visualize the correct

needle position in the sacral canal [1-3]. This lack of visualization can lead to uncertainty regarding the complete dose of the anesthetic solution injected. Incidents during the caudal block procedure were observed in the echo- group, highlighting the potential risks associated with blind needle placement [4-6]. In contrast, the use of ultrasound in the echo+ group allowed for initial assessment of the sacral region's anatomy, reducing the risk of complications [4-6].

The occurrence of intraoperative tachycardia in the echo- group suggests inadequate analgesia, which was resolved by administering morphine [7-9]. This finding underscores the importance of accurate needle placement and effective anesthesia delivery for optimal pain control. Non-visualization of the needle in the echo+ group may be attributed to factors such as lack of experience with ultrasound-guided techniques and poor echogenicity of the sacral structure due to increased ossification [10-12].

By providing real-time visualization, ultrasound guidance can help ensure precise needle placement, thereby improving the success rate of the block and reducing the incidence of complications. It also allows for a more accurate assessment of the spread of the local anesthetic, contributing to improved pain management outcomes. Further studies and training in ultrasound-guided caudal anesthesia techniques are warranted to enhance proficiency and optimize patient outcomes [11-12].

Conclusion

Furthermore, the use of ultrasound guidance in caudal anesthesia can enhance patient safety by minimizing the risk of accidental intravascular injection or injury to adjacent structures. It provides real-time visualization of important anatomical landmarks, aiding in accurate needle placement and reducing the likelihood of complications.

In addition to improving procedural accuracy, ultrasound guidance may also contribute to better postoperative outcomes. By ensuring proper delivery of the local anesthetic solution to the target area, ultrasound can enhance the effectiveness and duration of pain relief, leading to reduced postoperative pain scores and improved patient satisfaction [13-15].

Moreover, the ability to visualize the spread of local anesthetic within the sacral canal using ultrasound can help clinicians assess the adequacy of the block and make adjustments as necessary, potentially minimizing the need for supplemental analgesics and improving overall pain management.

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