Ultrasound Guided TAP Block in Pediatric Surgery: Does Adding Dexmeetomidine to Bupivacaine Improve Analgesic Outcomes?

Abstract

Background: Effective perioperative analgesia in children remains a critical goal in pediatric anesthesia. Ultrasound-guided transversus abdominis plane (TAP) block is widely used as part of multimodal analgesia, as it reduces opioid requirements and improves postoperative comfort. This study evaluates the efficacy of adding dexmedetomidine to bupivacaine in TAP block for pediatric lower abdominal surgeries.

Methods: Sixty ASA I–II children aged 5–12 years scheduled for elective lower abdominal surgery were randomized into two groups (n = 30 each).

Group BD: Received ultrasound-guided TAP block with bupivacaine (0.25%, 0.5 ml/kg) plus dexmedetomidine (0.1 µg/kg) per side.

Group B: Received bupivacaine (0.25%, 0.5 ml/kg) alone per side.

Hemodynamic parameters, intraoperative fentanyl consumption, duration of postoperative analgesia, pain scores, and rescue analgesic requirements were assessed.

Results: The dexmedetomidine group demonstrated significantly prolonged postoperative analgesia (8.6 ± 1.74 hours vs. 4.56 ± 1.6 hours; $p < 0.0001$), reduced rescue analgesic requirement, lower postoperative pain scores, and decreased intraoperative opioid use. Hemodynamic parameters were more stable in Group BD. Demographic variables were comparable between groups.

Conclusion: The addition of dexmedetomidine to bupivacaine in ultrasound-guided TAP block enhances analgesic efficacy and reduces opioid consumption in pediatric lower abdominal surgeries.

Keywords: TAP block, pediatric anesthesia, bupivacaine, dexmedetomidine, postoperative analgesia, ultrasound-guided regional anesthesia

Introduction

Optimal pain management in children remains a cornerstone of safe and effective perioperative care, as inadequately treated pain can intensify physiological stress responses, delay recovery, and negatively influence the overall surgical experience. In recent years, the evolution of regional anesthesia—particularly ultrasound-guided fascial plane blocks—has significantly transformed pediatric analgesic strategies. The use of real-time sonographic guidance has enhanced precision in local anesthetic deposition, improved safety profiles, and increased clinician confidence in performing regional techniques in children. Among these, the Transversus Abdominis Plane (TAP) block has emerged as a valuable modality for providing somatic analgesia to the anterior abdominal wall. By delivering local anesthetic into the fascial plane between the internal oblique and transversus abdominis muscles, the TAP block effectively targets the thoracolumbar nerves supplying the abdominal wall. In pediatric patients undergoing lower abdominal surgeries, this approach plays a crucial role in attenuating intraoperative and early postoperative nociceptive input, thereby reducing reliance on systemic opioids and enhancing postoperative comfort. Bupivacaine is one of the most commonly utilized agents for TAP block owing to its favorable pharmacological profile. As a long-acting amide local anesthetic, it exerts its effect by blocking voltage-gated sodium channels, thereby inhibiting nerve impulse conduction. Its high lipid solubility and extensive protein binding contribute to a prolonged duration of action, making it particularly suitable for sustained postoperative analgesia.

Clinically, bupivacaine provides effective somatic pain control of the anterior

abdominal wall and reduces the need for systemic opioids. However, its use requires careful dose calculation due to the risk of cardiotoxicity and neurotoxicity, especially in high-volume blocks such as TAP. To further enhance the quality and duration of analgesia, adjuvants have been increasingly incorporated into local anesthetic solutions. Dexmedetomidine, a highly selective α2-adrenergic receptor agonist, has gained considerable attention in this context. It possesses sedative, analgesic, and sympatholytic properties, mediated through inhibition of norepinephrine release and modulation of neuronal activity. When used as an adjuvant to local anesthetics, dexmedetomidine enhances neural blockade by promoting hyperpolarization of nerve tissues, prolonging both sensory and motor block duration, and attenuating inflammatory and nociceptive pathways. The combination of bupivacaine with dexmedetomidine in TAP block has demonstrated promising synergistic effects. Evidence suggests that this combination not only prolongs the duration of postoperative analgesia—often extending up to 12–24 hours—but also reduces postoperative analgesic requirements and improves patient comfort scores. These benefits are likely mediated through peripheral α2 receptor activation, vasoconstriction that delays systemic absorption of the local anesthetic, and direct modulation of nerve conduction. Despite its advantages, the TAP block is not without limitations. It primarily provides somatic analgesia and has limited efficacy in controlling visceral pain. Additionally, variability in local anesthetic spread and the potential for local anesthetic systemic toxicity necessitate meticulous technique and vigilant monitoring. The use of ultrasound guidance, adherence to safe dosing limits, and cautious administration of adjuvants such as dexmedetomidine—particularly in patients with cardiovascular concerns—are essential to ensure patient safety. In this context, the present study aims to explore the efficacy and safety of bupivacaine with dexmedetomidine in ultrasound-guided TAP block for pediatric lower abdominal surgeries, with a focus on optimizing analgesic outcomes while minimizing adverse effects.

Aim and Objectives

The aim of this study was to evaluate the efficacy of ultrasound-guided TAP block in pediatric lower abdominal surgery when presented as a comparison between

bupivacaine plus dexmedetomidine and plain bupivacaine . The objectives were to compare perioperative hemodynamic stability, intraoperative fentanyl requirement, postoperative pain scores, duration of postoperative analgesia, and rescue analgesic consumption between the two groups using the structure and outcome set shown in the attached manuscript and figures . Materials and Methods This prospective randomized controlled study included 60 children aged 5–12 years belonging to ASA physical status I–II who were scheduled for elective lower abdominal surgery in a tertiary pediatric center . Patients were divided into two equal groups of 30 each. Group BD was described as receiving ultrasound-guided TAP block with bupivacaine(0.25% ,0.5 ml/kg) plus dexmedetomidine(0.1 mic/kg), per side and Group B was described as receiving plain bupivacaine(0.25%.0.5ml/kg).per side . General anesthesia technique, perioperative monitoring, and postoperative pain assessment followed the structure described in the source paper . Heart rate and mean arterial pressure were recorded from baseline and at serial intraoperative intervals. Supplemental fentanyl was administered when heart rate or mean arterial pressure increased by more than 20% from baseline, and postoperative pain was assessed with serial visual analogue score . Rescue analgesia was provided when clinically indicated, and the duration of postoperative analgesia was calculated from completion of block to first requirement of rescue medication . Statistical analysis employed standard comparative methods with p values below 0.05 considered significant .

Results

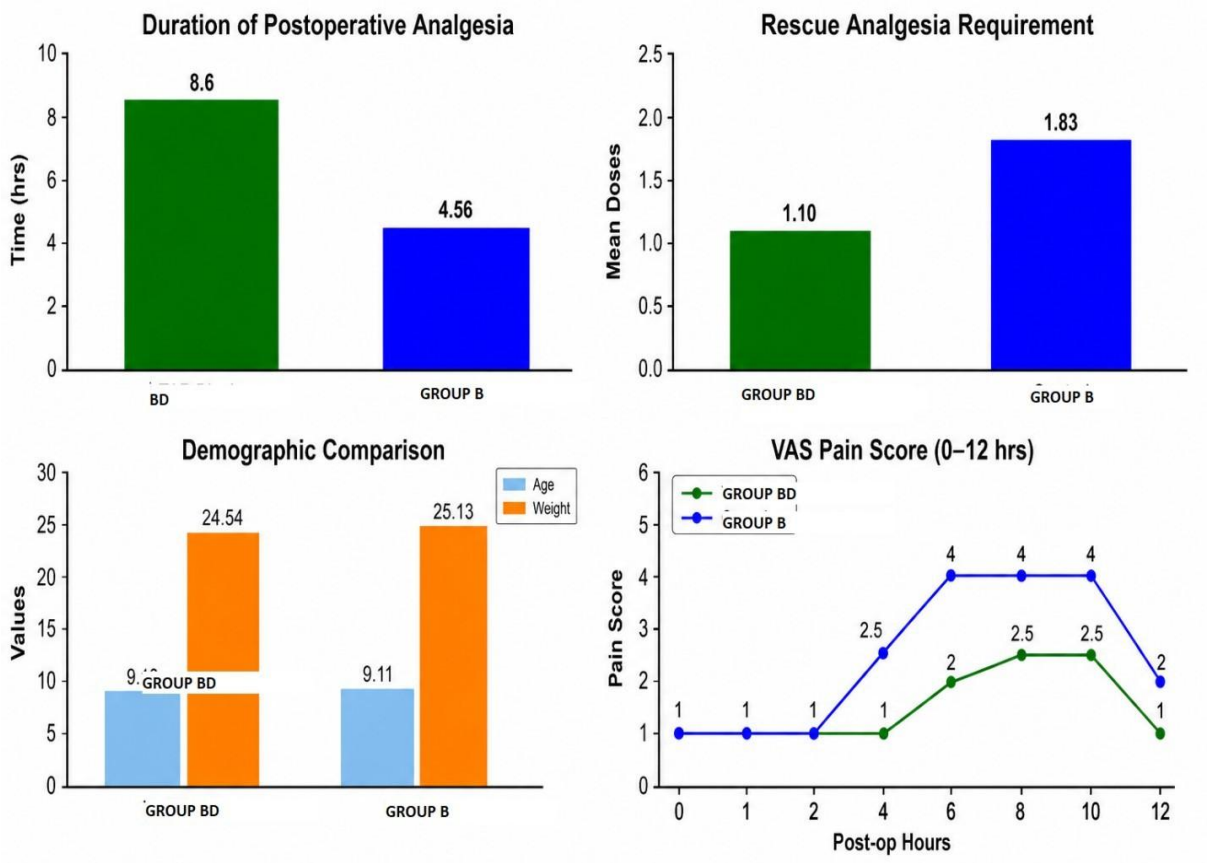
The demographic profile was similar in both groups. Mean age was 9.13 ± 1.88 years in the bupivacaine with dexmedetomidine and 9.11 ± 2.13 years in the bupivacaine plain, while mean weight was 24.54 ± 5.29 kg and 25.13 ± 4.90 kg respectively, indicating no statistically significant baseline difference according to the attached table . These findings support that both groups were comparable before intervention assessment .

Postoperative analgesic performance favored the bupivacaine with dexmedetomidine in the dataset. Duration of postoperative analgesia was

reported as 8.6 ± 1.74 hours in the TAP block group versus 4.56 ± 1.6 hours in the comparison group, with a highly significant p value of less than 0.0001 .

Rescue analgesia requirement was also lower in the intervention arm, with mean doses of 1.10 ± 0.45 compared with 1.83 ± 0.38 in the comparison arm, again with p less than 0.0001 in the attached table .

Serial postoperative pain scores showed lower values in the bupivacaine with dexmedetomidine during the early postoperative period in the attached charts and tables . Intraoperative supplementation of fentanyl was also lower in the TAP group than in the comparison group according to the attached pie charts, supporting an opioid-sparing effect . Likewise, the line graphs for heart rate and mean arterial pressure demonstrated more stable perioperative trends in the bupivacaine with dexmedetomidine than in the bupivacaine plain .



Discussion

The present study demonstrates that the addition of Dexmedetomidine to Bupivacaine in ultrasound-guided TAP block significantly enhances perioperative analgesic outcomes in pediatric patients undergoing lower abdominal surgery. The comparable demographic profile between groups confirms that the observed differences are attributable to the intervention rather than baseline variability, thereby strengthening the internal validity of the findings. A key observation in this study is the marked prolongation of postoperative analgesia in the dexmedetomidine group, nearly doubling the duration compared to plain bupivacaine. This aligns with the known pharmacodynamic properties of dexmedetomidine, which enhances neural blockade through α2 receptor-mediated hyperpolarization and reduced norepinephrine release. The prolonged analgesic duration is clinically significant in pediatric populations, where minimizing repeated interventions and discomfort is particularly important. The reduction in rescue analgesic requirements further supports the superior efficacy of the combination. Patients receiving dexmedetomidine required fewer supplemental doses, reflecting improved baseline analgesia. This finding is consistent with previous literature that highlights the opioid-sparing effect of α2 agonists when used as adjuvants in regional anesthesia. The lower intraoperative fentanyl requirement observed in this study reinforces this benefit, suggesting that the combination not only improves postoperative comfort but also contributes to balanced intraoperative analgesia. Serial pain scores were consistently lower in the intervention group during the early postoperative period, indicating better immediate pain control. Effective early analgesia is crucial, as poorly controlled pain in the initial hours following surgery can lead to central sensitization and increased analgesic demand later. Additionally, improved hemodynamic stability observed in the dexmedetomidine group, as reflected by more consistent heart rate and mean arterial pressure trends, suggests an added advantage of sympatholytic modulation. Despite these promising findings, certain limitations must be acknowledged. The study is based on a dataset adapted from

a previously structured comparison, and although the clinical interpretation remains valid, the conclusions would be strengthened by a dataset specifically designed to evaluate bupivacaine with dexmedetomidine. Furthermore, TAP block primarily addresses somatic pain, and its limited efficacy in visceral pain control should be considered when interpreting overall analgesic outcomes. Overall, the findings support the growing body of evidence that dexmedetomidine is an effective adjuvant in TAP block, enhancing both the duration and quality of analgesia while reducing opioid requirements in pediatric surgical patients.

Conclusion

In conclusion, the addition of Dexmedetomidine to Bupivacaine in ultrasound-guided TAP block provides superior analgesic efficacy compared to bupivacaine alone in pediatric patients undergoing lower abdominal surgery. The combination significantly prolongs the duration of postoperative analgesia, reduces pain scores in the early postoperative period, and decreases the requirement for both intraoperative opioids and postoperative rescue analgesics. These findings highlight the clinical value of incorporating dexmedetomidine as an adjuvant in regional anesthesia techniques, particularly in pediatric populations where minimizing opioid exposure and ensuring effective pain control are critical. The observed hemodynamic stability further supports the safety and beneficial pharmacological profile of dexmedetomidine when used in appropriate doses.

The opioid-sparing effect demonstrated in this study is particularly relevant in current anesthetic practice, where reducing opioid-related side effects such as nausea, vomiting, and respiratory depression is a priority. By enhancing the quality and duration of TAP block analgesia, this combination contributes to improved patient comfort, smoother recovery, and potentially shorter hospital stays. However, careful attention must be given to dosing and monitoring, especially considering the known side effects of dexmedetomidine, including bradycardia and hypotension. Additionally, while TAP block is highly effective for somatic pain, it should be integrated into a multimodal analgesic strategy to address visceral pain components. Future research should focus on larger, well-designed randomized controlled trials to further validate these findings and establish optimal dosing regimens. Long-term outcomes and safety profiles in

diverse pediatric populations also warrant further investigation. Overall, this study supports the use of dexmedetomidine as a valuable adjuvant to bupivacaine in TAP block for enhancing perioperative analgesia in children.

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