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Original contribution

Dexmedetomidine decreases the required amount of bupivacaine for ultrasound-guided transversus abdominis plane block in pediatrics patients: a randomized study☆,☆☆,★

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ABSTRACT

Background: The effect of dexmedetomidine on the potency of bupivacaine for transversus abdominis plane (TAP) block in pediatric patients has not been investigated.
Study objective: The primary objective of this study was to assess the effectiveness of dexmedetomidine to decrease the concentration of bupivacaine needed for analgesia for ultrasound-guided TAP block in a pediatric patient undergoing hernia repair or hydrocelectomy.
Design: This is a randomized, double-blind, up-down, dose-finding study.
Setting: Operating room.
Patients: Sixty American Society of Anesthesiologists I and II patients aged 1-4 years scheduled for elective unilateral herniorrhaphy or hydrocelectomy.
Interventions: Patients were randomly assigned to 1 of the 2 groups: group B (0.125% bupivacaine, 1 mL/kg) TAP block or group BD (0.125% bupivacaine plus 2 μg/kg dexmedetomidine, 1 mL/kg) TAP block.
Measurements: The response of each child was observed for 60 seconds after skin incision and evaluated as 'unsuccessful' when skin incision caused a change in hemodynamic parameters (heart rate and mean blood pressure) 20% more than the preincision values. If the response was determined to be unsuccessful, the concentration of bupivacaine administrated to the next patient was increased by 0.02%. If it was successful, the concentration of bupivacaine administrated to the next patient was decreased by 0.02%.
Results: The minimum local anesthetic concentration of bupivacaine was 0.0839% (0.0137) in the B group and 0.0550% (0.0169) in the BD group. The difference was statistically significant ($t = 7.165$, $P = .0001$). The total postoperative analgesic dosage of morphine was significantly higher in the B group (0.17 ± 0.04 mg/kg) than the BD group (0.11 ± 0.02 mg/kg, $P = .001$).
Conclusions: The addition of 2 μg/kg of dexmedetomidine reduced the minimum local anesthetic concentration of bupivacaine used for a TAP block and improved postoperative analgesia in children undergoing surgery for inguinal hernia repair or hydrocelectomy.

1. Introduction

Optimal postoperative pain control is of utmost importance in the surgical population [1,2]. Analgesic techniques in pediatric patients having surgery are often delayed by the inherent difficulties of conducting a large randomized clinical trial in those patients [3,4]. The optimal dose of local anesthetics in pediatric regional anesthetic techniques remains unknown [5,6].

Transversus abdominis plane (TAP) block aims to supply analgesia to the anterior abdominal wall in which 3 muscle layers are identified lateral to the rectus abdominis: the external oblique, internal oblique, and the transversus abdominis [7,8]. The TAP plane, which lies between the internal oblique and transversus abdominis muscles, encases the thoracolumbar nerve roots (T8–L1), which deliver sensory innervation to the skin and muscles of the anterior abdominal wall [9,10]. Although the TAP block has improved analgesic outcomes after surgery in adults, its benefits in children are still not determined. A wide range of dosing selection of local anesthetics in TAP block is currently seen in clinical practice [11-13].

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Dexmedetomidine is a highly selective α2-adrenoreceptor agonist recently introduced to anesthesia. It produces a dose-dependent sedation, anxiolysis, and analgesia without respiratory depression [14,15]. α2-Agonists are known to afford hemodynamic stability during the intraoperative period because of their sympatholytic properties. Dexmedetomidine can prolong the duration of local anesthetics [14,16]. The effect of dexmedetomidine on the potency of bupivacaine for TAP block in pediatric patients has not been investigated.

In the present study, we conducted a prospective, randomized, double-blind clinical trial to assess the effect of dexmedetomidine to decrease the required concentration of bupivacaine analgesic dose for ultrasound-guided TAP block in pediatric patients undergoing hernia repair or hydrocelectomy.

2. Methods

2.1. Patients and study design

This randomized, double-blind, up-down, dose-finding study was carried out in Alexandria main university hospital between March 2015 and July 2015 on 60 American Society of Anesthesiologists I and II patients aged between 1 and 4 years and weighing between 9 and 22 kg scheduled for elective unilateral herniorrhaphy or unilateral hydrocelectomy. Approval for the study was received by the Ethics Committee, Faculty of Medicine, Alexandria University. The study was registered at the Pan African Clinical Trials Registry identifier PACTR201502001009132. Informed consent was obtained from parents or legal guardians of all participating patients. Patients were excluded if they had a history of allergy to amide local anesthetics or neuromuscular, neurological, psychiatric, or blood-clotting disorders.

Patients were randomly assigned using a table of random numbers and sealed envelope assignment to 1e of 2 groups: group B (bupivacaine, 1 mL/kg) TAP block or group BD (bupivacaine plus 2 μg/kg dexmedetomidine, 1 mL/kg) TAP block. The preparation of the study drugs was carried out by an anesthetist not involved with the case, and the drugs looked identical for both groups.

2.2. Surgical procedure and clinical observations

All children enrolled in the study received a standardized anesthetic regimen. All the children fasted for 6 hours before surgery but not premeditated. Upon arrival in the operating room, in each of the patients, O_2 saturation, heart rate, electrocardiogram, and noninvasive arterial blood pressure were monitored. Anesthesia was induced with sevoflurane and oxygen via face mask if the patient did not have an intravenous catheter before being taken to the operating room. Then a 22-gage intravenous cannula was placed in the upper limbs after the loss of the eyelash reflex. Propofol was given at a single dose of 2 mg/kg to facilitate insertion of an appropriate-sized laryngeal mask airway. Anesthesia was maintained with 1 minimum alveolar concentration of sevoflurane and oxygen. Ultrasound-guided unilateral TAP block was performed by a single anesthetist according to the method described by Suresh et al [17]. Skin incision was performed at least 15 minutes after injection of the TAP block. A single anesthetist blinded to group allocation was responsible for all the data collection. All surgeries were performed by the same surgeon.

The primary end point of the study is the minimum local anesthetic concentration (MLAC). For each patient, the target concentration of TAP block bupivacaine was determined using the modified Dixon's up-and-down method starting with 0.125% in each group, with 0.02% as a step size and the same total volume of 1 mL/kg. Increasing or decreasing the target concentration of TAP block was determined by the response of the previous child in the same group. The response of each child was observed for 60 seconds after the skin incision and was evaluated as "successful" or "unsuccessful." "Unsuccessful" was recorded when the skin incision caused a change in hemodynamic parameters (heart rate and mean blood pressure) 20% more than the preincision values. If the response was determined to be unsuccessful, the concentration of TAP block bupivacaine administered to the next patient was increased by 0.02%. If it was successful, the concentration of bupivacaine administered to the next patient was decreased by 0.02%. All responses were assessed in a blind fashion by an independent physician who was unaware of the test concentrations of bupivacaine dexmedetomidine or group assignments. When the skin incision response was determined to be unsuccessful, all surgical operations were stopped, and simultaneously, a rescue dose of 2 μg/kg of fentanyl was intravenously administrated to enhance analgesia. The secondary end points were pain scores measured by the *Face, Legs, Activity, Cry, Consolability scale* (FLACC) pain scores [18], postoperative sedation, time to analgesic requirement, and adverse events (eg, bleeding, hematoma, infection, bradycardia, hypotension, *respiratory depression* which was defined as Spo_2 lower than 90%, and postoperative nausea and vomiting [PONV]).

If the FLACC pain score was ≥4, a dose of morphine (0.05 mg/kg) was provided as rescue analgesia. The *duration of analgesia* was defined as the time between the TAP block and the first postoperative rescue analgesia. The sedation was assessed using an objective score based on eye opening (eyes open spontaneously = 0, eyes open in response to verbal stimulation = 1, and eyes open in response to physical stimulation = 2) [19].

Table 1
Demographic, experimental characteristics, and postoperative adverse effects

	Group				Test of sig.
	B		BD		
	(n = 30)		(n = 30)		
Age (y)	2	(1-4)	2	(1-4)	Mann-Whitney $z = 0.633$, $P = .527$
Weight (kg)	13	(10-20)	12	(9-22)	Mann-Whitney $z = 0.392$, $P = .695$
Duration of surgery (min)	25	(23-38)	27	(22-32)	Mann-Whitney $z = 1.721$, $P = .085$
Type of surgery					
Inguinal hernia	16	53.3%	18	60.0%	$\chi^2 = 0.271$, $P = .602$
Hydrocele	14	46.7%	12	40.0%	
PONV	1	3.3%	1	3.3%	–
Respiratory depression	0	.0%	0	.0%	–
Hypotension	1	3.3%	3	10.0%	Fisher's exact test $P = .612$
Bradycardia	1	3.3%	1	3.3%	–
Total morphine (mg/kg)					Mann-Whitney
Median (min-max)	0.15	(0.10-	0.10	(0.10-0.15)	$z = 4.61$, $P = .0001$
Mean ± SD	0.86 ± 0.18	0.25)	0.56 ± 0.21		
Bupivicaine (mg/kg)					Mann-Whitney
Median (min-max)	0.85		0.45		$z = 5.05$, $P = .0001$
Mean ± SD	0.17 ± 0.04	(0.65-1.25)	0.11 ± 0.02	(0.25-1.25)	

Median (min-max), mean ± SD.