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Original contribution

Dexmedetomidine and ketamine for sedation during spinal anesthesia in children

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Abstract

Study Objective: To evaluate the combination of dexmedetomidine and ketamine for sedation during lumbar puncture and sedation for spinal anesthesia in children.

Design: Retrospective analysis of quality assurance data sheets and anesthetic records.

Setting: Developing countries with the humanitarian group, Kids First.

Patients: 12 infants and children, ranging in age from two to 9 years.

Interventions: A bolus dose of ketamine (two mg/kg) and dexmedetomidine (one μg/kg) was given over three minutes followed by a continuous infusion of dexmedetomidine (two μg/kg/hr for the first 30 min, followed by one μg/kg/hr for the duration of the case). Supplemental analgesia/sedation was provided by ketamine (0.5 mg/kg) as needed.

Measurements: The need for supplemental ketamine, the ability to complete the procedure, and heart rate (HR), blood pressure, end-tidal carbon dioxide ($ETCO_2$), and oxygen saturation values were recorded.

Main Results: Effective sedation for lumbar puncture and performance of spinal anesthesia were achieved in all patients. One patient required a supplemental dose of ketamine (0.5 mg/kg). Following the bolus dose of ketamine and dexmedetomidine, HR increased by 11 ± 4 bpm. The greatest HR increase was 20 bpm. No patient had a HR increase ≥ 20% from baseline. The HR decrease was ≤ 30 bpm in 10 of the 12 patients, and the greatest HR decrease was 58 bpm. Systolic blood pressure (SBP) increased from baseline by 10 ± 3 mmHg after administration of the bolus dose of ketamine and dexmedetomidine. During the subsequent dexmedetomidine infusion, SBP decreased by 11 ± 9 mmHg. No patient's respiratory rate decreased to less than 10 breaths/min or increased above 24 breaths/min during the procedural sedation. The highest $ETCO_2$ was 45 ± 2 mmHg ($P < 0.0001$). Oxygen saturation remained ≥ 95% during the procedure in all patients.

Conclusion: A combination of ketamine and dexmedetomidine provides effective sedation during spinal anesthesia in infants and children, with limited effects on cardiovascular and ventilatory function.

1. Introduction

Advantages of spinal anesthesia in infants and children include a decreased risk of apnea in newborns and avoidance of general anesthesia in patients with co-morbid diseases

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[1,2]. Aside from these concerns, there has been recent concern over the potential effects of general anesthetic agents on neuronal apoptosis and eventual neurocognitive outcome in neonates and infants [3-5]. Spinal anesthesia provides a safe, effective, and inexpensive alternative to general anesthesia when working in areas with limited resources. Given their level of neurocognitive development, infants and children require sedation and analgesia during the performance of regional anesthetic techniques to ensure immobility. In addition to the need for sedation and analgesia during placement of the regional anesthetic technique, ongoing sedation may be required to alleviate anxiety and provide sedation during performance of the surgical procedure. The goals of the agent or combination of agents used for this purpose are to provide sedation and analgesia during block placement, as well as ensure patient immobility and hemodynamic stability.

Dexmedetomidine is a centrally acting α_2-adrenergic agonist that is effective in various clinical scenarios, providing sedation during mechanical ventilation, preventing emergence delirium following general anesthesia, providing procedural sedation during non-invasive radiologic procedures such as magnetic resonance imaging (MRI), and in controlling withdrawal following the prolonged use of opioids and benzodiazepines [6-16]. Dexmedetomidine may be ineffective as the sole agent for painful procedures [17-19], necessitating a second agent. We present our clinical experience with a combination of dexmedetomidine and ketamine for sedation during spinal anesthesia in children.

2. Materials and methods

2.1. Data collection

This retrospective review of patients' medical records was approved by the Institutional Review Board of the University of Missouri and by Kids First (Nashville, TN, USA), the sponsoring organization for the orthopedic surgical trips to developing countries. The protocol for sedation was standardized and data were collected prospectively as part of an ongoing quality assurance project. These patients were cared for during orthopedic surgical trips to Santo Domingo, Dominican Republic, and San Miguel, Mexico, for Kids First. The use of dexmedetomidine was approved by the Ministry of Health of the respective governments.

Demographic data included age, weight, gender, and underlying co-morbid medical conditions. To evaluate the efficacy of the sedation regimen, the need for supplemental doses of ketamine or changes in the dexmedetomidine infusion rate were noted. Hemodynamic effects were evaluated by noting heart rate (HR) and blood pressure [systolic (SBP) and diastolic (DPB)] changes at baseline, for each minute for the first 5 minutes following the start of the sedation, and at 5-minute intervals thereafter. Respiratory effects were evaluated by recording respiratory rate (RR) and end-tidal carbon dioxide ($ETCO_2$) at similar times as the hemodynamic variables. Data are presented as means ± SD.

2.2. Sedation protocol

Patients were fasted for 4 to 6 hours. Routine ASA monitors were placed. An intravenous (IV) cannula was placed either after application of topical anesthetic cream or following inhalation induction of sevoflurane in oxygen. After IV cannula placement, the sevoflurane was discontinued and the patient was allowed to breathe 100% oxygen for 5 minutes prior to administration of the dexmedetomidine and ketamine to ensure that the end-tidal sevoflurane concentration was $\leq$ 0.1%. A nasal cannula was placed, oxygen was delivered at two L/min, and $ETCO_2$ was monitored. The sedation regimen included a bolus of dexmedetomidine (one μg/kg) and ketamine (two mg/kg). These two medications were mixed in the same syringe and given over three minutes. Following the induction of sedation, the patient was turned to the lateral decubitus position. The area over the lumbar vertebrae was washed and 0.5% lidocaine was infiltrated over the L_3-L_4 interspace. A 22-gauge, 1.5-inch (3.75 cm) spinal needle with a stylet was inserted until free flow of cerebrospinal fluid was obtained. Isobaric bupivacaine was injected, the needle was removed, and the patient was turned supine. At this point, additional sedation was begun, with a dexmedetomidine infusion starting at two μg/kg/hr for the first 30 minutes followed by one μg/kg/hr until the end the procedure. Additional doses of ketamine (0.5 mg/kg) were given only if the sedation was inadequate. At the completion of the procedure, each patient was transported to the post-anesthesia care unit (PACU).

2.3. Statistical analysis

Hemodynamic and respiratory changes following administration of dexmedetomidine and ketamine were compared with baseline values using analysis of variance with Tukey's post-hoc test. The high and low values of the hemodynamic parameters following administration of the ketamine/dexmedetomidine bolus dose and during the subsequent dexmedetomidine infusion were compared with baseline values using a paired *t*-test. All data are presented as means ± SD.

3. Results

The retrospective case series included 12 pediatric patients, 7 boys and 5 girls, ranging in age from 2 to 9 years (5.0 ± 2.4 yrs) and weighing from 11 to 38 kg (24.3 ± 8.7 kg). Co-morbid diseases included arthrogryposis in two patients and cerebral palsy in one. The orthopedic procedures