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Combined spinal and caudal epidural anesthesia for ureteral reimplantation in pediatric patients: a case series

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ABSTRACT

Objective: To demonstrate the use of a combination of spinal and caudal epidural anesthesia instead of general for prolonged urologic procedures. The technique involves single shot spinal anesthesia (SA) followed by placement of a caudal epidural catheter for prolongation of surgical anesthesia when the effects of SA dissipate.

Methodology: We retrospectively report the successful use of the technique in six infants undergoing ureteral reimplantation with a surgical duration of 110 to 166 min (mean 129 min, median 126.5 min).

Results: Combined spinal and caudal epidural anesthesia was successful in all 6 infants. In one infant, SA provided surgical anesthesia for the duration of the case so the caudal epidural catheter was not dosed. Sedation was provided by dexmedetomidine with an initial bolus dose (0.6-1.5 µg/kg) in all 6 patients. Five of the 6 patients then received an infusion of dexmedetomidine (0.5-1.0 µg/kg/hour). Four of the 5 patients who received a dexmedetomidine infusion received one additional bolus dose (0.5-1 µg/kg) due to inadequate sedation, patient movement, or increased heart rate.

Conclusions: Combined spinal and caudal epidural anesthesia can be used as an alternative to general anesthesia for prolonged urologic procedures. The technique is described and previous reports of combined spinal and caudal epidural anesthesia in infants reviewed.

Key words: Regional anesthesia; Spinal anesthesia; Neurotoxicity; Ureteral reimplant

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INTRODUCTION

Spinal anesthesia (SA) instead of general anesthesia (GA) was used during the 1980's to avoid postoperative apnea following the use of halothane in high-risk, former preterm neonates.[1] With the introduction of sevoflurane into clinical practice, the risk of apnea was shown to be limited and interest in SA decreased.[2] More recently, there have been numerous reports in the literature regarding the potential long-term neurocognitive effects of GA during infancy and the neonatal period.[3,4] While there is insufficient prospective evidence to clearly prove a causal relationship, there has been a renewed interest in SA to avoid the need for GA during the potentially vulnerable time period. Despite its efficacy, even with the use of adjunctive agents, the duration of surgical anesthesia from currently available agents for SA is limited to a maximum of 80-90 min.[5,6] Given its

limited duration of action, single-shot SA is applicable only for surgical procedures that can be accomplished in less than this time frame. We retrospectively review our experience with a technique that combines SA with caudal epidural anesthesia for more prolonged surgical procedures. The technique is presented, its applications discussed, and previous reports from the literature regarding the combined use of spinal and epidural anesthesia in the pediatric population reviewed.

METHODOLOGY

The retrospective review and presentation of these cases was approved by the Institutional Review Board of Nationwide Children's Hospital (Columbus, Ohio). Patients were identified through a query for the electronic medical record database for patients that had received both spinal and caudal epidural anesthesia. The medical records were then reviewed for patient demographics (chronological and gestational age, weight, and associated comorbid conditions) and the surgical procedure. Anesthetic information included the medications used for spinal and caudal epidural anesthesia, duration of the procedures, and problems with placement of the neuraxial anesthetic techniques. Adverse effects related to neuraxial anesthesia including failure indicated by the need to convert to general anesthesia, hypotension, bradycardia or respiratory insufficiency were noted. The efficacy of the block was determined by noting the response to the surgical incision and the ability to complete the procedure without supplemental anesthetic agents. The intraoperative use of sedative agents, their dosing, and mode of administration (infusion or bolus) were recorded. The postoperative disposition was noted including the need for inpatient admission.

RESULTS

The study cohort included 6 infants in this study, ranging in age from 10 months to 2 years and in weight from 8.8 to 16.1 kg (Table 1). The primary surgical procedure included bilateral ureteral reimplantation in five and unilateral in one patient. The surgical duration varied from 110 to 166 min (mean 129 min, median 126.5 min). Combined spinal and caudal epidural anesthesia was successfully used in the surgical procedures for 5 infants, as one infant did not require dosing of the epidural catheter as the duration of the SA alone was long enough for the surgical procedure. The catheter was appropriately placed and secured, but the SA was adequate for the duration of the procedure.

The specifics of the technique for spinal anesthetic and caudal epidural anesthesia were similar for all cases. On the day of surgery, the patient was held *nil per os* (NPO) for 6 hours for solids and 2 hours for clear liquids. In cooperation with the surgeon, the use of combined SA and caudal epidural anesthesia was planned to avoid GA. After discussion with the parents and review of the anesthetic options, informed consent was obtained for SA. Preoperatively, a topical anesthetic cream (LMX cream, 4% topical lidocaine, Ferndale Laboratories, Ferndale, MI) was applied midline over the lumbar region of the back over the site of the planned lumbar puncture for SA. After transferring the patient to the operating room, applying standard American Society of Anesthesiologists' (ASA) monitors, and cleansing the lumbar area with chlorhexidine, SA was performed using aseptic technique while the patient was awake and positioned in the sitting position. A 22 gauge, 1.5-inch spinal needle with stylet was inserted at the L3-L4 interspace and advanced carefully until free flow of cerebrospinal fluid (CSF) was obtained. At that time, the local anesthetic solution (isobaric 0.5% bupivacaine) with epinephrine 1:200,000 and containing clonidine was injected (Table 2). Dosing for bupivacaine included 0.5-0.7 mg/kg with epinephrine 1:200,000 plus the addition of clonidine (1 μg/kg). The infant was then placed supine and the onset of motor and sensory blockade evaluated. A peripheral intravenous catheter was placed in the foot and intravenous fluids administered. As needed, supplemental sedation was provided by dexmedetomidine (bolus and infusion as indicated in Table 2). Dexmedetomidine dosing included an initial bolus dose of 0.6-1.5 μg/kg in all 6 patients. Five of the 6 patients then received an infusion of dexmedetomidine at 0.5-1.0 μg/kg/hour while one patient received only a single bolus of dexmedetomidine. In 4 of the 5 patients who received a dexmedetomidine infusion, one additional bolus of dexmedetomidine (0.5-1 μg/kg) was required due to inadequate sedation, patient movement, or increased heart rate. Following successful SA, the patient was placed in the left lateral decubitus position for caudal epidural placement. After sterile preparation, the caudal epidural space was accessed using a 5 cm, 20-gauge Crawford needle (Epimed, Johnstown, New York) and a 24-gauge caudal catheter was advanced 5-10 cm into the epidural space to allow anesthesia of the sacral and lower lumbar dermatomes as dictated by the surgical site. The needle was removed and the catheter secured. A test dose of lidocaine 1.5% with epinephrine 1:200,000 (1 ml) was administered followed by a bolus and then an infusion of chloroprocaine. The patient was placed supine and the surgical procedure was started under SA.

In one patient, the duration of the SA was long enough for completion of the surgical procedure so the caudal epidural catheter was not dosed. In 3 patients, the caudal epidural catheter was dosed

with a bolus of 3% chloroprocaine (1.3-1.5 mL/kg) followed by an infusion of 3% chloroprocaine at 1 or 1.5 mL/kg/h. In one patient, a continuous infusion of 3% chloroprocaine was started via the caudal epidural catheter at 1 mL/kg/h without a bolus and in the final patient, a bolus of 0.2% ropivacaine was administered via the caudal epidural catheter. In all patients the combination of SA with caudal epidural anesthesia

Table 1: Demographic data of the study cohort

Patient #	Gestational age (term or weeks)	Age at time of surgery	Weight (kg)	Gender	Co-morbid conditions	Surgical procedure	Surgical duration (min)	Intraoperative fluids (ml) and medications
1	Term	15 months	9.4	Female	VUR, GERD, recurrent UTIs	Bilateral ureteral reimplant	110	LR (250 ml); ceftriaxone (480 mg); acetaminophen (100 mg)
2	Term	2 years	16.3	Female	ETD, small kidney, ureterocele, UTI, VUR	Right ureteral reimplant, excision of right ureterocele	133	LR (350 ml); cefazolin (850 mg)
3	36 weeks	22 months	9.3	Female	VUR	Bilateral ureteral reimplant	166	LR (200 ml); ketorolac (4.5 mg)
4	Term	2 years	13.1	Female	Global developmental delay, hypotonia, short stature, ETD, VUR	Bilateral ureteral reimplant	136	LR (200 ml); ketorolac (6 mg);
5	Term	16 months	9.9	Male	Hydroureteronephrosis, acute URI with fever, VUR	Cystoscopy, bilateral reimplant with takedown left ureterostomy	110	LR (250 ml); cefazolin (500 mg)
6	Term	10 months	8.8	Female	TOF status post repair, VUR, recurrent pyelonephritis, history of difficult postoperative pain management	Bilateral ureteral reimplant	120	LR (250 ml); cefazolin (440 mg); ketorolac (4 mg)

VUR = vesicoureteral reflux; GERD = gastroesophageal reflux disease; UTI = urinary tract infection; LR = lactated ringers; ETD = Eustachian tube dysfunction; URI = upper respiratory infection; TOF = Tetralogy of Fallot

Table 2: Intraoperative data regarding medication dosing

Patient #	Agent for SA and dose (ml)	Clonidine used (yes or no) and dose (μg/kg)	Epinephrine used (yes or no)	Agent for caudal epidural and dose (bolus + infusion)	Agent for sedation (dose and infusion or bolus)
1	Bupivacaine (0.7 mg/kg)	Yes; 1	Yes	3% chloroprocaine (1.3 ml/kg → 1.5 ml/kg/hr)	Dexmedetomidine (1 μg/kg → 0.5-1 μg/kg/hr infusion); one additional bolus of 0.5 μg/kg.
2	Bupivacaine (0.5 mg/kg)	Yes; 1	Yes	3% chloroprocaine (1.5 ml/kg → 1.0 ml/kg/hr)	Dexmedetomidine (1 μg/kg → 0.5-1 μg/kg/hr infusion); one additional bolus of 0.5 μg/kg.
3	Bupivacaine (0.7 mg/kg)	Yes; 1	Yes	3% chloroprocaine (1.3 ml/kg → 1.0 ml/kg/hr)	Dexmedetomidine (1.2 μg/kg → 1 μg/kg/hr infusion; one additional bolus of 0.5 μg/kg.
4	Bupivacaine (0.5 mg/kg)	Yes; 1	Yes	None	Dexmedetomidine (0.6 μg/kg bolus → 0.5-1 μg/kg/hr infusion.
5	Bupivacaine (0.6 mg/kg)	Yes; 1	Yes	3% chloroprocaine (1.5 ml/kg → 1 ml/kg/hr)	Dexmedetomidine (1.5 μg/kg bolus → 1 μg/kg/hr infusion); one additional bolus of 1 μg/kg.
6	Bupivacaine (0.7 mg/kg)	Yes; 1	Yes	0.2% ropivacaine (0.7 ml/kg) + chloroprocaine (300 mg)	Dexmedetomidine (1.5 μg/kg bolus)

SA = spinal anesthesia

provided effective surgical anesthesia without the need for supplemental intravenous/inhalational anesthetic agents or opioids. Intraoperative fluids and additional medications administered are outlined in Table 2. The postoperative disposition was favorable and the post-anesthesia care unit (PACU) stay was uncomplicated in all 6 infants. Five infants were discharged to home the day following surgery, while one infant was discharged to home on postoperative day 3 due to concerns regarding a postoperative fever.

DISCUSSION

Our institution has developed a SA program to offer an alternative to GA for appropriate cases in light of caregiver and parental concerns related to the potential long-term neurocognitive effects of general anesthetic agents.[7] While initially restricted to surgical procedures lasting less than 90 min, it has become apparent that there may be applications of regional anesthetic techniques suitable for more prolonged surgical procedures. While most studies approximate the duration of SA to 60 min, others have reported successful use of SA in procedures lasting up to 90 min with prolongation of the duration of SA by the addition of adjunctive agents such as dexmedetomidine, clonidine, and epinephrine.[8-11]

However, even with adjunctive agents, a single shot SA may not provide a duration long enough for more involved surgical procedures. As such, we used SA followed by caudal epidural anesthesia to provide more prolonged surgical anesthesia.[12-14] This combined technique can be used to circumvent the temporal limitations of SA alone, offering a viable alternative to GA for longer procedures, which may be particularly relevant given the ongoing concerns of the potential long-term neurocognitive effects of GA. In our combined SA and epidural anesthesia technique, SA is administered to the awake patient and once an adequate effect is achieved, the anesthesia from SA is used to allow the painless placement of the caudal epidural catheter. Once the effects of the SA begin to dissipate, generally after 60-90 min, the caudal epidural catheter is dosed. We generally use chloroprocaine for caudal epidural anesthesia as its rapid metabolism allows the use of sufficient volume (bolus and infusion) to provide effective surgical anesthesia over the required dermatomes.[15,16]

While the neuraxial technique provides surgical anesthesia, given the duration of the procedure and the cognitive level of the patients involved, supplemental sedation is generally required. In all 6 of our patients, sedation with dexmedetomidine was provided. One patient received a single bolus dose while the other 5 received a bolus followed by an infusion. Additional boluses were required based on the patient's clinical status or to treat agitation and tachycardia. We have adopted dexmedetomidine for this patient population and clinical scenario, given its limited effects on respiratory function, maintaining ventilation and airway patency in the presence of sedation.[17,18] Additionally, unlike other inhalational and intravenous anesthetic agents, dexmedetomidine has been shown to have limited apoptotic effects and may protect against apoptosis when co-administered with other agents.[19] Despite these effects, adverse hemodynamic have been reported with its use, stressing the need for appropriate monitoring (standard ASA monitoring) and clinical observation. In addition to avoiding potential neurotoxicity, regional anesthesia may provide other advantages over GA including intraoperative hemodynamic stability (decreased hypotension and bradycardia), more effective blunting of the surgical stress response, lack of a need for airway management or supplemental oxygen, and limited need for parenteral opioids.[20] Our clinical experience would support this, as we noted no clinically significant changes in heart rate or blood pressured related to neuraxial anesthesia in our patients.

CONCLUSION

In summary, while SA has typically been limited to procedures lasting less than 70-75 min, this report presents an effective technique combining spinal and caudal epidural anesthesia for prolonged urologic procedures lasting on average more than 120 min. Combining methods of regional anesthesia can provide the surgical team with an extended window of time to perform complex surgical procedures such as bilateral ureteral reimplantation. Furthermore, the surgical anesthesia provided by the initial SA provides effective anesthesia for placement of the caudal epidural catheter without the need for additional agents. Given the prolonged duration of the procedure, supplemental sedation is generally required during the procedure given limited ability of infants and children to remain quiet for a lengthy surgical procedure. Key to the success of this regional instead of general anesthesia program has been the cooperation of a well-trained, multidisciplinary team of surgeons, pediatric anesthesiologists, and nurses.

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Conflicts of Interest: None

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