BJA

British Journal of Anaesthesia, 0 (0): 1–7 (2017)

doi: 10.1093/bja/aex078
Paediatrics

PAEDIATRICS

Effect of caudal block using different volumes of local anaesthetic on optic nerve sheath diameter in children: a prospective, randomized trial

B. Lee[1,2], B.-N. Koo[1,2], Y. S. Choi[1,2], H. K. Kil[1,2], M.-S. Kim[1,2] and J. H. Lee[1,2,*]

[1]Department of Anesthesiology and Pain Medicine, Severance Hospital, 50-1 Yonsei-ro, Seodaemun-Gu, Seoul 03722, Republic of Korea and [2]Anesthesia and Pain Research Institute, Yonsei University College of Medicine, 50-1 Yonsei-ro, Seodaemun-Gu, Seoul 03722, Republic of Korea

*Corresponding author. E-mail: NEOGENS@yuhs.ac

Abstract

Background: Caudal block is commonly administered for postoperative analgesia in children. Although caudal block with 1.5 ml kg^{-1} local anaesthetic has been reported to reduce cerebral oxygenation in infants, the effect of caudal block on intracranial pressure (ICP) in children has not been well investigated. Optic nerve sheath diameter (ONSD) correlates with degree of ICP. This study aimed to estimate the effects of caudal block on ICP according to volume of local anaesthetic using ultrasonographic measurement of ONSD in children.

Methods: Eighty patients, 6- to 48-months-old, were randomly allocated to the high-volume (HV) or low-volume (LV) groups for caudal block with ropivacaine 0.15%, 1.5 ml kg^{-1} or 1.0 ml kg^{-1}, respectively. Measurement of ONSD was performed before (T0), immediately after (T1), and 10 min (T2) and 30 min (T3) after caudal block.

Results: The two groups exhibited significant differences in ONSD according to time ($P_{Group \times Time}$=0.003). The HV group exhibited significantly greater changes in ONSD from T0 to T2 and T3 than the LV group. However, in both groups, ONSDs at T1, T2 and T3 were significantly greater compared with those at T0, with the highest values at T2.

Conclusions: Caudal block with a high volume of local anaesthetic can cause a greater increase in ICP than caudal block with a low volume of local anaesthetic. However, caudal block with 1.0 ml kg^{-1} of local anaesthetic can also result in a significant increase in ICP.

Clinical trial registration. NCT02768493.

Key words: anaesthesia, caudal; intracranial hypertension; optic nerve; paediatrics; ultrasonography

Caudal block is commonly used for postoperative analgesia in paediatric patients because of its safety and efficacy in all types of surgery below the umbilicus.[1 2] Although a volume of 1–1.25 ml kg^{-1} of local anaesthetic is generally used for caudal block for abdominal incision up to the thoracic dermatomes,[1 3] a higher volume (1.5 ml kg^{-1}) of local anaesthetic has been reported to not only increase the level of cranial spread but also provide better quality and longer duration of analgesia in comparison with the conventional volume (1.0 ml kg^{-1}).[4] However, caudal block with a high volume of local anaesthetic reduces cerebral blood flow and regional oxygenation probably by increasing intracranial pressure (ICP) in infants, which raises safety concerns regarding administration of high-volume (HV) caudal block.[5]

; **Editorial decision:** February 18, 2017; **Accepted:** February 23, 2017

Editor's key points

- Caudal block can lead to increases in intracranial pressure.
- The volume dependence of this effect was investigated in 80 children undergoing urological procedures.
- Both high (1.5 ml kg^{-1}) and low (1.0 ml kg^{-1}) volumes of local anaesthetic injected in the caudal space increased intracranial pressure measured as optic nerve sheath diameter.

Direct ICP measurement in the ventricle or brain parenchyma (the gold standard method for ICP measurement) is an invasive procedure.[6] Among the non-invasive alternatives for ICP assessment, there is increasing evidence that optic nerve sheath diameter (ONSD) measured by ultrasonography correlates with degree of ICP and is able to detect intracranial hypertension.[7–9] Furthermore, the correlation between ONSD and ICP, and the diagnostic potential of ONSD for the detection of increased ICP (IICP), have been demonstrated in children.[10–14] However, the effects of caudal block on ONSD or ICP have rarely been investigated in paediatric patients. Therefore, this prospective, randomized, double-blinded study aimed to investigate the effect of caudal block on ICP with different volumes of local anaesthetics through ultrasonographic measurement of ONSD in children.

Methods

Patients

This study was approved by the Severance Hospital institutional review board (protocol number: 4-2016-0192) and registered at ClinicalTrial.gov (NCT02768493). Written informed consent was obtained from the parents of all children. Among children undergoing urological surgery at Severance Hospital, 80 patients, 6- to 48-months-old, with body weight ≤16 kg and treatment plan for caudal block for analgesia, were enrolled. The limit on body weight was set because the maximum volume of local anaesthetic for caudal block in children is restricted to 25 ml.[1] Patients with the following conditions were excluded: symptoms or signs of spinal anomalies or infection at the sacral region; coagulopathy; increased ICP; ophthalmic diseases; history of increased ICP; and expected duration of surgery <30 min.

Anaesthesia

The procedure for anaesthesia was a modification of the routine anaesthetic protocol for paediatric urological procedures at our institution. Anaesthesia was induced with sodium thiopental (5 mg kg^{-1}) (Pentothal sodium, 250 mg $ampule^{-1}$, JW Pharm., Seoul, Korea) combined with sevoflurane 4% in 100% oxygen delivered through a face mask to ensure sufficient anaesthetic depth for securing the airway with a laryngeal mask. All patients were mechanically ventilated without muscle relaxation agents or opioids in order to maintain 4.7–5.3 kPa of end-tidal carbon dioxide ($EtCO_2$). Anaesthesia was maintained with sevoflurane in a 40% O_2/air mixture, and the inspired concentration of sevoflurane was adjusted to maintain mean arterial pressure (MAP) within 80–120% of the baseline value. Electrocardiography, pulse oximetry, non-invasive arterial blood pressure (NIBP), nasopharyngeal temperature, $EtCO_2$ measurement and gas analysis were employed as standard monitors.

Caudal block

Equal numbers of patients were randomly assigned to the HV or low-volume (LV) groups using a computer-generated randomization table (http://www.random.org). Randomization and group assignment were performed by the principal investigator (J.H.L.). Three investigators (J.H.L., B.-N.K. and Y.S.C.) administered caudal blocks according to group allocation. The HV and LV groups were administered caudal block with ropivacaine 0.15%, 1.5 ml kg^{-1} and 1.0 ml kg^{-1}, respectively. After induction of anaesthesia, the sacral cornua and hiatus were visualized by ultrasonography (E-CUBE i7, ALPINION Medical Systems, Seoul, Republic of Korea) in a left lateral decubitus position, and the needle-entry site was identified over the sacrococcygeal ligament between the cornua. The optimal angle for entering the sacral epidural space was measured, and a 5 cm bevelled 22-gauge block needle was inserted into the sacral epidural space. Aspiration test was performed to exclude intravascular placement. Local anaesthetic was then manually injected at a rate <0.5 ml s^{-1}, during which turbulence in the sacral caudal space was analysed on transverse ultrasound images to confirm the spread of anaesthetic into the epidural space. Surgery was

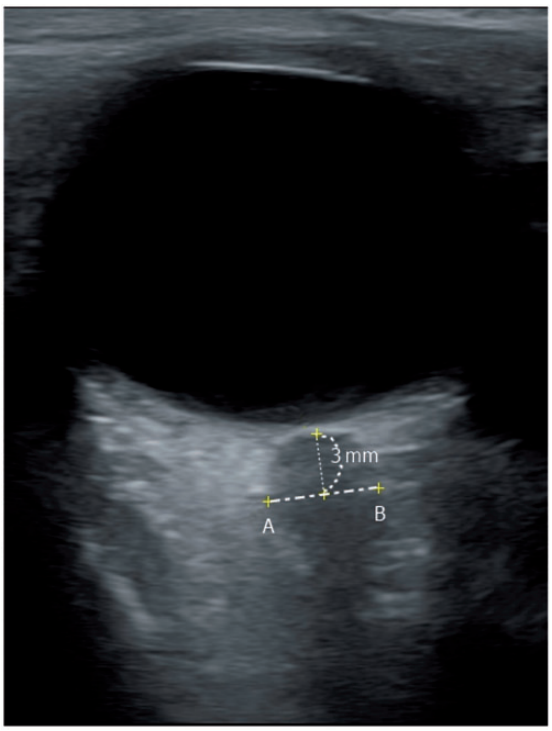

Fig 1 Measurement of optic nerve sheath diameter (ONSD) by ultrasonography. Axial images of the orbit were acquired in the plane of the optic nerve. ONSDs were measured 3 mm posterior to the optic nerve head (A–B).