Anaesthetic Techniques

Thoracic epidural anaesthesia in infants and children

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When compared with conventional analgesic techniques, epidural anaesthesia not only provides improved analgesia, but also has several beneficial effects on the postoperative respiratory, cardiovascular, and metabolic status of the patient. Although the efficacy and safety of caudal and lumbar epidural anaesthesia in children has been demonstrated, there is little information concerning the use of thoracic epidural anaesthesia. The purpose of our review was to evaluate the safety of thoracic epidural anaesthesia in infants and children. We retrospectively reviewed our three-year experience with thoracic epidural anaesthesia for postoperative analgesia in children. Epidural catheters were placed at the thoracic level without difficulty in 63 children ranging in age from three months to 18 yr and in weight from 3.2 to 78 kg. Postoperative analgesia was provided by the continuous infusion of a bupivacaine/fentanyl mixture, supplemented with intermittent epidural fentanyl by bolus as needed. Epidural catheters were successfully placed in all patients. No inadvertent dural punctures were noted. No episodes of respiratory depression related to epidural analgesia occurred. Minor adverse effects including pruritus occurred in six patients, three of whom required pharmacological intervention with diphenhydramine. Our review suggests that this is a safe and effective method of postoperative analgesia following thoracic surgery in children.

Lorsqu'elle est comparée avec les techniques analgésiques conventionnelles, l'anesthésie épidurale procure une analgésie supérieure, mais aussi des effets cardio-vasculaires, respiratoires et métaboliques bénéfiques. Quoiqu'on ait déjà démontré l'efficacité et la sécurité de l'anesthésie caudale et épidurale lombaire en pédiatrie, on connait mal chez l'enfant l'utilisation de l'épidurale thoracique. Nous avions pour objectif d'évaluer la sécurité de l'épidurale thoracique chez le nourisson et l'enfant. Nous avons révisé de façon rétrospective notre expérience de trois ans avec l'épidurale thoracique utilisée pour produire l'analgésie post-opératoire chez l'enfant. Des cathéters épiduraux ont été installé sans difficulté au niveau thoracique chez 63 enfants dont l'âge variait entre trois mois à 18 ans et pesant de 3,2 à 78 kg. L'analgésie postopératoire a été réalisée avec une perfusion continue d'un mélange bupivacaïne/fentanyl, supplémentée au besoin par des injections intermittentes de fentanyl. Des cathéters épiduraux ont été insérés avec succès chez tous ces enfants. Il n'y a pas eu de ponction épidurale accidentelle. On n'a pas décelé de dépression respiratoire d'origine épidurale. Des effets secondaires mineurs comme le prurit sont survenus chez six patients dont trois ont été traités avec de la diphenhydramine. Cette étude suggère que cette technique est sécuritaire et efficace pour produire l'analgésie postopératoire en chirurgie thoracique pédiatrique.

Key words
ANAESTHESIA: paediatric;
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ANALGESIA: postoperative;
PAIN: postoperative.

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In children, postoperative analgesia is generally provided by either parenteral narcotics or regional anaesthetic techniques such as epidural anaesthesia. Although the efficacy of epidural anaesthesia in providing postoperative analgesia in children has been demonstrated,[1-3] these studies have utilized either caudal or lumbar placement of the epidural catheter. The majority of experience with thoracic epidural analgesia in children has involved catheter placement from the caudal approach.[4-6]

Our review of the literature has found only three previous reports concerning the use of epidural catheters placed at the thoracic level for postoperative analgesia in children.[1,7,8] The earliest of these studies by Meigner *et al.*[7] demonstrated the safety and efficacy of this technique in eight children. The second study[8] included 30

children only three of whom were five years of age or younger. The third study performed by Ecoffey *et al.*[1] reported on nine infants in whom the epidural catheter was placed at the T_{10-11} level for provision of analgesia following the Kasai procedure (hepatobiliary duodenostomy for biliary atresia). Due to the lack of a large experience in young children and infants, we undertook a retrospective review of our three-year experience with this technique.

Methods

We retrospectively reviewed the records of patients less than 20 yr of age in whom an epidural catheter had been placed at the thoracic level. In addition, the records of the pain management service were reviewed. This includes prospective data collected on all patients in whom an epidural catheter is placed. When the same patient had more than one surgical procedure, each postoperative course was considered separately.

The following demographic data were obtained: age, weight, sex, and primary medical problem. Intraoperative data included the type of surgical procedure, anaesthetic technique and agents, and difficulties encountered during epidural catheter placement. Further data concerning the epidural catheter included: level of placement, duration of use, medications administered via the catheter, mode of medication delivery (intermittent versus continuous), and technical problems with the catheter during postoperative use. The charts were also examined for complications related to epidural analgesia including infection or bleeding at the insertion site, toxicity related to local anaesthetic administration, pruritus, urinary retention or respiratory depression.

Postoperative pain orders were written by the pain management service. The need for and response following supplemental analgesia with bolus dose epidural fentanyl were assessed using the usual criteria of the nursing staff (observation of behaviour and vital signs in younger patients supplemented by direct inquiries of pain in older patients). No parenteral narcotics were administered to any of the patients while the epidural catheter was in place. Initially patients were admitted to the Pediatric Intermediate Care Unit. However, the last ten patients have been admitted to the regular inpatient ward with monitoring that includes continuous pulse oximetry and measurement of respiratory rate every two hours.

Results

Thoracic epidural catheters were placed in 63 children, ranging in age from three months to 18 yr and in weight from 3.2 kg to 78 kg. Twelve patients were less than one year of age and a total of 34 were five years of age or less. Surgical procedures included a lateral thoracotomy in 48 patients. Of these 48, the primary procedure was excision of metastatic lesions in 25, biopsy in eight, division of vascular ring in four, lobectomy in three, primary tumour resection in three, colonic interposition in two, repair of diaphragmatic hernia in two, and pneumoectomy in one. Twelve patients had a thoracoplasty for repair of either a pectus excavatum or carinatum deformity while the remaining three patients underwent median sternotomy for tumour excision.

The epidural catheters were left in place for 48 to 72 hr. One catheter was inadvertently removed by the surgeon on postoperative day two during a dressing change. All other catheters functioned without difficulty. The level of placement varied from T_6 to T_{11}. Postoperative chest *x*-ray verified that the tip of the catheter was positioned at T_3 to T_8 in all patients. The timing of catheter insertion varied according to the discretion of the attending anaesthetist and surgeon. Therefore, although all catheters were placed following the induction of general anaesthesia, placement occurred both before and after the surgical procedure. Equipment included a 19 gauge epidural catheter (Arrow Theracath) which was placed through a 17 gauge, 3.5″ Tuohy needle or a 20 gauge catheter placed through a 18 gauge, 2″ Tuohy needle (Preferred Medical Products) using the loss of resistance techniques. Following placement, the catheter was secured in place with a transparent bio-occlusive dressing.

Following placement, intravascular placement was excluded using a test dose that consisted of 1 to 3 ml bupivacaine 0.25% with epinephrine (1:200,000). Postoperative analgesia was provided by an initial bolus of 0.2 to 0.3 $ml \cdot kg^{-1}$ of bupivacaine 0.25% (maximum of 10 ml) with 0.5 to 1.0 $\mu g \cdot kg^{-1}$ fentanyl followed by a continuous infusion of bupivacaine 0.1% to 0.125% with fentanyl. The concentration of fentanyl was adjusted to deliver 0.5 to 0.75 $\mu g \cdot kg^{-1} \cdot hr^{-1}$ with an infusion rate of 0.3 $ml \cdot kg^{-1} \cdot hr^{-1}$. When supplemental analgesia was required, one of two techniques was used. In the first 53 patients, the continuous infusion was supplemented with epidural fentanyl (1 $\mu g \cdot kg^{-1}$) administered according to our previously described protocol by the ICU nursing staff.[9] In the last ten patients, we have switched to a PCA-epidural device which can be activated by the patient or bedside nurse.

No cardiorespiratory complications related to epidural analgesia were identified in any of the patients. Urinary retention could not be assessed accurately since most of patients had Foley catheters in place for a variable part of the postoperative course. Six patients had mild pruritus, three of whom required pharmacological intervention with diphenhydramine. Our retrospective review failed to identify any patients with repeated episodes of vomiting related to epidural analgesia.

Discussion

We have retrospectively reviewed our three-year experience with thoracic epidural analgesia in children. Although previous studies have documented the efficacy and safety of epidural analgesia in children, there is limited information concerning placement at the thoracic level. As this is a retrospective review, evaluation of the efficacy of analgesia is difficult. However, our purpose is not to assess the efficacy of this technique nor to compare it with another modality. Rather, we have attempted, albeit retrospectively, to demonstrate the safety and feasibility of placement of thoracic epidural catheters in children. In our review, catheter placement was successful in the initial interspace chosen in 60 of 63 patients. In the remaining three patients, placement was successful at the second interspace attempted.

In addition to judging the adequacy of analgesia, a second problem with a retrospective review is the identification of complications. However, prospective data were collected by the pain management service on all patients. Episodes of respiratory depression whether they required intervention or not were recorded on these records. Therefore we are certain that important complications such as respiratory depression were not overlooked. However, the exact incidence of minor complications such as pruritus and vomiting may be more difficult to ascertain. However, the need for pharmacological intervention would show up either on the pain management service records or in the patients' charts. Therefore, our review may have missed some episodes of pruritus or vomiting which did not require pharmacological intervention.

For this technique to be necessary, its superiority over other techniques such as caudal or lumbar placement must be proven. The first question is: does the administration of thoracic epidural narcotics have any advantage over lumbar administration? With the administration of epidural opioids, two choices exist: lipophilic or hydrophilic opioids. Because of the segmental nature of epidural analgesia with lipophilic opioids such as fentanyl or sufentanil, placement at or near the level of the surgery is recommended for optimal analgesia.[10] Bodily *et al.*[11] demonstrated in adult patients that higher doses of fentanyl were required to achieve equal analgesia with lumbar than with thoracic administration. These higher doses result in higher systemic levels, related to uptake by the epidural vasculature, and may lead to a higher incidence of adverse effects. Additionally, the placement of the catheter near the level of surgical incision allows the use of local anaesthetics which may further improve analgesia when compared with the use of narcotic alone.[12]

An alternative to the use of lipophilic epidural narcotics placed near the surgical site is the administration of hydrophilic narcotics such as morphine. The advantage of epidural morphine is that its hydrophilic nature not only provides a longer duration of action, but caudal or lumbar administration provides analgesia for operations at or above the thoracic level.[13-15] However, the incidence of adverse effects appears to be considerably higher with epidural morphine than with lipophilic narcotics such as fentanyl.[10] This includes not only bothersome effects such as nausea, vomiting, and pruritus, but also more serious consequences such as delayed respiratory depression.[16,17] Most importantly, CO_2 responsiveness is altered for up to 24 hr following epidural morphine.[18] One additional adverse effect in adults reported with epidural morphine, but not with fentanyl, is reactivation of herpes simplex infections.[19,20]

With such information, it appears that the administration of epidural fentanyl at the thoracic level is advantageous over either the administration of larger doses at the lumbar level or the use of epidural morphine. Another means of achieving catheter placement without direct insertion at the thoracic level is to thread the catheter from the caudal level. Although this technique has been described successfully by three sets of investigators,[4-6] we have found it to be unreliable. During advancement, the catheter may become kinked, double back on itself, or meet resistance resulting in an inability to achieve the desired level. In the initial study of Bosenberg *et al.*[4] 19 of 20 catheters were successfully placed. The study of Rasch *et al.*[5] involved 30 patients. In 12 of the 30 the level of placement was T_{10} to T_{12} and in only seven was the level above T_{10}. The lower level of placement was the desired level since many of their patients were undergoing upper abdominal procedures. Both of these studies involved mainly neonates and infants. The most recent study of Gunter *et al.*[6] involved older children (11 mos to 10 yr). Once again in this study, many of the patients were undergoing abdominal procedures and therefore the desired level of placement was T_6 in four patients and T_{10} in seven patients. Therefore, although this appears to be an attractive alternative to direct thoracic placement, its use outside the infant age range is limited as is experience with placement at higher thoracic dermatomes. Additionally, all three studies describe manoeuvres such as flexion and extension of the vertebral column to facilitate passage which suggests that such placement may be more time-consuming than direct thoracic placement. Gunter *et al.* also stated that, due to increased epidural fat in older patients, extension of this technique to preadolescents and adolescents has met with limited success.

Our intention was not to compare our technique with those of previous authors, but rather to demonstrate the feasibility of direct placement of the epidural catheter at

the thoracic level even in small infants and children. As there are no controlled, prospective comparisons of the two techniques, the choice will depend on the experience and expertise of the anaesthetist.

We have no clear explanation why these techniques are not used more extensively in children. We are unaware of reports of adverse effects indicating that this technique is relatively more dangerous in children. Contraindications and complications are the same as for adults. Additionally, although smaller equipment is currently available, we have not found difficulty in using the standard adult-sized needles and catheters even in infants. Needle placement, identification of the epidural space, and catheter advancement were accomplished without difficulty.

Our experience suggests that direct placement of a thoracic epidural catheter is feasible even in infants and small children. Although we are not suggesting that these techniques should be practiced by those unfamiliar with their use, we have found that they can be easily taught. While other options are available such as the use of epidural morphine, previous studies suggest a decreased incidence of adverse effects with lipophilic narcotics such as fentanyl. Likewise, although other options exist such as threading a catheter from the caudal approach, future studies are needed to directly compare these two techniques as far as success rates, time required for completion, and incidence or adverse effects.

References

1 *Ecoffey C, Dubousset AM, Samii K.* Lumbar and thoracic epidural anesthesia for urologic and upper abdominal surgery in infants and children. Anesthesiology 1986; 65: 87–90.

2 *Dalens B, Tanguy A, Haberer JP.* Lumbar epidural anesthesia for operative and postoperative pain relief in infants and young children. Anesth Analg 1986; 65: 1069–73.

3 *Desparmet J, Meistelman C, Barre J, Saint-Maurice C.* Continuous epidural infusion of bupivacaine for postoperative pain relief in children. Anesthesiology 1987, 67: 108–10.

4 *Bösenberg AT, Bland BAR, Schulte-Steinberg O, Downing JW.* Thoracic epidural anesthesia via the caudal route in infants. Anesthesiology 1988; 69: 265–9.

5 *Rasch DK, Webster DE, Pllard TG, Gurkowski MA.* Lumbar and thoracic epidural analgesia via the caudal approach for postoperative pain relief in infants and children. Can J Anaesth 1990; 37: 359–62.

6 *Gunter JB, Eng C.* Thoracic epidural anesthesia via the caudal approach in children. Anesthesiology 1992; 935–8.

7 *Meignier M, Souron R, Le Neel JC.* Postoperative dorsal epidural analgesia in the child with respiratory disabilities. Anesthesiology 1983; 59: 473–5.

8 *Tozbikian HG.* Continuous thoracic epidural blockade reduces blood loss in pectus deformity repair in children. Reg Anesth 1992; 17: 36S.

9 *Tobias JD, Oakes L, Austin BA.* Pediatric analgesia with epidural fentanyl citrate adminstered by nursing staff. South Med J 1992; 85: 384–7.

10 *Grass JA.* Sufentanil: clinical use as postoperative analgesic – epidural/intrathecal route. Journal of Pain and Symptom Management 1992; 7: 271–86.

11 *Bodily MN, Chamberlain DP, Ramsey DH, Olsson GL.* Lumbar versus thoracic epidural catheter for post-thoracotomy analgesia. Anesthesiology 1989; 71: A1146.

12 *George KA, Wright PMC, Chisakuta A.* Continuous thoracic epidural fentanyl for post-thoracotomy pain relief: with or without bupivacaine? Anaesthesia 1991; 46: 732–6.

13 *Rosen KR, Rosen DA.* Caudal epidural morphine for control of pain following open heart surgery in children. Anesthesiology 1989; 70: 418–21.

14 *Brodsky JB, Kretzschmar KM, Mark JBD.* Caudal epidural morphine for post-thoracotomy pain. Anesth Analg 1988; 67: 409–10.

15 *Tobias JD, Deshpande JK, Wetzel RC, Fackler J, Maxwell LG, Solca M.* Postoperative analgesia: use of intrathecal morphine in children. Clin Pediatr (Phila) 1990; 29: 44–8.

16 *Krane EJ.* Delayed respiratory depression in a child after caudal epidural morphine. Anesth Analg 1988; 67: 79–82.

17 *Etches RC, Sandler AN, Daley MD.* Respiratory depression and spinal opioids. Can J Anaesth 1989; 36: 165–85.

18 *Attia J, Ecoffey C, Sandouk P, Gross JB, Samii K.* Epidural morphine in children: pharmacokinetics and CO_2 sensitivity. Anesthesiology 1986; 65: 590–4.

19 *Gieraerts R, Navalgund A, Vaes L, Soetens M, Chang JL, Jahr J.* Increased incidence of itching and herpes simplex in patients given epidural morphine after Cesarean section. Anesth Analg 1987; 66: 1321–4.

20 *Crone LA, Conly JM, Storgard C, et al.* Herpes labialis in parturients receiving epidural morphine following cesarean section. Anesthesiology 1990; 73: 208–13.