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Effects of Postoperative Patient Controlled Epidural Analgesia in Pediatric Patients Undergoing Lower Extremity Surgery

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= Abstract =

Background: A limited number of studies have been conducted on postoperative epidural analgesia in pediatric patients. There have been primarily dealt with spinal or abdominal surgeries where multiple dermatomal segments needed to be blocked and morphine was given either through the caudal approach or by direct catheter placement. This study evaluated the safety and efficacy of postoperative continuous patient controlled epidural analgesia (PCEA) in children undergoing lower extremity surgery using a bupivacaine and fentanyl via lumbar approach.

Methods: The patient population consisted of 40 children ranging in age from 5 to 12 years. Patients were randomly divided into two groups according to postoperative pain relief regimen; the control group received an intramuscular injection of ketorolac 1 mg/kg t.i.d. and meperidine 0.5 mg/kg p.r.n., and the epidural group received PCEA (0.1% bupivacaine + fentanyl 2μg/ml) through an epidural catheter positioned at the surgical dermatomal level of the spinal cord. In the epidural group the volume of the initial dose was 1 ml/segment in children ≤ 10 years of age and dose (age in years) ml/10/segment in children > 10 years of age. The basal infusion rate was 0.1 ml/kg/hr (bolus: 0.05 ml/kg, lockout time: 30 minutes). Pain scores were measured upon arrival at the ward, and 6 and 24 hours thereafter.

Results: The epidural group had significantly lower pain scores and minimal side effects. A significant correlation was observed between the bolus number and the incidence of nausea/vomiting in the epidural group.

Conclusions: This study shows that PCEA targeted at the surgical dermatome is a safer and more effective regimen for postoperative pain relief than conventional postoperative pain relief in pediatric patients undergoing lower extremity surgery. **(Korean J Anesthesiol 2003; 44: S 14～S 19)**

Key Words: Lower extremities surgery; patient controlled epidural analgesia; pediatric.

INTRODUCTION

In the past, there have been misconceptions about pain in children. It was believed that unlike adults, children neither felt pain nor remembered it afterwards. Nowadays, it is well established that pain cause suffering and physiologic abnormalities in children similar to those that occur in adults.

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Although the beneficial effects of adequate postoperative epidural analgesia compared to systemic analgesia in attenuating various stress responses in children have been suggested,[1] there is only limited number of studies with postoperative epidural analgesia in pediatric patients[2-6] for the fear of side effects of the opioid used,[7] technical difficulties and complications associated with the epidural catheter placement.[8] Furthermore, these studies have dealt only with spinal and abdominal surgeries where morphine was the main analgesic for multiple dermatomal segments blockage. Currently, there are few reports on postoperative patient controlled epidural analgesia (PCEA) with fentanyl tailoring the surgical dermatomal level for the lower extremity surgery in the pediatric patients.

This study evaluates the safety and efficacy of PCEA using fentanyl and bupivacaine mixture in pediatric patients undergoing orthopedic lower extremity surgery.

METHODS

Patient population

Forty orthopedic children scheduled for elective lower extremities surgery from July 2001 to October 2001 were selected. All the children were 5-12 years old and the physical status was ASA class I or II. The children were randomly divided into two groups; 1) control group, who received conventional postoperative pain medications by orthopedic surgeon, and 2) epidural group, who received patient controlled epidural analgesia.

Anesthetic technique

All patients were premedicated with glycopyrolate 0.004 mg/kg i.v. and were brought to the operating room after ketamine 1 mg/kg i.v. was injected. After the induction of general anesthesia with thiopental 5 mg/kg i.v. and vecuronium 0.1 mg/kg i.v., the airway was secured with an endotracheal tube and the patients' lungs were mechanically ventilated with a tidal volume of 10 ml/kg and a respiratory rate of 16-20 breaths/min in order to maintain normocarbia according to the capnography. Anesthesia was then maintained with isoflurane. Epidural group patients were positioned to the left lateral recumbent position for an epidural catheter insertion. An 18 gauge Tuohy needle with 20 gauge multiorifice epidural catheter was used and the needle was passed through either L2/3, L3/4, L4/5 or L5/S1 intervertebral space using loss of resistance technique. The catheter was placed 3 to 5 cm into the epidural space either cephalad or caudad direction in order to bring the tip of the catheter at the dermatomal level of the surgery.

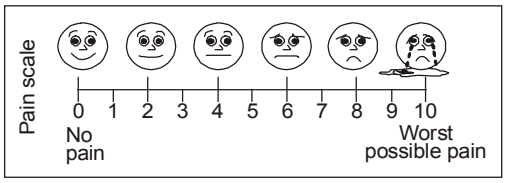
Postoperative pain management

Analgesics started immediately after the emergence of anesthesia in both groups. In control group, conventional pain medication was administered (intramuscular injection of ketorolac 1 mg/kg t.i.d. and meperidine 0.5 mg/kg p.r.n.). In epidural group, PCEA regimen (a mixture of fentanyl 2μg/ml and 0.1% bupivacaine in 100 ml of normal saline) were administered via epidural catheter by aimplus® (ABBOTT, USA) infusion pump. The initial bolus was given immediately after the emergence of anesthesia. The volume of the initial bolus was 1 ml per segment in patients between the ages of 5 and 10 years and (age in years) × ml/10 per segment in patients older than 10 years of age. The basal infusion rate of the mixture was 0.1 ml/kg/hr and the patient controlled bolus was 0.05 ml/kg with a lock-out time of 30 minutes. After initiation of the continuous infusion of epidural analgesics, all patients were monitored in the recovery room with pulse oximetry and noninvasive blood pressure measurement for 1 hour to detect signs of respiratory depression or hypotension. Analgesics started immediately after the emergence of anesthesia in both groups.

Data collection

Before the day of the surgery, an anesthesiologist evaluated all patients. A standardized pain scale and questionnaire were explained to the patients in the presence of their parents (Fig. 1). Patients were asked to check pain scores on resting and moving status for three different times; upon arrival at the ward, 6 hours thereafter and 24 hours after the first measurement. Parents were asked also to fill out the questionnaire regarding side effects. The number of adjuvant bolus administration was

counted in epidural group, and the number of intramuscular bolus of meperidine p.r.n. in control group. The incidence of nausea, vomiting, and voiding difficulty was compared between the two groups. An anesthesiologist collected questionnaires 2 days after the surgery.



Date:
Begin of the surgery/end of the surgery:
Unit no: Name: Sex/Age:
Wt./Ht.: Dx.: OP name:
Catheter at L / . Upward/downward cm.
Composition: 0.1% bupivacaine + fentanyl 2μg/cc
Basal rate: 0.1 ml/kg/hr, Bolus: 0.05 ml/kg (lock time: 30 min)
Initial bolus (injected after emergence): 1 ml/segment (5-10 year-old),
(Age in years) ml/10/segment (> 10 year-old)

- Scoring according to the pain scale:
  1) Upon arrival at the ward:. . (at rest , moving)
  2) After 6 hours: (at rest , moving)
  3) After 24 hours: (at rest , moving)
- Pruritus: Y/N: if yes → is further treatment necessary? .. Y/N
- Nausea/Vomiting: Y/N: if yes → is further treatment necessary? Y/N
- Voiding difficulty: Y/N
- Time and number of boluses:

Fig. 1. Pain scale and questionnaire.

Statistical analysis

Data were analyzed with Student t-test and Chi-square test using SPSS® 10.0 (SPSS Inc., USA) statistical software. A P value of < 0.05 was taken to be statistically significant.

RESULTS

The age, body weight, duration of the surgical procedure and number of bolus injection did not differ significantly between the two groups (Table 1).

The range of depth from the skin to the epidural space was 1.7 to 2.8 cm. There were no epidural puncture related complications such as accidental dural puncture. None of the patients in the epidural group developed respiratory depression or hypotension in the recovery room and thereafter.

Pain scores of the epidural group were significantly lower in all measurements compared to the control group (Fig. 2-4).

The incidences of pruritus, nausea/vomiting and voiding difficulty were statistically insignificant between the two groups and there was no need for further treatments (Table 2). None of the patients in the epidural group had voiding difficulty. However, two patients in the control group developed voiding difficulties on the first postoperative day, but there was no statistically significant correlation with the number of bolus administration (i.e. intramuscular

Table 1. Demographic Data of Patients

	Epidural group (n = 20)	Control group (n = 20)	P value
Age (yr)	7.8 ± 2.5	7.3 ± 2.1	NS
Weight (kg)	28.9 ± 9.8	28.7 ± 8.4	NS
Height (kg)	124.4 ± 16.4	120.0 ± 12.7	NS
Duration (min)	187.0 ± 25.2	182.3 ± 22.0	NS
Number of bolus*	2.0 ± 2.6	2.0 ± 1.5	NS

Values are expressed as mean ± SD. NS: Not significant. Student t-test was used to compare the values ($P < 0.05$). *Bolus consists of 0.05 ml/kg mixture of 0.1% bupivacaine and fentanyl 2μg/ml in the epidural group and meperidine 0.5 mg/kg i.m. in the control group.

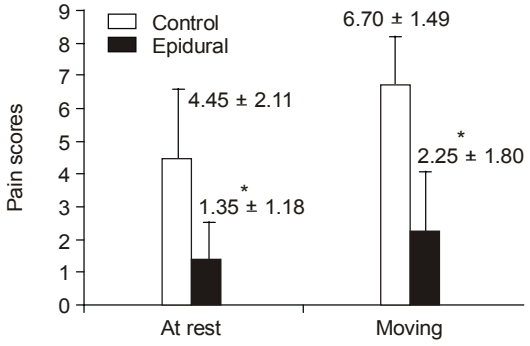


Fig. 2. Comparison of pain scores upon arrival at the ward. Student t-test was used to compare the values (P < 0.01). Values are mean ± SD.

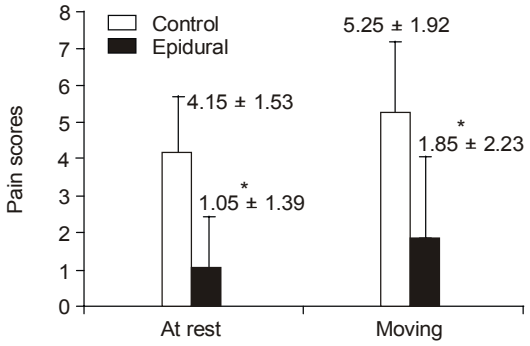


Fig. 3. Comparison of pain scores after 6 hours from the first measurement. Student t-test was used to compare the values (P < 0.01). Values are mean ± SD.

meperidine injection).

In the epidural group, there was a significant correlation between the number of bolus administered and the incidence of nausea/vomiting (r = 0.624, P < 0.01).

DISCUSSION

Intramuscular injection of opioid by the nurse is still the mainstay for the postoperative pain relief in pediatric patients. Due to the fear of opioid related side effects and technical difficulties of epidural catheterization, more effective analgesic techniques like continuous intravenous opioids or epidural analgesics are not frequently applied to the pediatric patients. In the recent 10 years, number

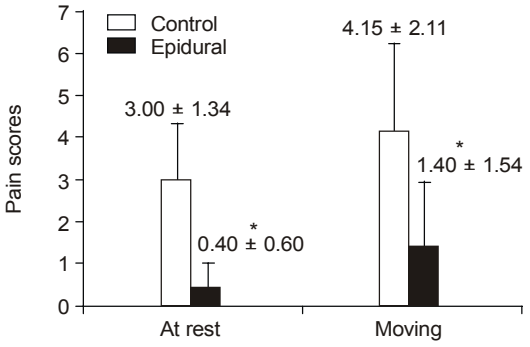


Fig. 4. Comparison of pain scores after 24 hours from the first measurement. Student t-test was used to compare the values (P < 0.01). Values are mean ± SD.

Table 2. Incidence of Complications Related to Analgesics

	Epidural group (n = 20)	Control group (n = 20)	P value
Pruritus	5	4	NS
Nausea/vomiting	6	3	NS
Voiding difficulty	0	2	NS

Chi-square test was used to compare the values (P < 0.05). Values are number of patients. NS: Not significant.

of studies have dealt with the safety and efficacy of epidurally administered analgesics[2-6] in pediatric patients. Our results were also satisfactory in terms of postoperative pain relief with minimal side effects.

To clarify the efficiency of PCEA targeted at the surgical dermatome, we selected the pediatric orthopedic patients who needed L1 to S1 spinal segments blockades. PCEA had the advantage of blocking only limited spinal segments as well as achieving complete postoperative pain relief without side effects when the epidural catheter was positioned correctly and proper dosage of the drugs was used. We have chosen the lumbar intervertebral space to take the advantage of sparing the sacral plexus and still obtained an adequate pain relief by precise tailoring of the spinal segments. Caudal approach could also be favored in terms of technical practicability but there remains the possibility of catheter dislodgement and urinary retention by blocking the sacral plexus,[9] especially when using

opioids. The determination of the volume of the epidurally administered bolus would be of paramount importance. There are some recommendations for the volume of the epidurally administered local anesthetics per spinal segment[10,11] and in our study, we used the formulae by Schulte-Steinberg[11] and obtained adequate pain relief without urinary retention. We used fentanyl as a main analgesic instead of morphine for its high lipophilicity. It has potential advantage of blocking more limited segments at the site of the injection.[12] We have chosen the lower limit of the recommended infusion rate of 0.1% bupivacaine and fentanyl 2μg/ml,[13] based on our clinical experiences with patients being more sensitive to systemically and epidurally administered morphine and on our preliminary cases having severe nausea/vomiting with 3μg/ml of fentanyl mixture.

With a setting of PCEA regimen, we were able to obtain significantly lower pain scores in the epidural group than the control group at all measurements with minimal opioid side effects, which required no further treatments or dose adjustments.

There are many articles about measurement of pain in children. Since it is considered to be reliable to use numeric rating scale in children older than 5 years of age,[14-17] we used the standardized pain scale[2] and limited our study population to children older than 5. There were two five years old patients in the epidural group and even though they appear to be satisfied in our and their mothers' opinions, when they were asked to check the pain scale, the scores were between 5 and 8. This limitation may have contributed to large standard deviation in 6 hr measurement of pain scores after arrival to ward (Fig. 3) and 24 hr measurement (Fig. 4) at moving. Even though it did not have an effect on the overall P value (< 0.01), there should be a more objective way to assess the severity of pain in children, which takes the parents opinions into account.

In the epidural group, 8 children underwent either hip or ankle surgeries where only 2 or 3 spinal segments were needed to be blocked. A complete analgesia was achieved without any bolus requirements with pain scores ranging from 0 to 2 points. However, 3 patients who underwent contracture release with incisions ranging from L1 dermatome to S1 dermatome, pain scores were ranging from 2 to 8 points on the first postoperative day, requiring 6 to 8 boluses and they all had either pruritus or nausea/vomiting or both. Since our data show a significant correlation between the number of epidurally administered boluses and the incidence of nausea/vomiting, local anesthetic boluses without fentanyl might have been more suitable choice to avoid untoward opioid side effects in surgical procedures requiring more than 5 segments coverage. Since the recommended continuous infusion rate of the local anesthetics and opioid mixture is weight dependent,[13] there should be individual alterations of the infusion rate of the local anesthetics or the opioid dosage according to the spinal segments to obtain complete pain relief without side effects, yet it merits further prospective clinical investigations.

In conclusion, by placing the epidural catheter at the dermatomal level of the surgery via lumbar approach and administering highly lipophilic fentanyl instead of morphine, we found that it is safe and efficient to use PCEA with low concentrations of bupivacaine and fentanyl in pediatric patients undergoing orthopedic surgery of the lower limbs. Together with the result that the number of epidurally administered boluses have significant correlation with the incidences of nausea/vomiting, this study suggests that drugs and dosing for epidural analgesia should be individualized for the types of surgery in order to obtain complete postoperative pain relief without side effects.

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