

Effects of postoperative
patient controlled epidural
analgesia in pediatric patients
undergoing lower extremities
surgery

Thesis by

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patient controlled epidural
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Directed by Professor Yong - Taek Nam

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List of Contents

Abstract	1
. Introduction	3
. Materials and methods	5
1. Patient population	5
2. Anesthetic management and epidural catheter placement	5
3. Epidural infusion	6
4. Data collection	6
5. Statistical analysis	7
. Results	9
. Discussion	13
. Conclusion	16
References	17
Abstract in Korean	19

List of Figures

Figure 1. Pain scale and questionnaire - - - - -	8
Figure 2. Comparison of pain scores upon arrival at the ward - - - - -	10
Figure 3. Comparison of pain scores after 6 hours from the first measurement - - - - -	10
Figure 4. Comparison of pain scores after 24 hours from the first measurement - - - - -	11

List of Tables

Table 1. Demographic data of patients - - - - - 12

Table 2. Incidence of analgesics related complications - - - - - 12

Abstract

Effects of postoperative patient controlled epidural analgesia in pediatric patients undergoing lower extremities surgery

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Background: There has been limited number of studies of postoperative epidural analgesia in pediatric patients, mostly dealing with spinal or abdominal surgeries where multiple dermatomal segments needed to be blocked and morphine was used either through caudal approach or direct catheter placement by the surgeon. This study evaluates the safety and efficacy of postoperative continuous patient controlled epidural analgesia in children undergoing orthopedic lower extremities surgery using bupivacaine and fentanyl mixture via lumbar approach in order to minimize untoward side effects.

Method: 40 ASA class I or II patients between the ages of 5 and 12 years were randomly allocated into two groups; one group receiving conventional pain medications (intramuscular injection of ketorolac 1 mg/kg t.i.d. and meperidine 0.5 mg/kg p.r.n.) and the other group receiving patient controlled epidural analgesia. The epidural catheter was inserted at the lumbar intervertebral space in lateral recumbent position after

induction of general anesthesia. The composition of the analgesics was 0.1% bupivacaine + fentanyl 2 µg/ml in 100 ml of normal saline. The volume of the initial bolus was 1 ml/segment in children between the ages of 5 and 10 years and (age in years) × ml/10/segment in children older than 10 years of age. The basal infusion rate was 0.1 ml/kg/hr and the volume of the bolus was 0.05 ml/kg with a lock - out time of 30 minutes. Pain scores were measured 3 times with a standardized pain scale with questions regarding side effects; upon arrival at the ward, 6 hours thereafter and 24 hours after the first measurement. Results: The pain scores were significantly lower in the epidural group ($p < 0.01$) with minimal side effects requiring no further treatment (including no voiding difficulties in the epidural group). There was a significant correlation between the number of bolus and the incidence of nausea/vomiting in the epidural group ($r = 0.624$, $p < 0.01$). Conclusion: By placing the epidural catheter at the dermatomal level of the surgery via lumbar approach and using the highly lipophilic fentanyl instead of morphine, this study showed the safety and efficacy of the patient controlled epidural analgesia using low concentrations of bupivacaine and fentanyl in pediatric patients undergoing orthopedic surgery at the lower limbs.

Key Words: patient controlled epidural analgesia, pediatric, lower extremities surgery

Effects of postoperative patient controlled epidural analgesia in pediatric patients undergoing lower extremities surgery

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I. Introduction

In the past, there have been misconceptions about pain in children. It was believed that children neither felt pain as much as adults nor remember it afterwards. Nowadays, it has been well established that pain causes suffering and physiologic abnormalities in children similar to those that occur in adults.

Although the beneficial effects of adequate postoperative epidural analgesia compared to systemic analgesia in attenuating various stress responses in children have been suggested¹, there is only limited number of studies with postoperative epidural analgesia in pediatric patients²⁻⁶ for the fear of side effects of the opioid used⁷, technical difficulties and complications associated with epidural catheter placement⁸.

Furthermore, these studies have dealt only with spinal and abdominal surgeries where morphine was used and multiple dermatomal segments needed to be blocked. There are

currently no articles dealing with lower extremities surgery and fentanyl as the epidural opioid where exact tailoring of the dermatomal level could result in fewer side effects of the opioid used.

This study evaluates the safety and efficacy of postoperative continuous epidural analgesic drug infusion using fentanyl and bupivacaine mixture in pediatric patients undergoing orthopedic lower extremities surgery.

. Materials and methods

1. Patient population

Forty ASA class I or II patients between the ages of 5 and 12 years scheduled for elective orthopedic lower extremities surgery from July, 2001 to October, 2001 were randomly divided into two groups; one group receiving conventional pain medications by the department of orthopedic surgery, usually intramuscular injection of ketorolac 1 mg/kg t.i.d. and meperidine 0.5 mg/kg p.r.n. (control group) and the other group receiving patient controlled epidural analgesia (epidural group). The starting point of the analgesics was immediately after the emergence of anesthesia in both groups.

2. Anesthetic technique and catheter placement.

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. 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 normocarbida according to the capnography. Anesthesia was then maintained with isoflurane and patients were positioned to left lateral recumbent position for 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.

3. Epidural infusion

The authors have used aimplus[®] (ABBOTT, Chicago, IL, USA) infusion pump and each continuous infusion was a mixture of fentanyl 2 µg/ml and 0.1% bupivacaine in 100 ml of normal saline.

The composition of the initial bolus was the same as the continuous infusion and was given immediately after the emergence of anesthesia. The volume of the initial bolus was 1ml per segment in patients between the ages of 5 and 10 years and $(\text{age in years}) \times \text{ml}/10$ 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 measurements for 1 hour to detect signs of respiratory depression or hypotension.

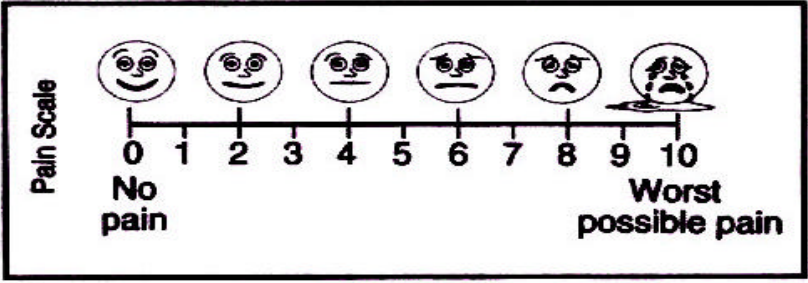
4. Data collection

All patients were evaluated by an anesthesiologist before the day of the surgery and were explained of the questionnaire

with a standardized pain scale in the presence of their parents (Fig.1). The patients were asked to record the pain scores for three times; upon arrival at the ward, 6 hours thereafter and 24 hours after the first measurement. The parents were asked to fill out the questions regarding side effects and number of boluses administered. Adjuvant intramuscular injection of meperidine was considered as bolus in the control group. An anesthesiologist collected the questionnaires 2 days after the surgery.

5. Statistical analysis

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



Pain Scale

0 1 2 3 4 5 6 7 8 9 10

No pain Worst possible pain

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:30min)

Initial bolus (injected after emergence): 1ml/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

. Results

The ages, weights, duration of the surgical procedure and number of bolus did not differ significantly between the 2 groups (Table 1).

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

The pain scores of the epidural group were significantly lower at all measurements compared to the control group (Fig. 2, 3, 4).

The incidences of pruritus, nausea/vomiting and voiding difficulty were statistically insignificant between the two groups and no further treatments were necessary (Table 2). None of the patients in the epidural group had voiding difficulty, however two patients in the control group had voiding difficulty on the first postoperative day but there was no statistically significant correlation with the number of bolus administered (intramuscular meperidine injection).

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

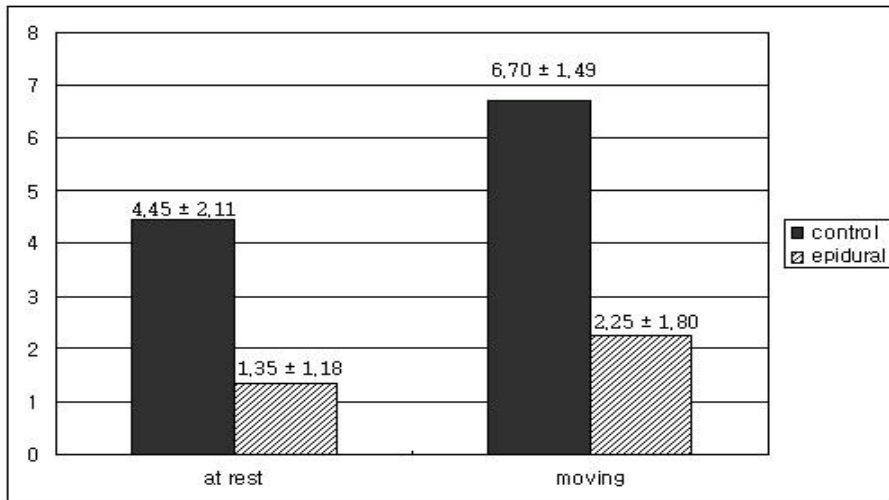


Fig 2. Comparison of pain scores upon arrival at the ward. Student t- test was used to compare the values ($p < 0.01$). Values are mean \pm SD.

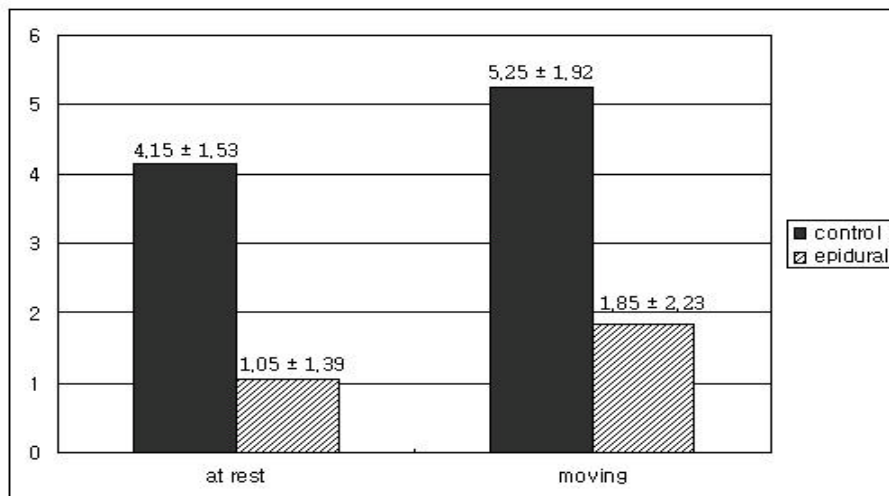


Fig. 3. Comparison of pain scores after 6 hours from the first measurement. Student t- test was used to compare the values ($p < 0.01$). Values are mean \pm SD.

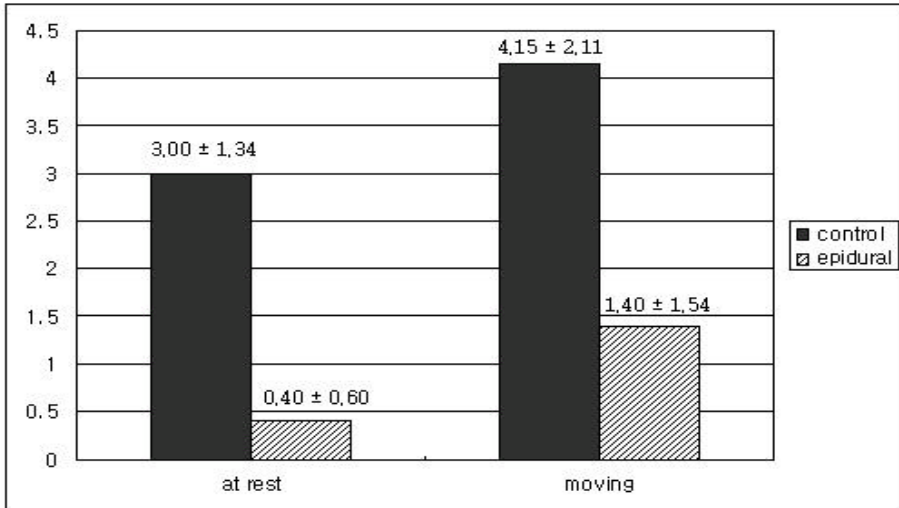


Fig 4. Comparison of pain scores after 24 hours from the first measurement. Student t-test was used to compare the values ($p < 0.01$). Values are mean \pm SD.

Table1. Demographic data of patients

	Epidural group (n = 20)	Control group (n = 20)	p value
Age (years)	7.75 ± 2.45	7.30 ± 2.13	NS
Weight (kg)	28.85 ± 9.82	28.65 ± 8.43	NS
Height (kg)	124.40 ± 16.43	120.00 ± 12.74	NS
Duration (min)	187.00 ± 25.21	182.30 ± 22.01	NS
Number of bolus ¹	1.95 ± 2.560	2.00 ± 1.49	NS

Student t- test was used to compare the values (p<0.05). Values are expressed as mean±SD. NS: Not significant.

¹ Bolus consists of 0.5 ml/kg of 0.1 % bupivacaine + fentanyl 2 µg/ml in the epidural group and meperidine 0.5 mg/kg i.m. in the control group.

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.

. Discussion

The mainstay for the postoperative pain relief in pediatric patients is still nurse - administered intramuscular injection of opioid in Korea, despite the availability of more effective techniques such as intravenous opioids and epidural analgesics, because of technical difficulty and fear of opioid related side effects. In the recent 10 years, there has been number of studies showing the safety and efficacy of epidurally administered analgesics²⁻⁶ in pediatric patients and our results also showed significant pain relief with minimal side effects.

The reason the authors selected pediatric patients undergoing orthopedic surgery to the lower limb was that the sensory segments that need to be blocked are limited to L1 to S1. Hence, having the advantage of needing to block limited spinal segments and the possibility of obtaining complete postoperative pain relief without side effects by correct positioning of the epidural catheter and proper dosing of the drugs. 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 plexus⁹, especially when using opioids. We have chosen the lumbar intervertebral space to take the advantage of sparing the sacral plexus and still obtain adequate pain relief by precise tailoring of the spinal segments. Therefore, 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 - Steinberg¹¹ and obtained

adequate pain relief without urinary retention. Our choice of fentanyl instead of morphine was based on the high lipophilicity of the drug, therefore having the potential advantage of blocking more limited segments at the site of the injection¹². We have chosen the lower limit of the recommended infusion rate of 0.1% bupivacaine + fentanyl 2 µg/ml¹³, based on our clinical experience with Korean patients being more sensitive to systemically and epidurally administered morphine and on our preliminary cases having severe nausea/vomiting with 3 µg/ml of fentanyl mixture.

For the reasons mentioned above, we were able to obtain significantly lower pain scores in the epidural group at all measurements with minimal opioid side effects, which required no further treatment or adjustment of the dosing.

There are many articles about measurement of pain in children and since it is considered reliable to use numeric rating scale in children older than 5 years of age¹⁴⁻¹⁷, we used the standardized pain scale² and limited our study population to children older than 5 years of age. But in 2 of the 20 patients in the epidural group with both being 5 years old, despite both children 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 the reversal of the pain scores considering the standard deviation in figures 3 and 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 8 children of the epidural group who underwent either hip or ankle surgery where only 2 or 3 segments needed to be

blocked, complete analgesia was achieved without any bolus requirements with the pain scores ranging from 0 to 2 points. However, in 3 patients who underwent contracture release with incisions ranging from L1 dermatome to S1 dermatome, their 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 in the same group. With our data showing significant correlation between the number of epidurally administered boluses and the incidence of nausea/vomiting, boluses consisting of local anesthetics without fentanyl might have been more suitable 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 according to the weight¹³ and not the spinal segments, there should be individual alterations of the infusion rate of the local anesthetics or the opioid dosing according to the spinal segments to obtain complete pain relief without side effects, yet it merits further prospective clinical investigations.

. Conclusion

By placing the epidural catheter at the dermatomal level of the surgery via lumbar approach and using the highly lipophilic fentanyl instead of morphine, this study showed the safety and efficacy of the patient controlled epidural analgesia using low concentrations of bupivacaine and fentanyl in pediatric patients undergoing orthopedic surgery at the lower limbs. Together with the result that the number of epidurally administered boluses having significant correlation with the incidence of nausea / vomiting, this study suggests that drugs and dosing for epidural analgesia should be individualized to the type of surgery in order to obtain complete postoperative pain relief without side effects.

References

1. Wolf AR, Eyres RL, Laussen PC, Edwards J, Stanley IJ, Rowe P et al. Effect of extradural analgesia on stress responses to abdominal surgery in infants. *Br J Anaesth* 1993; 70: 654 - 660.
2. Arms DM, Smith JT, Osteyee J, Gatrell A. Postoperative epidural analgesia for pediatric spine surgery. *Orthopedics* 1998; 21: 539 - 544.
3. Wolf AR, Hughes D. Pain relief for infants undergoing abdominal surgery: comparison of infusions of i.v. morphine and extradural bupivacaine. *Br J Anaesth* 1993; 70: 10 - 16.
4. Molik KA, Engum SA, Rescorla FJ, West KW, Scherer LR, Grosfeld JL. Pectus excavatum repair: Experience with standard and minimal invasive techniques. *J Pediatr Surg* 2001; 36: 324 - 328.
5. Kester K. Epidural pain management for the pediatric spinal fusion patient. *Orthopaedic Nursing* 1997; 16: 61 - 62.
6. Caudle CL, Freid EB, Bailey AG, Valley RD, Lish MC, Azizkhan RG. Epidural fentanyl infusion with patient - controlled epidural analgesia for postoperative analgesia in children. *J Pediatr Surg* 1993; 23: 554 - 558.
7. Rawal N. In: Raj PP, editor. *Practical management of pain: Spinal opioids for acute pain management*. 3rd ed. St. Louis: Mosby Inc; 2000. p. 698 – 702.
8. Kafiluddi R, Hahn MB. In: Raj PP, editor. *Practical management of pain: Epidural neural blockade*. 3rd ed. St. Louis: Mosby Inc; 2000. p. 646 - 50.

9. Payne KA, Hendrix MR, Wade WJ. Caudal bupivacaine for postoperative analgesia in pediatric lower limb surgery. *J Pediatr Surg* 1993; 28: 155 - 157
10. Takasaki M, Dohi S, Kawabata Y, Takahashi T. Dosage of lidocaine for caudal anesthesia in infants and children. *Anesthesiology* 1977; 47: 527 - 529.
11. Schulte - Steinberg O. Regional anesthesia for children. *Ann Chir Gynaecol* 1984; 73: 158.
12. Raj PP, Anderson SR. In: Waldman SD, editor. *Interventional pain management: Continuous regional analgesia*. 2nd ed. Philadelphia: W.B. Saunders Company; 2001. p 424 - 425.
13. Goldschneider KR, Mancuso TJ, Charles BB. In: Loeser JD, editor. *Bonica's management of pain: Pain and its management in children*. 3rd ed. Philadelphia: Lippincott Williams & Wilkins; 2001. p 803 - 805.
14. Bieri D, Reeve RA, Champion GD. The faces pain scale for the self - assessment of the severity of pain experienced by children. *Pain* 1990; 41: 139 - 150.
15. McGrath PA, Seifert CE, Speechley KN. A new analogue scale for assessing children's pain: an initial validation study. *Pain* 1996; 64: 435 - 443.
16. Scott PJ, Ansell BM, Huskisson EC. Measurement of pain in juvenile chronic polyarthritis. *Ann Rheum Dis* 1977; 36: 186 - 187.
17. AbuSaad H, Holzemer WL. Measuring children's self-assessment of pain. *Issues Compr Pediatr Nurs* 1981; 5: 337 - 349.

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morphine

bupivacaine fentanyl

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5 12

ASA class 1 2

ketorolac 1 mg/kg t.i.d. meperidine 0.5

mg/kg p.r.n.

0.1% bupivacaine

fentanyl 2 µg/ml

100 ml

0.1

ml/kg/hr

5 10

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0.05 ml/kg/30min

6

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