Comparison of Patient-controlled Epidural Analgesia and Continuous Epidural Infusion for Labor Analgesia

Sheng-Huan Chen, MD; Shiue-Chin Liou, MD; Chao-Tsen Hung, MD; Ming-Hung Shih, MD; Chit Chen, MD; Shih-Chang Tsai, MD; Chi-Hao Tseng, MD; Shu-Yam Wong, MD

Background: In recent years, patient-controlled epidural analgesia (PCEA) has been developed as an attractive alternative to continuous epidural infusion (CEI) for labor pain control. PCEA is still not popular for labor pain control in Taiwan and disparities may exist between different ethnic and cultural groups toward the attitude of labor pain control. The aim of this study was to investigate whether there were any differences between PCEA and CEI in the maintenance of epidural analgesia for Taiwanese parturients undergoing spontaneous delivery.

Methods: We collected data of 179 parturient requests for epidural labor analgesia. They were allocated into two groups with PCEA (n = 81) or CEI (n = 98) for maintenance with the same solution of 0.08% ropivacaine and 2 μg/mL fentanyl mixture. The demographic characteristics, epidural maintenance methods, dosage requirements, obstetrical outcomes, intervention of inadequate analgesia or side effects, and the quality of labor analgesia of parturient were also analyzed.

Results: There were no differences in demographic characteristics, duration of 1st and 2nd stages, delivery methods, fetal Apgar scores, local anesthetics usage, and analgesic qualities between the PCEA and CEI groups. There were also more requirements for intervention by the anesthesiologist due to inadequate analgesia in the CEI group.

Conclusion: The results of this study provided further evidence that PCEA is a highly effective method of the control of labor pain, which was highly accepted by women in labor. In a busy obstetric unit, this could potentially improve parturient satisfaction and reduce the workloads of clinicians and nurses.

(Chang Gung Med J 2006;29:576-82)

Key words: labor analgesia, patient-controlled epidural analgesia, ropivacaine.

Most women experience significant pain during childbirth. Labor pain can be managed in many ways. Epidural analgesia is the most popular method which can provide excellent pain relief yet, allows the mother to be awake and cooperative during labor.[1] After the initial loading dose is given, epidur-

From the Department of Anesthesiology, Chang Gung Memorial Hospital, Taipei.
Received: Feb. 16, 2006; Accepted: May 1, 2006
Correspondence to: Dr. Shu-Yam Wong, Department of Anesthesiology, Chang Gung Memorial Hospital. 5, Fushing Street, Gueishan Shiang, Taoyuan, Taiwan 333, R.O.C. Tel.: 886-3-3281200 ext. 8704; Fax: 886-3-3281200 ext. 8140; E-mail: dw0909@cgmh.org.tw

al analgesia for labor pain may be maintained by continuous epidural infusions (CEI) or patient-controlled epidural analgesia (PCEA). CEI uses an infusion pump to supply constant epidural anesthetic solutions. However, anesthesia personnel need to adjust the infusion rate when patients experienced side effects or when analgesic requirements change during labor.[2,3] In recent years, patient-controlled epidural analgesia (PCEA) has been used as an attractive alternative to the CEI.[4-6] The technique of PCEA utilizes a device that the parturient presses for a dose of epidural medication in response to her perception of labor pain. Several researchers have shown that when compared with CEI, PCEA was associated with less local anesthetic usage and fewer side effects, as well as fewer anesthesiologists' interventions while providing even better analgesia and patient satisfaction.[7-11]

PCEA has not been broadly used for birth pain control in Taiwan and there are no reports of the comparison between PCEA and CEI for Taiwanese parturient. There is evidence that pain response varies among different ethnic and cultural groups and disparities exists in the acceptance of epidural analgesia for labor pain.[12,13] The method of PCEA requires that the parturient be willing to accept the responsibility to control their labor pain. Their motivation to self-administer analgesics may be different. We are interested to know whether our parturient would enjoy the same benefits of PCEA for labor pain as women in Western countries have demonstrated.

METHODS

Data of the demographic characteristics, technique of maintenance, obstetric outcome, duration of epidural analgesia, total doses, need for supplementary drugs, analgesic qualities and any complaints requiring intervention were collected of the parturient. Cases with premature fetus (< 36 weeks) were excluded from analysis because they usually had complicated labor courses. Because our main focus was to compare the epidural maintenance period, the patients who delivered within 90 min of the start of epidural analgesia were omitted from analysis because the analgesia effect may have contributed significantly by the loading dose.

We provided on-demand epidural analgesia for parturient who asked for relief of labor pain without contraindications of epidural block. With the patient in a left lateral decubitus position, the L2 to L5 epidural space was identified using standard loss-of-resistance to air technique with an 18-gauge Tuohy needle. An 18-gauge open-end multiple-orifice epidural catheter (B. Braun™) was then inserted 3 to 5 cm in the cephalic direction into the epidural space without negative aspiration for blood or cerebrospinal fluid. The initial loading was given incrementally with 15 ml 0.67% lidocaine and 50 μg fentanyl with 1:300000 epinephrine. After 30 minutes, when each mother was comfortable, she was allocated to either the CEI or PCEA group to maintain epidural analgesia. This is a retrospective study without randomization because the chosen method was based on the preference of the anesthesiologists who was in charge of our obstetric unit.

In the CEI group, the epidural solution, 0.08% ropivacaine and 2 μg/mL fentanyl mixture, was infused with a pump at a rate between 8 to 12 mL/h determined by the anesthesiologist. In the PCEA group, the epidural catheter was attached to a patient-controlled analgesia device (Abbott Pain Management Provider) which was programmed to deliver 6 mL patient-triggered boluses of the same epidural solution with 5 min lock-out interval and 4-hour limit of 80 mL. There was no continuous background infusion. Labor was managed according to institutional standard labor ward protocols. The decision to proceed to operative delivery was made by the obstetrical team according to maternal or fetal indications. All parturient had continuous tocodynamometer and fetal heart rate monitoring. Maternal blood pressure and heartbeat were also measured at regular intervals.

Parturients were asked to inform the anesthesiologist of inadequate analgesia. Additional analgesia was given at 6 mL 0.25% ropivacaine in either group and the continuous infusion rate in CEI group was adjusted in increments of 2 mL/hour. The anesthesiologist might also be called for intervention for any side effects that were considered related to epidural analgesia. The maintenance epidural analgesia was discontinued after full dilatation of the cervical os for parturient to regain the sensation for pushing. After delivery, patients were asked by a nurse anesthetist to rank the quality of analgesia as "excellent", "good", "fair" or "unsatisfactory".

The patient demographics, gestational weeks, fetus body weight, pain control duration, 1st stage, 2nd stage, and local anesthetic usage were compared using unpaired t-tests. Chi squared tests was used for comparisons of percentage of nulliparity, labor by induction, need for supplement boluses, and incidences of complications such as leg numbness and pruritus. A *p* value of 0.05 or less was considered significant.

RESULTS

Maternal age, body weight, height, parity, cervix diameter at epidural catheterization, gestational age, fetal weight, and labor characteristics for subjects in both study groups are presented in Table 1. There were no significant differences between the two groups. The duration of epidural analgesia, 1st stage, 2nd stage of delivery courses, calculated mean local anesthetics usage, cesarean section rate are listed in Table 2. Both groups were comparable except the duration of epidural analgesia was significantly shorter in the PCEA group (CEI: 408.9 min ± 310.8 vs. PCEA: 320.5 min ± 211.3, $p = 0.031$) (Table 2). No infant had a 5-min Apgar score less than 8 in either group.

Parturient requesting additional analgesics were significantly more frequent in the CEI group than in the PCEA group (Table 3). Concerning side effects that required intervention, none in the PCEA group but in the CEI group 3.1% needed adjusting infusion rate due to unpleasant sensation with leg numbness and 2.0% asked for treatment for pruritus (Table 3). However, this did not achieve statistical significance. There were no other adverse effects related to epidural analgesia in either group such as hypotension, extensive sensory blockade, and respiratory depression. Ninety percent of subjects in the PCEA group and 85.2% in the CEI group considered the analgesic qualities to be good or excellent (Fig. 1). There were three cases in the CEI group rated their quality as unsatisfactory but no statistically significance differences of overall analgesic qualities existed between the two groups.

Table 1. Demographic and Obstetric Characteristics

	PCEA, n = 81		CEI, n = 98		*p*
	Mean	SD	Mean	SD	
BW (kg)	67.6	10.3	69.2	9.6	0.275
Height (cm)	159.1	5.6	159.3	5.1	0.786
Age (yr)	29.8	4.0	28.9	3.8	0.124
Gestational weeks	39.0	1.4	38.8	1.1	0.293
Baby BW (g)	3214.1	345.2	3206.3	362.9	0.884
Parity = 0	71.6%		76.5%		0.494
Cervical dilation <3 cm	53.9%		67.3%		0.065
Labor by induction	48.1%		51.0%		0.765

Abbreviations: SD: standard deviation; BW: body weight.

Table 2. Duration of Pain Control, 1st and 2nd Stages, Mean Hourly Local Anesthetic Usage and Cesarean Section Rate of the Two Groups

	PCEA		CEI		*p*
	Mean	SD	Mean	SD	
Pain control duration (min)	320.5	211.3	408.9	310.8	0.031
1st Stage (min)	229.4	182.2	249.6	218.2	0.508
2nd Stage (min)	50.5	44.5	47.5	38.5	0.631
Local anesthetics usage/hour (mg)	9.0	4.8	9.6	3.4	0.365
Rate of cesarean section	14.8%		9.7%		0.255
Reasons for cesarean section					
Prolong latent phase	3.7%		2.0%		0.660
Second arrest	1.2%		1.0%		1.000
Fetal distress	4.9%		3.1%		0.703
Chorioamnionitis	4.9%		3.1%		0.703

Abbreviation: SD: standard deviation.

Table 3. Requirement for Intervention for Inadequate Analgesia and Side Effects

	PCEA	CEI	*p*
Need for supplemental boluses (%)	3.7	29.6	0.000
Total number of supplemental boluses (%)	3.7	46.9	0.000
Leg numbness requiring decreasing dosage (%)	0	3.1	0.253
Incidence of pruritus requiring treatment (%)	0	2.0	0.502

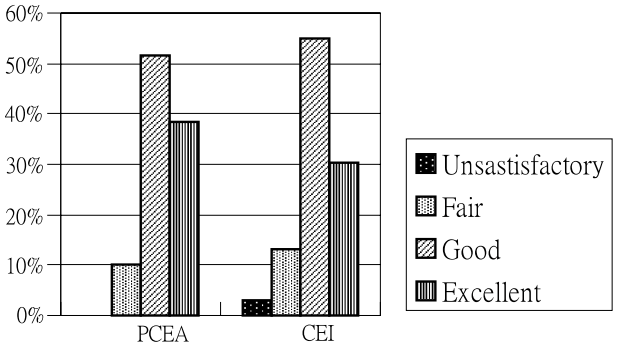

Fig. 1 Overall qualities of labor analgesia in both groups.

DISCUSSION

Our findings were consistent with those from previous studies showing that, as compared with CEI for labor analgesia, PCEA required significantly fewer anesthesiologists' interventions for inadequate analgesia.[2,3,5-9] In a busy obstetric unit with increased demand for epidural analgesia, this could reduce the workload of the anesthesiologists and obstetric nurses. Although regular follow-up was still necessary, it is much more satisfying to visit a comfortable parturient at a convenient time, than to be called to see a woman in distress asking for supplementary medication. An additional benefit may be the possible reduction of risk of infection in those who underwent PCEA because the frequencies for opening the epidural infusion systems for additional doses were fewer.

The concept of patient-controlled dosing was easily understood and well accepted by most of our parturient. No clinical deleterious effects were noted for the babies or mothers relating to epidural analgesia in group PCEA during the studying period. However, regardless of the apparently problem-free use of PCEA, there remains anxiety concerning the overuse of the demand button causing an overdose.[14] Multiple safety features of PCEA technology help minimize the risk. The lockout interval, bolus size, and 4-hour limit are programmed and act independently to prevent excessive administration.

Before providing the method of PCEA, there had been concern that the mothers may favor not to have the obligation of pressing a button for her own pain relief. However, during the interviewing process, we found that most parturient were satisfied in having control over their labor pain. The dosage was controlled by each individual thus allowing her to trade of therapeutic effects and side-effects. Some of the parturient even spared to press the button and were content to feel the sensation of uterus contraction once they had learn the skill of controlling it. The method of PCEA was welcomed by obstetric and anesthesia personnel because of fewer patient complaints.

Using PCEA, our patients titrated their own requirements and data analysis showed large variations in the mean hourly epidural solution usage (mean, 11.2 mL/h; interquartile range, 7.0~14.7 mL/h). Therefore, no single set continuous infusion rate will meet the needs of all individuals. A high setting of infusion rate serves the analgesic need for most mothers in labor; however, increased untoward effects may lower their satisfaction. A low setting of infusion rate may reduce the incidence of side effects but more frequent supplementation of analgesics may be necessary. The concept of PCEA is appealing because it permits the patient to self-administer only the amount of local anesthetic she requires to produce analgesia thus it can theoretically reduce the incidence of side effects.[11,15,16] Although not statistically significant, the PCEA group seemed to have fewer side effects requiring intervention.

Efficacies of PCEA were depended on the type and concentrations of drugs used and the setting of the program. For the setting of PCEA program, we adapted from the ideas of several authors that shorter lockout interval (5 min) with a small bolus dose may increase the efficacies without hazards of excessive dosing.[11,17] For epidural medication, there is a trend for the combination of diluted local anesthetic and lipophilic opioids, most often 2 μg/mL fentanyl.[18] Theoretically, the two drugs act by different mechanisms so their effects might be synergistic. This should therefore allow a decrease in the amounts of each drug to be administered and thereby minimizes the degree of side effects.[19-21] Ropivacaine was chosen as the local anesthetic because it was reported to be associated with less cardiac and central nervous system toxicity and has fewer motor blocks.[22] A relatively low concentration of ropivacaine, 0.08%, was selected. However our incidences of inadequate analgesia were not as high as in some other studies.[8,15,23]

We did not investigate the second stage analgesic effect because epidural medication was usually discontinued in our institute after full cervical os dilatation, fearing that parturient might have no sensation of urge to push. However, as the expectation of parturient toward analgesia qualities rises, PCEA might be more convenient for mothers to titrate their own requirements during the second stage. Although high concentrations of local anesthetics are generally considered necessary for controlling pain during the second stage, it has been demonstrated that a large mass from a high volume provided by repeated PCEA boluses may also provide the same analgesia requirement.[24]

The cesarean rate seemed higher in the PCEA

group than in the CEI group, although the difference was not statistically significant. Further analysis shows that many factors could influence a clinician's decision to proceed with cesarean delivery (Table 2). Although controversies still exists, it is generally accepted that epidural analgesia, with either administration mode, would not cause an increase in the cesarean section rate.[1,3,6,10]

Although not statistically significant, it seems that parturient received epidural analgesia earlier in the CEI group than in PCEA group because more patients had Cervical dilation < 3 cm (67.3% versus 53.7%, $p = 0.065$). Earlier initiation of epidural analgesia has been suggested to prolong labor course. Our findings demonstrated that the PCEA group had shorter duration than the CEI group of epidural pain control. It could be suggested that prolongation might be caused by earlier epidural analgesia. Regarding the large population variability, larger case numbers are required to have acceptable power to detect any significant differences of the effects on labor course.

There might be doubt that bias might exist since this was a retrospective study and lack of a double-blind design. We believe this could be minimized since the main focus was the incidences of inadequate analgesia which was determined by the parturient. In addition, there was no specific intervention in either group and both groups received care under our usual obstetric analgesic practice.

In conclusion, PCEA for labor pain decreased the incidence of inadequate analgesia and reduced the number of side effects requiring intervention, when compared with the patients who received continuous epidural infusion. This study provided further evidence that PCEA is a highly effective method of labor pain control, which was highly accepted by the women in labor at our hospital. In a busy obstetric unit, PCEA could potentially improve parturient satisfaction and reduce the workload of both doctors and nurses.

REFERENCES

1. Eltzschig HK, Lieberman ES, Camann WR. Regional anesthesia and analgesia for labor and delivery. N Engl J Med 2003;348:319-32.
2. Collis RE, Plaat FS, Morgan BM. Comparison of midwife top-ups, continuous infusion and patient-controlled epidural analgesia for maintaining mobility after a low-dose combined spinal-epidural. Br J Anaesth 1999;82:233-6.
3. Purdie J, Reid J, Thorburn J, Asbury AJ. Continuous extradural analgesia: comparison of midwife top-ups, continuous infusions and patient controlled administration. Br J Anaesth 1992;68:580-4.
4. Ferrante FM, Lu L, Jamison SB, Datta S. Patient-controlled epidural analgesia: demand dosing. Anesth Analg 1991;73:547-52.
5. Viscomi C, Eisenach JC. Patient-controlled epidural analgesia during labor. Obstet Gynecol 1991;77:348-51.
6. Gambling DR, Yu P, Cole C, McMorland GH, Palmer L. A comparative study of patient controlled epidural analgesia (PCEA) and continuous infusion epidural analgesia (CIEA) during labour. Can J Anaesth 1988;35:249-54.
7. van der Vyver M, Halpern S, Joseph G. Patient-controlled epidural analgesia versus continuous infusion for labour analgesia: a meta-analysis. Br J Anaesth 2002;89:459-65.
8. Sia AT, Chong JL. Epidural 0.2% ropivacaine for labour analgesia: parturient-controlled or continuous infusion? Anaesth Intensive Care 1999;27:154-8.
9. Boutros A, Blary S, Bronchard R, Bonnet F. Comparison of intermittent epidural bolus, continuous epidural infusion and patient controlled-epidural analgesia during labor. Int J Obstet Anesth 1999;8:236-41.
10. Ledin ES, Gentele C, Olofsson CH. PCEA compared to continuous epidural infusion in an ultra-low-dose regimen for labor pain relief: a randomized study. Acta Anaesthesiol Scand 2003;47:1085-90.
11. Gogarten W. Patient-controlled epidural analgesia is the technique of choice for epidural analgesia in labour. Int J Obstet Anesth 2005;14:328-9.
12. Sheiner E, Sheiner EK, Shoham-Vardi I, Gurman GM, Press F, Mazor M, Katz M. Predictors of recommendation and acceptance of intrapartum epidural analgesia. Anesth Analg 2000;90:109-13.
13. Senden IP, van dW, Eskes TK, Bierkens PB, Laube DW, Pitkin RM. Labor pain: a comparison of parturients in a Dutch and an American teaching hospital. Obstet Gynecol 1988;71:541-4.
14. Lurie S. Patient-controlled epidural anesthesia during labor may be hazardous. Anesthesiology 1990;73:789-90.
15. Boselli E, Debon R, Cimino Y, Rimmele T, Allaouchiche B, Chassard D. Background infusion is not beneficial during labor patient-controlled analgesia with 0.1% ropivacaine plus 0.5 μg/ml sufentanil. Anesthesiology 2004;100:968-72.
16. Paech MJ. Patient-controlled epidural analgesia in labour--is a continuous infusion of benefit? Anaesth Intensive Care 1992;20:15-20.
17. Stratmann G, Gambling DR, Moeller-Bertram T, Stackpole J, Pue AF, Berkowitz J. A randomized comparison of a five-minute versus fifteen-minute lockout interval for PCEA during labor. Int J Obstet Anesth 2005;14:200-7.
18. Smedvig JP, Soreide E, Gjessing L. Ropivacaine 1 mg/ml,

plus fentanyl 2 μg/ml for epidural analgesia during labour. Is mode of administration important? Acta Anaesthesiol Scand 2001;45:595-9.
19. Elliott RD. Continuous infusion epidural analgesia for obstetrics: bupivacaine versus bupivacaine-fentanyl mixture. Can J Anaesth 1991;38:303-10.
20. Murphy JD, Henderson K, Bowden MI, Lewis M, Cooper GM. Bupivacaine versus bupivacaine plus fentanyl for epidural analgesia: effect on maternal satisfaction. BMJ 1991;302:564-7.
21. Jones G, Paul DL, Elton RA, McClure JH. Comparison of bupivacaine and bupivacaine with fentanyl in continuous extradural analgesia during labour. Br J Anaesth 1989;63:254-9.
22. Campbell DC, Zwack RM, Crone LA, Yip RW. Ambulatory labor epidural analgesia: bupivacaine versus ropivacaine. Anesth Analg 2000;90:1384-9.
23. Boselli E, Debon R, Duflo F, Bryssine B, Allaouchiche B, Chassard D. Ropivacaine 0.15% plus sufentanil 0.5 μg/mL and ropivacaine 0.10% plus sufentanil 0.5 μg/mL are equivalent for patient-controlled epidural analgesia during labor. Anesth Analg 2003;96:1173-7.
24. Bernard JM, Le RD, Frouin J. Ropivacaine and fentanyl concentrations in patient-controlled epidural analgesia during labor: a volume-range study. Anesth Analg 2003;97:1800-7.

硬脊膜外病患自控式和連續硬脊膜外注射對產痛止痛的比較

陳聖桓 劉雪金 洪銚辰 施明宏 陳 捷 蔡時彰 曾紀浩 黃樹欽

背 景： 近年來，除了連續硬脊膜外滴注法外，已經有利用病患自控式硬脊膜外止痛，來維持生產疼痛控制。在臺灣，以病患自控式硬脊膜外止痛的方法，控制生產疼痛並不普遍。由於不同種族及文化背景的人，對於生產止痛的態度可能會有差異，我們想要探討臺灣的產婦自然生產，以病患自控式和連續硬脊膜外滴注做止痛，是否有所差別。

方 法： 我們收集 179 例，接受自控式(81 人) 或連續滴注作硬脊膜外 (98 人) 做生產疼痛控制的產婦資料。分爲 PCEA 及 CEI 兩組，使用藥物都是 0.08% ropivacaine 和 2μg/mL 混合劑。分析的項目包括產婦基本資料，硬脊膜外止痛維持方法，使用藥物劑量，生產結果，是否需要追加止痛藥，副作用，以及止痛效果等。

結 果： 兩組基本資料，第一，二產程，生產方式，嬰兒 Apgar 評分，局部止痛藥使用劑量，以及止痛效果並無顯著差異。但 CEI 需要麻醉醫師處理突然疼痛的機會比較大。

結 論： 本報告進一步證明病患自控式硬脊膜外止痛，是一個產婦接受度很高的生產止痛方式。在繁忙的產房，使用病患自控式做硬脊膜外生產止痛，可增加產婦滿意度和減輕臨床醫護人員的工作負擔。

(長庚醫誌 2006;29:576-82)

關鍵字： 生產止痛，病患自控式硬脊膜外止痛，ropivacaine。

長庚紀念醫院 台北院區 麻醉部
受文日期：民國95年2月16日；接受刊載：民國95年5月1日
通訊作者：黃樹欽醫師，長庚紀念醫院 麻醉部。桃園縣333龜山鄉復興街5號。Tel: (03)3281200轉8704; Fax: (03)328200轉8140; E-mail: dw0909@cgmh.org.tw