Novel Labor Analgesic Technique

Computer-Controlled Dose-Needed Intermittent Epidural Drug Delivery without Opioid Supplementation

Nan Wang, MD, MSc; Shiqin Xu, MD, MPH; Fuzhou Wang, MD, PhD; Xiaofeng Shen, MD, MPH

SUMMARY

Epidural analgesia is the most effective technique to relieve labor pain. Much progress has been achieved in terms of providing more efficacious and safer labor analgesia. Maintenance regimens of labor analgesia have evolved from manual boluses to continuous infusions to patient-controlled boluses. Patient-controlled epidural analgesia (PCEA) plus programmed intermittent epidural boluses (PIEB) regimens reduce local anesthetic consumption, decrease the need for clinician boluses and produced better analgesic efficacy and higher patient satisfaction in comparison with continuous epidural infusion (CEI). Sole epidural local anesthetic without opioid supplementation produced a comparable analgesic effect, lower local anesthetic consumption, fewer side effects, less incidence of neonatal lower Apgar scoring in comparison with local anesthetic plus opioid for labor analgesia. Computer-controlled dose-needed intermittent epidural drug delivery without opioid supplementation is a reliable and effective method of maintaining epidural labor analgesia.

KEYWORDS

Labor Pain; Novel Technique; Analgesia; Opioid; Drug Delivery

Labor has been reported to be one of the most painful experiences during a woman’s life (1), and painful labor can be deleterious to mother and fetus through affecting several physiological processes adversely. The ideal labor analgesic technique should provide effective pain relief and meet the changing needs of the parturient throughout the phases of labor, with minimal adverse maternal/fetal effects and motor blockade so as to provide women in labor with a highly satisfactory birthing experience. The review focuses on current analgesic techniques that have been developed to attain this goal.

**PATIENT-CONTROLLED EPIDURAL ANALGESIA (PCEA)**

Epidural anesthesia, as the most effective procedure over other techniques (2), has provided efficacious and safe pain relief to the parturient for many years. Many studies have showed much lower pain scores following epidural analgesia with higher maternal satisfaction. Besides epidural analgesia is also associated with better fetal physiology and maternal cardiovascular and pulmonary (3). There is growing awareness of the importance of allowing the parturient to make decision in labor and delivery. So the use of a patient-controlled modality for controlling labor pain control, such as PCEA, has developed into an attention-getting alternative to the conventional continuous epidural infusion (CEI). The technique allows the parturient to self-administer a dose of epidural drug with or without a background infusion of the same medication.

PCEA was first described by Gambling et al. in 1988 (4) and entails the customization of settings for background infusion rates, demand boluses, lockout intervals and hourly dose limits that can be programmed specifically by the anesthesiologist for individual patients. Therefore, it allows better dose-needed matching as labor and pain progresses. In addition, types of PCEA regimens have ranged from a large bolus size with long lockout interval to a small bolus size with high background infusion rate. Classic studies have suggested that parturients on PCEA could get more satisfactory labor pain relief with significantly lower utilization of local anesthetics for labor analgesia, albeit a placebo effect could not be excluded, when compared to continuous infusions (4, 5). Specifically, compared with CEI, PCEA has been shown to be associated with a significant reduction in dose requirements hourly, varying from 17-47 % (4, 6) without clinically significant impact on obstetric or neonatal outcomes (7). Even though the use of PCEA has been almost two decades of clinical experience, the drug combination, optimal dose and settings with the best maternal comfort but without adverse effects on obstetric or neonatal outcomes have yet to be studied and determined. In particular, it still remains controversial whether a background infusion should be given for greater efficacy of PCEA use. Studies have found that patients who received PCEA without a background infusion reported a higher incidence of intense pain (8) and more clinician interventions (9) as compared to those with a background infusion. However the use of PCEA without a background infusion has been shown to reduce the amount of medication, by approximately one half, required maintaining labor analgesia compared with PCEA plus continuous infusion (6). In a review of PCEA studies, it was concluded that PCEA use was safe, led to reduced local anesthetic and opioid consumption but without compromising analgesia and may help to reduce work load (10). Subsequently, a meta-analysis compared the efficacy and safety of PCEA with CEI, with investigators mostly using bupivacaine or ropivacaine with or without opioids and no background infusion and found that the PCEA group required a lower dose of anesthetic, fewer anesthetic interventions, and therefore, fewer motor block of the extremities (7). There was no difference in frequency of motor block, mode of delivery or patient satisfaction between the two groups. Although findings of recent studies seem to support the use of background infusion for its greater analgesic efficacy, this is associated with increased drug utilization compared with demand-only PCEA (11).

**PROGRAMMED INTERMITTENT EPIDURAL BOLUSES (PIEB)**

A recent development changing the way PCEA is administered is PIEB, which is an automated and intermittent method of administering epidural local anesthetic with or without opioids. Instead of CEI, PIEB administered the same total hourly amount of local anesthetic as intermittent boluses and has been shown to be more effective than CEI for labor analgesia (12, 13). The PIEB resulted in similar analgesic efficacy, less need for unscheduled clinician rescue boluses and higher maternal satisfaction compared to CEI (14). Compared with PCEA, PIEB has been shown to be associated with a higher satisfaction rate (15). However, it has not been studied whether the maternal and fetal outcomes differ between these two techniques.
satisfaction. The technique also resulted in less local anesthetic use for maintenance of epidural labor analgesia. The mechanism proposed for the local anesthetic-sparing effect of PIEB is a more uniform spread of epidural local anesthetics when large volumes of local anesthetic are delivered with correspondingly high pressures (14).

**PCEA PLUS PIEB**

PIEB can be utilized as an alternative to CEI alone or as background maintenance with PCEA. Recently, PCEA combined with PIEB were compared with PCEA with a standard continuous background infusion (15). It was found that the PIEB resulted in reduced ropivacaine use and less PCEA demand boluses while maintaining similar epidural analgesia during labor. A meta-analysis of comparative studies demonstrated a statistically significant reduction in local anesthetic consumption and increased maternal satisfaction with PIEB (16). Recently, a study by McKenzie et al. (17) showed that using PIEB compared to CEI as the background administration epidural analgesia method in conjunction with PCEA significantly reduced the number of clinician rescue boluses while providing comparable labor analgesic efficacy. This clinical care impact study not only confirm the results of randomized controlled studies and but also suggest PIEB may be a preferable analgesic technique to CEI for the maintenance of labor analgesia. The findings of the study were consistent with ours. At our center, after successful induction of epidural analgesia, 186 healthy parturients in early labor randomly received 0.08% ropivacaine + 0.4 μg/ml fentanyl 5 ml either via PCEA plus PIEB or via PCEA plus CEI. Our study showed that the use of PIEB reduced drug consumption and PCEA boluses and resulted in better analgesic efficacy and higher patient satisfaction in comparison with CEI. There was no difference in side effects and assisted delivery rates. Here we conclude that PCEA plus PIEB reduced analgesic consumption and could be useful as the mode of maintenance for epidural analgesia. Hence, the computer-controlled dose-needed intermittent epidural analgesia without background infusion is a reliable and effective method of maintaining epidural labor analgesia.

**ROPIVACAINE IN EPIDURAL ANESTHESIA WITHOUT OPIOID SUPPLEMENTATION**

Traditionally, epidural labor analgesia was induced by injecting manually fractionated boluses of local anesthetics through an epidural-fractionated catheter which was inserted at lower lumbar interspaces. To our knowledge, prior to the 1980’s, the local anesthetics used for the purpose were primarily bupivacaine, lidocaine and 2-chloroprocaine and bupivacaine became the popular choice for the initiation of epidural labor analgesia and subsequent intermittent bolus top-ups. Nevertheless, bupivacaine is more cardiotoxic than other epidural local anesthetics (8) and motor blockade accompanies the analgesic efficacy especially at higher concentrations (19). In 1984, following a number of obstetric deaths due to bupivacaine (0.75% solution) cardiotoxicity, the search for long-acting, less toxic local anaesthetics was launched.

Ropivacaine is a left-turning molecule and was the first new local anesthetic agent to reach the market. Clinical studies in patients and volunteers suggested that ropivacaine was similar to bupivacaine in onset and extent of sensory block, although duration was shorter and motor block was less intense (20). Over the last few years, ropivacaine has increasingly been used in clinical anesthesia practice and pain management in China and the shorter duration of action of ropivacaine could be construed as a clinical advantage. However, high concentrations of local anesthetics could result in a high incidence of motor blockade (21) and also other unwanted effects such as maternal hypotension (22). In order to reduce these unwanted effects, opioids in the form of fentanyl or sufentanil were added to the local anesthetic solution used for subsequent maintenance of labor analgesia.

However the benefits of local anesthetic-sparing effects induced by opioids must be weighed against opioid-associated long-term and acute side effects for both newborns and mothers. Except for acute side effects such as nausea, vomiting, urinary retention, and pruritus (1), epidural opioid has been reported to be associated with rise in maternal temperature during labor (23), lower breast-feeding success rate at 6 weeks postpartum (24), fetal bradycardia, neonatal respiratory depression, and neonatal neurobehavior alterations (25), and overly poor outcomes in neonates (26). As early as 1980s, Golub et al. (27) had paid attention to the disposition and the long-term influence on neonatal behaviors of intrapartum narcotic analgesics in monkeys. The study has showed that the use of morphine analgesia in neonatal intensive care unit may lead to injury of the long-
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term behavioral, neurocognitive, and adaptive outcomes in early childhood (28). In all, opioids must be used with caution for epidural labor analgesia. It has been observed that sole ropivacaine was effective in relieving labor pain without motor blockade as compared to a combination of ropivacaine with fentanyl or clonidine (29). In addition, when comparing epidural fentanyl only with fentanyl plus bupivacaine during the second stage of labor, there was no significantly difference with regard to labor pain control, delivery method, maternal or neonatal outcomes, as well as the duration of the second stage of labor (30). Our previous study has observed the analgesic effect of epidural ropivacaine supplemented with sufentanil for labor, and found that this analgesic soup relieved labor pain effectively without significant delay of labor progress (31). But recently, in a published meta-analysis, sufentanil and fentanyl in combination with bupivacaine have been found to provide comparable analgesia via the intrathecal or epidural routes for labor pain relief, but the number of neonates with Apgar 7 was significantly greater in sufentanil and bupivacaine treated women (32). Our recent study by Wang et al. (33) has indicated that sole ropivacaine produced a comparable analgesic efficacy as the combination of ropivacaine and sufentanil for labor analgesia. Moreover, sole epidural ropivacaine was associated with lower analgesia-related cost, less incidence of neonatal lower 1-minute Apgar scoring, and fewer side effects, this study warranted us to reconsider the rationality of supplementing opioids with local anesthetics for labor analgesia.

CONCLUSIONS

Labor epidural analgesia techniques have progressed to provide more effective and predictable labor analgesia. Computer-controlled dose-needed intermittent epidural drug delivery without opioid supplementation may be preferable for maintenance of labor analgesia. Future studies are required to determine the optimal PIEB settings to maximize analgesic benefit and minimize maternal and neonatal side effects and impact on labor progress.

ARTICLE INFORMATION

Author Affiliations: Department of Anesthesiology, Gynecology and Obstetrics Hospital, Nanjing Medical University, Nanjing 210004, China

Author Contributions: Dr. Shen had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: All authors.

Acquisition, analysis, or interpretation of data: All authors.

Drafting of the manuscript: Nan Wang.

Critical revision of the manuscript for important intellectual content: All authors.

Statistical analysis: N/A.

Obtained funding: N/A.

Administrative, technical, or material support: Shen.

Study supervision: Shen.

Conflict of Interest Disclosures: All authors declared no competing interests of this manuscript submitted for publication.

Funding/Support: N/A

Role of the Funder/Sponsor: N/A

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