Labour analgesia: what's new and PCEA too?

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*"The delivery of the infant into the arms of a conscious and pain-free mother is one of the most exciting and rewarding moments in medicine."*¹

This statement encapsulates the passion of those championing the delivery of pain relief for women in labour throughout the world. Unfortunately, labour pain relief is an important aspect of women's health that is often completely neglected by healthcare administrators and providers. This is surprising considering that labour is reported to be one of the most painful experiences in a woman's life.² Recently, however, societal and professional healthcare attitudes have changed considerably. In 1992, the American College of Obstetrics and Gynecology (Committee Opinion on Pain Relief during Labour) acknowledged that "labour results in severe pain for many women." The Committee Opinion elaborated by stating that there is "no other circumstance where it is considered acceptable for a person to experience severe pain, amenable to safe intervention, while under a physician's care" and ultimately recognized that "maternal request is sufficient justification for pain relief during labour."

It is now well recognized that the only consistently effective method of pain relief during labour is lumbar epidural analgesia.^{3,4} Epidural labour analgesia possesses a long record of safety and has few associated complications. The American College of Obstetrics and Gynecology's guidelines for perinatal care clearly state that "epidural block is the most effective and least depressant (pharmacologic option), allowing for an alert, participating mother." As a result, the administration of analgesic medications into the lumbar epidural space has evolved to be considered the "gold standard" for pain relief during labour.

It is important to realize that the word "epidural" is, however, not a universal term. "Epidural" analgesia simply implies that labour pain relief is achieved as a result of medications administered into the epidural space, which temporarily interrupt the transmission of labour pain. Adverse effects including lower extremity motor blockade sufficient to preclude both maternal ambulation and expulsive efforts as well as interfer-

ence with spontaneous micturition varies widely depending upon the type and concentration of medication utilized. Over the past 60 years, labour epidural analgesia has undergone substantial changes. Currently, "state-of-the-art" techniques have been developed and are now used in routine clinical practice in many centres.

Historically, labour epidural analgesia was achieved by rapidly injecting a large volume of a high concentration of local anesthetic (typically 0.75% bupivacaine) through the epidural needle. Immediately following this "single-shot" of medication, the epidural needle was removed. Within ten to 20 min, women experienced profound labour analgesia lasting for 1–1.5 hr. Unfortunately, if the effect of the local anesthetic dissipated prior to delivery, and the women requested additional analgesia, the entire procedure had to be repeated. This "single-shot" technique, although effective, necessitated subjecting many women to multiple procedures during protracted labours. Considering that the average length of labour for nulliparous women is approximately ten hours, the limited duration of analgesia afforded by this technique was neither desirable for many women nor anesthesiologists. Consequently, many maternity centres reserved epidural labour analgesia for women with obstructed labours or those experiencing extreme maternal distress only in the late first stage of labour (> 7 cm).

In 1979, a correlation between the "single-shot" epidural technique and several maternal deaths was observed when 0.75% bupivacaine was administered leading to its removal from the market.⁵ These catastrophes resulted from the unrecognized injection of the local anesthetic through an epidural needle placed intravascularly or intrathecally. As a result, a significant advance in the technique of providing and maintaining labour epidural analgesia emerged. This advance, the epidural catheter, first used in the 1940's, was reintroduced into routine clinical practice after numerous advancements in manufacturing methods. Unlike the epidural needle, the catheter remained in the epidural space to facilitate the administration of supplemental analgesia or anesthesia thus avoiding the need for repeated epidural needle reinsertion.

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The use of the epidural catheter also brought forth the development of a much safer method of administering the local anesthetic solution. To avoid similar catastrophic complications associated with the “single-shot” epidural needle technique, it became recommended practice to inject only small (3–5 mL) doses of local anesthetic incrementally through the epidural catheter. Administration of local anesthetic solutions through the epidural needle was discouraged as it was no longer considered “safe” clinical practice. This new “fractionated bolus” technique also incorporated “passive” observation for blood or cerebrospinal fluid (CSF) followed by “active” aspiration from the epidural catheter in an attempt to detect the accidental migration of the catheter either intrathecally or intravascularly. This practice is undertaken immediately prior to and following every injection. Just as important, continued to be the assessment of the parturient (constant vigilance) with each injection. Hence, the concept that every dose administered through the epidural catheter is a “test dose” has become the foundation of modern obstetric regional analgesia/anesthesia practice. This “safer” technique enabled anesthesiologists to quickly identify catheter migration intravascularly or intrathecally prior to the administration of the entire volume of local anesthetic.

Concurrently, anesthesiologists began to appreciate the advantage of a properly placed epidural catheter to facilitate the administration of regional surgical anesthesia for an instrumented (forceps) or Cesarean delivery. Considering the significant maternal risks associated with the administration of general anesthesia in the parturient population (failed intubation, hypoxemia, aspiration) this multifunctional analgesic (anesthetic) catheter technique has become an invaluable tool in avoiding these catastrophic complications. Consequently, a significant reduction in maternal mortality has been observed over the past 20 years.⁶

The next significant advance in epidural analgesia involved the method of maintaining labour pain relief. Although the use of the epidural catheter negated the need to subject women to multiple epidural needle placements, the duration of action of the analgesic solutions was not altered. By administering intermittent, fractionated volumes (“top ups”) of the epidural analgesic solutions labour pain relief was maintained, at best, intermittently. Unfortunately, these intermittent analgesic “top ups” lead to dramatic swings in parturient comfort due to unavoidable delays in the delivery of subsequent injections. As a result, women experienced discomfort that might last 30–60 min or longer every one to two hours until delivery. The successful introduction of continuous infusion epidural

analgesia (CIEA) provided a method of avoiding these episodes of recurring periods of pain as a consequence of the wearing off of the intermittent “top up.”^{7–9}

Prior to the late 1980’s, the local anesthetics, bupivacaine, lidocaine and 2-chlorprocaine, were primarily used to provide epidural labour analgesia. Subsequently, undiluted bupivacaine (0.5%) became popular for the initiation of epidural analgesia as well as intermittent “top ups” and CIEA. Although effective analgesia was achieved, this high concentration of bupivacaine also produced dense motor blockade of the labouring woman’s lower extremities and expulsive muscles. This adverse effect also interfered with maternal awareness of contractions during the second stage of labour and more importantly, negated any maternal urge to push during delivery. As a consequence of the profound anesthesia and motor blockade, it became necessary to discontinue CIEA during the transition period or second stage of labour.⁸ As expected this resulted in the return of excruciating labour pain, with subsequent loss of maternal control at the time of delivery.

In an attempt to reduce the adverse effect of the undiluted “high” concentrations of bupivacaine for the maintenance of epidural labour analgesia, the opioid, fentanyl was added. The addition of fentanyl to bupivacaine permitted a reduction in the maintenance concentration of bupivacaine from 0.5% to as low as 0.065% while still maintaining effective labour analgesia.⁹ Although the combination of 0.065% bupivacaine plus 2 $\mu\text{g}\cdot\text{mL}^{-1}$ fentanyl was reported,⁹ unfortunately many anesthesiologists continue to use much higher concentrations of bupivacaine (0.1–0.25%) combined with 2 $\mu\text{g}\cdot\text{mL}^{-1}$ fentanyl to maintain epidural labour analgesia. Even when diluted, bupivacaine continues to be associated with sufficient motor blockade to preclude maternal ambulation, reduced maternal awareness and expulsive efforts at delivery. However, by reducing the concentration of bupivacaine much less motor blockade has been observed resulting in the continuation of CIEA throughout the transition and second stage of labour. This advancement has been shown to significantly reduce maternal pain and greatly improve maternal satisfaction with the childbirth experience.^{3,8–10}

In response to both parturient and obstetrical concerns regarding the undesirable effects of maternal motor blockade associated with the use of epidural bupivacaine, investigators have continued to search for the ideal form of labour analgesia. The ideal labour analgesic must be devoid of the undesirable effects of motor blockade while simultaneously maintaining the unique advantages of epidural analgesia. Several criteria must be fulfilled before being considered the ideal

labour analgesic modality (Table I). In addition to those listed, the ideal labour analgesic should also facilitate a maternal sense of composure and control, as well as the option of ambulation especially during a long labour. From the obstetrical caregiver's perspective, the ideal labour analgesic should also give a rested parturient the energy, strength and sensation to perform expulsive efforts at the time of delivery with the ability to assume various birthing positions. To achieve these goals, recent developments have facilitated maternal ambulation while receiving effective regional labour analgesia.

In an attempt to achieve analgesia devoid of motor blockade, much attention was focused in the 1990's on intrathecal analgesia. Over the past decade clinical investigations have followed a logical progression and provided the rationale for the development of the intrathecal analgesic solutions currently utilized.¹¹ Of the intrathecal opioids, sufentanil has been extensively investigated and produces effective analgesia within two minutes, lasting approximately two hours.^{12,13} Unfortunately, it affords ineffective analgesia during the transition and second stage of labour. Consequently, in an attempt to improve intrathecal labour analgesia, particularly during the second stage of labour, bupivacaine (2.5 mg) was added to sufentanil (10 µg). This combination of sufentanil and bupivacaine provides rapid, profound, consistent ambulatory analgesia lasting longer (2.5–3 hr) with efficacy in both the first and second stage of labour.¹⁴ Attempts to reduce the doses of both sufentanil (5 µg) and bupivacaine (1.25 mg) have recently been shown to be less effective in terms of analgesic profile, duration and efficacy during the transition or second stage.^{15,16} Currently, the most efficacious intrathecal analgesic solution to be developed which permits labouring women to ambulate, is a combination of intrathecal sufentanil (10 µg) and bupivacaine (2.5 mg). Unfortunately, the "single-shot" intrathecal analgesic technique is limited by the finite duration of action (2–3 hr) and lacks the advantage of facilitating supplemental analgesia or surgical anesthesia.

In an attempt to maximize the advantages of "single-shot" intrathecal analgesia and epidural catheter, the combined spinal-epidural (CSE) technique has recently gained widespread popularity.¹¹ The CSE technique affords rapid, profound, consistent, ambulatory labour analgesia provided by intrathecal sufentanil and bupivacaine as well as the potential to provide additional analgesia or anesthesia via the epidural catheter.

The ability of labouring women to ambulate is provided by the intrathecal component of the CSE technique and has resulted in many anesthesiologists and

TABLE I Characteristics of the ideal labour analgesic

Maternal and fetal safety
Ease of administration
Consistent, predictable, rapid onset
Maternal composure and control during both the 1st and 2nd stages of labour
Analgesia through all stages of labour
Devoid of motor blockade, enabling ambulation and various birthing positions
Preserve the stimulus for expulsive efforts during the 2nd stage of labour
Retain maternal expulsive efforts
Facilitate the delivery of supplemental analgesia without additional invasive procedures
Facilitate the delivery of anesthesia for surgery to avoid the need for general anesthesia

Ref (11): *Campbell DC. Techniques in Reg Anesth and Pain Management 1997; 1: 113–7.*

TABLE II Motor assessment to determine ability to ambulate unassisted

Assessment	Task
Leg strength	Straight leg raise (both legs)
Postural hypotension	Sit at bedside
Leg strength & postural hypotension	Stand at bedside
Leg strength	Partial deep knee bend
Ambulation	Six unassisted steps

Assessment performed 15–20 min following intrathecal analgesia (*) and 30 min following epidural analgesia (**).

* Ref (14): *Campbell DC, et al. Anesthesiology 1997; 86: 525–31.*

** Ref (26): *Campbell DC, et al. Anesth Analg 2000; 90: 1384–9.*

parturients renaming this technique the "Walking Epidural." With increased awareness of this technique, many labouring women are currently requesting the option of ambulation and it has become widely accepted. At the University of Saskatchewan protocols are in place to assess each woman's ability to ambulate unassisted while under the influence of either intrathecal or epidural medication (Table IV). For additional safety, it is our policy that each ambulating woman must be reassessed every time they either sit or lay down and during ambulation they must be accompanied by their significant other, labour coach or nurse. The clinical benefits of ambulation on the progress of labour and labour outcome, other than improved patient satisfaction, remains controversial^{17–19} and has yet to be thoroughly investigated. There is, however, no question that the initiation and maintenance of epidural labour analgesia with high (> 0.1%) concentrations of local

TABLE III Low concentration epidural solution preparation

100 mL preservative-free 0.9% saline (100 mL mini-bag)
Add: 20 mL 0.5% ropivacaine
Add: 250 µg (5 mL) fentanyl
Total volume = 125 mL
Final concentration: 0.08% ropivacaine + 2 µg·mL ⁻¹ fentanyl

Ref (26): *Campbell DC, et al. Anesth Analg* 2000; 90: 1384–9.

anesthetics has become undesirable due to the resultant significant motor blockade which interferes with maternal expulsive efforts.

The CSE ambulatory labour analgesia technique fulfills many of the characteristics necessary to be considered ideal. However, for labours lasting longer than the analgesic effects of the intrathecal solutions (i.e., 2–3 hr) additional medications must be administered through the epidural catheter to maintain analgesia until the postpartum period. Unfortunately, even low concentration (< 0.1%) bupivacaine solutions produce sufficient motor blockade over time to preclude ongoing ambulation. As a result, at our institution, the CSE technique is generally reserved for women with evidence of rapidly progressive labour and advanced cervical dilatation. This permits the majority of women to deliver while receiving effective intrathecal analgesics that are devoid of motor block.

With the limitations of the CSE technique, recent efforts have focused upon attempts to improve the method of epidural analgesia initiation to reduce, if not eliminate, motor blockade while providing effective labour analgesia within a reasonable timeframe (i.e., < 20 min). This area of investigation must be viewed in context as many anesthesiologists continue to administer 10–15 mL of undiluted bupivacaine (0.25–0.5%) to initiate epidural labour analgesia. Prior to embarking on this line of research, the practice of administering a small volume (3 mL) of a high concentration of local anesthetic (1.5% lidocaine plus 5 mg·mL⁻¹ epinephrine) as a single epidural “test dose” prior to initiating epidural analgesia in the labouring parturient had to be reexamined.²⁰ Much evidence exists today that supports the view that 3 mL of 1.5% lidocaine plus 5 µg·mL⁻¹ epinephrine is unnecessary and neither sensitive nor specific to detect intravascular epidural catheter placement in the labouring parturient.^{21,22} Conversely, the philosophy that every dose administered through the epidural catheter is a “test dose” is now widely accepted. The intrathecal injection of medication intended for the epidural space is easily detected by the observation of rapid

TABLE IV Low concentration epidural labour analgesia

<i>Initiation (*)</i>
1) Withdraw 20 mL of 0.08% ropivacaine + 2 µg·mL ⁻¹ fentanyl from 125 mL infusate solution
2) Place epidural catheter as per usual (do not use 20 mL syringe (sterile) for local infiltration)
3) Have nurse transfer 20 mL of infusate to 20 mL sterile syringe on epidural tray
4) Observe catheter for CSF/blood; aspirate catheter for CSF/blood
5) Inject 5 mL of infusate through epidural catheter as “initial dose”
6) Observe catheter for CSF/blood; aspirate for CSF/blood
7) Secure epidural catheter to parturient’s back then reposition supine with L(R)UD
8) Ensure no motor blockade nor analgesia (with next contraction)
9) Inject additional 5 mL boluses incrementally (× 3) aspirating before and after each injection
10) Instruct parturient that analgesia will be initially begin within 3–5 contractions (five minutes)
11) Instruct parturient that profound analgesia will occur within an additional 3–5 contractions

Note: If parturient experiencing perineal pressure from advanced labour (i.e., cervix is ≥ 7 cm dilated) then also administer 100 µg of fentanyl

* Ref (26): *Campbell DC, et al. Anesth Analg* 2000; 90: 1384–9.

Maintenance options

Use remaining 105 mL of 0.08% ropivacaine + 2 µg·mL⁻¹ fentanyl

CIEA alone:	10–12 mL·hr ⁻¹
CIEA + PCEA (top up)@:	CIEA: 10–12 mL·hr ⁻¹ PCEA: bolus: 5 mL; lockout: 10 min; No 4-hr limit
CIEA + PCEA:	CIEA: 5 mL·hr ⁻¹ PCEA: bolus: 5 mL; lockout: 10 min; No 4-hr limit
PCEA:	PCEA: Bolus: 5 mL; lockout: 10 min; No 4-hr limit

@ = most common option utilized currently at the University of Saskatchewan; CSF = cerebrospinal fluid; CIEA = continuous infusion epidural analgesia; PCEA = patient-controlled epidural analgesia.

onset of profound analgesia similar to that observed with intrathecal analgesics.

To avoid motor blockade, low concentrations (< 0.1%) of bupivacaine combined with fentanyl (commonly 2 µg·mL⁻¹) were administered to initiate labour analgesia. Much to the surprise of many anesthesiologists these solutions have been shown to effectively initiate epidural labour analgesia.^{23–26} Specifically, the initiation of effective labour analgesia [visual analogue scale pain score (VAS < 30/100)] was reported in 80% of women with a 15-mL bolus of 0.1% (15 mg) bupi-

TABLE V Safety features of PCEA labour analgesia

CSA approved devices
Computer controlled
Programmed by the anesthesiologist
Delivery of small doses of the analgesic maintenance solution
Defined lockout period
Hourly limits - unnecessary with appropriate nursing supervision
Parturient initiated - self-administered
Established monitoring protocols for nursing staff

PCEA = patient-controlled epidural analgesia; CSA = Canadian Standards' Association.

vacaine plus 2 $\mu\text{g}\cdot\text{mL}^{-1}$ (30 μg) fentanyl.²³ In a subsequent study, 65% of parturients were able to ambulate following labour epidural analgesia (LEA) initiated with a 15-mL bolus of 0.1% bupivacaine (15 mg) plus 5 $\mu\text{g}\cdot\text{mL}^{-1}$ (75 μg) fentanyl.²⁴ At the University of Saskatchewan, we have observed effective initiation of LEA with 20 mL of 0.08% (16 mg) bupivacaine plus 2 $\mu\text{g}\cdot\text{mL}^{-1}$ (40 μg) fentanyl in four fractionated (5 mL) boluses and similar rates of ambulation. Although this combination of bupivacaine and fentanyl provides effective epidural analgesia, the "ideal" epidural labour analgesic with the local anesthetic, bupivacaine, appears to be limited by the continued observation of maternal motor blockade.

Preliminary reports using the newer local anesthetic, ropivacaine, at high concentrations suggested less motor blockade than similar concentrations of bupivacaine.^{27,28} Consequently, a randomized controlled clinical trial was undertaken at the University of Saskatchewan to compare ropivacaine and bupivacaine for the initiation of epidural labour analgesia.²⁹ The study compared the efficacy of 20 mL of either 0.08% ropivacaine plus 2 $\text{mg}\cdot\text{mL}^{-1}$ fentanyl or 0.08% bupivacaine plus 2 $\text{mg}\cdot\text{mL}^{-1}$ fentanyl (Table II). Each blinded solution was administered in four fractionated (5 mL) boluses with the total volume given within five minutes (Table IV). Both solutions produced effective labour analgesia, with parturients reporting VAS = 0/100 in a mean time of 12 min in both groups. Importantly, all (100%) of the women receiving the ropivacaine were able to ambulate unassisted compared to significantly fewer (75%) of women receiving bupivacaine. This method of initiation of epidural labour analgesia with ropivacaine has become the mainstay of our routine clinical practice (Table IV). Of importance, this same solution is also used to effectively maintain epidural labour analgesia and it now appears that a true "Walking Epidural" for women

throughout labour is now possible.

Within the past several years, significant technological advances have also occurred that directly impact anesthesiologists' ability to maintain epidural labour analgesia. New continuous infusion pumps have been developed with the capability to receive patient input and deliver medication on demand. These new infusion pumps facilitate the labour analgesic modality known as patient-controlled epidural analgesia (PCEA). Since their introduction at the University of Saskatchewan in January 1995, these new infusion pumps have gained widespread acceptance and have become the primary delivery system for the maintenance of epidural labour analgesia.

The PCEA technique empowers labouring women by providing them with a means of controlling the amount of medication they receive, once epidural analgesia is established. This is undertaken using strict parameters that are programmed by the anesthesiologist utilizing customized settings for each labouring woman. The combination of 0.08% ropivacaine plus 2 $\mu\text{g}\cdot\text{mL}^{-1}$ fentanyl is administered via the PCEA pump programmed to deliver a continuous infusion of 10 $\text{mL}\cdot\text{hr}^{-1}$ with PCEA setting of a 5-mL bolus with a ten-minute lockout interval and no dose limit. Several safety features have made this form of labour analgesia popular (Table V). The use of PCEA without a continuous infusion has been shown to reduce, by approximately one half, the amount of epidural medication required to maintain labour analgesia compared to a continuous infusion.^{30,31} This technological advance significantly increases the satisfaction of labouring women particularly due to the sense of control while receiving epidural analgesia solutions.^{32,33}

The use of ropivacaine combined with the PCEA technique, at the University of Saskatchewan, provides the majority of labouring women the option to freely ambulate unassisted while receiving epidural analgesia. These changes now empower labouring women during one of life's most painful experiences with a sense of control and composure while retaining the physical strength and sensation necessary for childbirth. As such this combination of effective analgesics and technology very closely, if not completely, fulfills the requirements to be considered the "ideal" labour analgesic.

Conclusion

Modern epidural labour epidural analgesic techniques and medications have resulted in more consistent, predictable and effective analgesia utilizing contemporary techniques which enable anesthesiologists to provide many options to women in labour. Our desire to improve patient care and safety, while increasing the

satisfaction and participation of women in their labour and delivery experience, continues to be one of the primary goals and challenges for those providing obstetric analgesia services.

*"During the first stage of labour the patient usually prefers to move about her room...therefore, she should not be compelled to take to her bed unless she feels so inclined."*³⁴

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