Neuraxial analgesia effects on labour progression: facts, fallacies, uncertainties and the future

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Background

Although there has been a recent decline in the number of births in the USA, the caesarean birth rate has risen steadily over the past 14 years, and as of 2010, has reached 32.8% of all women delivered in the USA. This represents a 60% increase since 1996.1 Epidural analgesia for labour and delivery was introduced in 1938, but began gaining popularity in the 1970s,2,3 such that approximately 61% of women delivered in the USA receive such analgesia 4 (Figure 1).

This concomitant increase has prompted some to question whether the rise in caesarean birth rates has been influenced by the increased use of epidural analgesia during childbirth. This concern is buttressed by the fact that the leading indication for primary caesarean is dystocia, diagnosed when labour is ineffective, and that epidural analgesia reportedly prolongs labour, specifically the second stage.

The most popular techniques for neuraxial analgesia during labour include continuous lumbar epidural (Figure 2) and combined spinal-epidural analgesia (Figure 3). A third less popular technique, continuous spinal analgesia, was withdrawn from the US market in the 1990s because of technical problems leading to neurological sequelae. However, with the advent of new equipment and procedural changes, there is renewed interest.

Although neuraxial analgesia in labour is undisputedly superior to other methods of pain relief such as intravenous opioids, there is concern that neuraxial analgesia lengthens labour and leads us to question, ‘Is it a friend or foe?’

Labour progression

Traditionally, the duration of labour was subject to personal interpretation because there was no consensus as to when labour commenced.6 Friedman first described the normal labour curve in 1954 and continued to extensively study labour over the next four decades. Subsequently, his sigmoid-shaped labour curve was widely accepted.7-9

The American College of Obstetricians and Gynecologists (ACOG) has defined normal labour as ‘the presence of uterine contractions of sufficient intensity, frequency, and duration to bring about demonstrable effacement and dilation of the cervix’.10 In contrast, abnormal labour remains difficult to define. Importantly, frequent interventions such as the use of epidural analgesia have been reported to alter normal labour, further complicating its meaning.11

On the other hand, dystocia, or difficult labour, is characterised by abnormally slow labour progress and arises from four distinct abnormalities: (1) expulsive forces, (2) presentation,
mechanistically simplified into three categories to include prolongation, protraction and arrest disorders (Table 1).12

Recently, investigators forming The Consortium on Safe Labor studied 62,415 women and found that nulliparous women progress from 4 to 6 cm cervical dilatation much more slowly than previously thought. Another finding showed that epidural analgesia was associated with slower labour.11,13 Therefore, these authors proposed re-examining the definitions of normal and abnormal labour. One such suggestion would be allowing labour to continue longer than is currently practiced, possibly resulting in a reduction in caesarean section rates.

**Pain and dystocia**

There are reports on the association between the intensity of labour pain and dystocia. Although these studies do not establish a cause and effect relationship, they strongly suggest that greater labour pain is associated with obstructed labour.14,15 It is well documented that there is a correlation between endogenous plasma epinephrine and cortisol levels with labour progression.16 Indeed, women in labour who request epidural analgesia have significantly higher cortisol levels than women who do not. These levels decrease after relief of pain.17 Similarly, epinephrine levels decrease after initiation of epidural analgesia.18 This decrease in α- and β-adrenergic receptor stimulation may enhance uterine perfusion leading to a more effectual contraction pattern.19,20 This is probably because of the greater sensitivity of the uteroplacental vascular bed to catecholamines in comparison to systemic vasculature.21 This is further evidenced by epidural analgesia reducing maternal epinephrine levels by eliminating the psychological and physical stress associated with painful uterine contractions or by denervating the adrenal medulla.18

In this review, we will address the impact of neuraxial analgesia on the progress of labour by subdividing the topics to include generally accepted facts, fallacies, areas where

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**Table 1. Three labour disorders based upon Friedman labour curves**

<table>
<thead>
<tr>
<th>Labor pattern</th>
<th>Nulliparous</th>
<th>Multiparous</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Prolongation disorder, hours</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prolonged latent phase</td>
<td>&gt;20</td>
<td>&gt;14</td>
</tr>
<tr>
<td><strong>Protraction disorders, cm/hour</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protracted active-phase dilatation</td>
<td>&lt;1.2</td>
<td>&lt;1.5</td>
</tr>
<tr>
<td>Protracted descent</td>
<td>&lt;1</td>
<td>&lt;2</td>
</tr>
<tr>
<td><strong>Arrest disorders, hours</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prolonged deceleration phase</td>
<td>&gt;3</td>
<td>&gt;1</td>
</tr>
<tr>
<td>Secondary arrest of dilatation</td>
<td>&gt;2</td>
<td>&gt;2</td>
</tr>
<tr>
<td>Arrest of descent</td>
<td>&gt;1</td>
<td>&gt;1</td>
</tr>
</tbody>
</table>

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uncertainty exists, and the future direction of epidural, combined spinal-epidural and continuous spinal analgesia.

Facts

Epidural analgesia is associated with prolonged labour

The effect of epidural analgesia on the progress of labour has been extensively studied. For example, Anim-Souman et al.\(^1\) performed a Cochrane review of epidural analgesia effects in labour using 38 trials involving 9658 parturients. Although there were no significant differences in the length of the first stage of labour, second stage was lengthened by an average of 15 minutes. Of course, the clinical significance of such a limited prolongation is debatable.

Epidural analgesia is associated with an increased risk of instrumental delivery

In the same Cochrane review, 23 randomised trials \((n = 7935)\) were analysed comparing operative (forceps or vacuum-assist) deliveries in relation to epidural analgesia. Operative vaginal delivery was linked to epidural analgesia (relative risk 1.42; 95% confidence interval [95% CI] 1.28–1.57).\(^1\) Several theories of possible aetiologies include local anaesthetic agents and narcotics interference with normal expulsive efforts via suppression of the bear-down reflex\(^2\) and failure of appropriate time to allow internal rotation of the fetal head.\(^2\)

Combined spinal-epidural is associated with an increased risk of instrumental delivery

There are four studies that included 925 women that showed no statistical difference in risk of instrumental delivery between combined spinal-epidural and epidural analgesia.\(^2\)

Fallacies

Early epidural placement slows labour progression and increases risk of caesarean delivery

Based upon previous studies,\(^2\) epidural analgesia initiation before 4-cm cervical dilatation was associated with slower labour progression. Several groups of investigators have concluded that this is indeed not the case.\(^2\) These studies included women who demonstrated cervical change, indicating spontaneous labour; who were at least 3 cm dilated; or who made no mention of minimum cervical dilatation. Wong et al.\(^3\) and Wang et al.\(^4\) on the other hand, demonstrated in two large randomised controlled trials that even before 2-cm cervical dilatation, neuraxial placement had no effect on labour progression. Furthermore, these investigators observed no effects of early labour analgesia on operative vaginal or caesarean birth rates. More recently, a systematic review of six studies \((n = 15399)\) showed no increased risk of caesarean (pooled risk ratio 1.02, 95% CI 0.96–1.08) or instrumental (pooled risk ratio 0.96, 95% CI 0.89–1.05) delivery for women receiving early epidural (defined as dilatation \(\leq 3\) cm) in comparison with late epidural placement.\(^3\)

The aforementioned findings have led ACOG to conclude that,

There is no other circumstance where it is considered acceptable for an individual to experience untreated severe pain, amenable to safe intervention, while under a physician’s care. In the absence of a medical contraindication, maternal request is a sufficient medical indication for pain relief during labor. Pain management should be provided whenever medically indicated.\(^3\)

Ambulatory epidural analgesia hastens labour

Maternal ambulation has been reported to enhance pelvic diameters, increase coordination of uterine contraction intensity and frequency, and shorten stage I labour.\(^2\) The ‘walking epidural’, typically described as a low-concentration local anaesthetic combination, is found to minimise motor blockade of the lower extremities, was thought to hold promise for hastening labour by allowing for ambulation. In the three randomised controlled studies,\(^5\) there was no effect on labour progression benefit with maternal ambulation during neuraxial analgesia. These studies also concluded that maternal ambulation had no effect on analgesia requirement or mode of delivery.

Neuraxial analgesia increases the risk of caesarean delivery

The authors of the previously described Cochrane Review analysed 27 trials on the effects of epidural analgesia on caesarean rates and found no effect on the overall risk of caesarean delivery.\(^1\) Similarly, combined spinal-epidural was not found to increase caesarean delivery rates.\(^2\)

Uncertainties

Epidural analgesia interferes with the propagation of muscular activity within the uterus

Some investigators have theorised that epidural analgesia lengthens labour by provoking dysfunctional propagation of electrical activity within the uterine muscle. Per this theory, there is inhibition of the fundal origin of uterine contractions with disruption of the transmission of contractions to the lower uterine segment.\(^6\) Other investigators have directly analysed uterine activity with and without epidural analgesia and found that such analgesia did not influence uterine activity in the first stage of labour. However, there was a lower level of uterine contraction,
frequency and intensity in the second stage.\textsuperscript{39} It was hypothesised that the observed decrease in uterine activity during the second stage may contribute to the increased operative vaginal delivery rate.\textsuperscript{40}

**Neuraxial analgesia cause fetal malposition**

Lateral and posterior positions of the fetal head may be associated with more painful, prolonged or obstructed labour and difficult delivery.\textsuperscript{41} One suggestion is that epidural analgesia may be associated with failure of spontaneous rotation to an occiput anterior position.\textsuperscript{12} Fetal position was an outcome in four trials of neuraxial analgesia during labour and the results of these trials have not resolved the controversy whether or not neuraxial analgesia affects fetal position.\textsuperscript{19} Of interest, it is postulated that early initiation of epidural analgesia increases the risk of malposition versus later labour secondary to optimal positioning of the fetal head at this stage.\textsuperscript{23}

**Routine use of epidural analgesia during labour**

A recent study by Wassen et al.\textsuperscript{42} assessed the effects of routine epidural analgesia during labour versus initiation upon maternal request. Although the authors suggest that routine epidural analgesia may increase the rate of operative deliveries, the difference between vaginal (difference 4.5%; 95% CI –1.6 to 10.6) or via caesarean (3.6%; 95% CI –3.1 to 10.3) did not reach statistical significance. Also, adverse labour outcomes such as incidence of shoulder dystocia, postpartum haemorrhage, manual placenta extraction, and third/fourth-degree perineal lacerations; and neonatal outcomes were no different. However, maternal hypotension and motor blockade were significant in the routine epidural analgesia group.

**Combined spinal-epidural analgesia shortens labour**

There are only six randomised trials where the effects of combined spinal-epidural analgesia on labour were assessed. As shown in Table 2, combined spinal-epidural analgesia was compared with epidural analgesia in four trials and showed inconsistent effects on labour duration.

<table>
<thead>
<tr>
<th>Study</th>
<th>CSE (mean ± SD)</th>
<th>Epidural (mean ± SD)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tsen, 1999\textsuperscript{43}</td>
<td>3.8 ± 2.6</td>
<td>5.1 ± 2.6</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Norris, 2001\textsuperscript{45}</td>
<td>10.0</td>
<td>9.8</td>
<td>NS</td>
</tr>
<tr>
<td>Cortes, 2007\textsuperscript{46}</td>
<td>1.5</td>
<td>1.55</td>
<td>0.90</td>
</tr>
<tr>
<td>Frigo, 2011\textsuperscript{44}</td>
<td>4.01 ± 1.43</td>
<td>4.60 ± 1.39</td>
<td>0.043</td>
</tr>
</tbody>
</table>

CSE, combined spinal-epidural; NS, not significant. Reported in hours (mean ± SD).

Specifically, Tsen et al.\textsuperscript{43} and Frigo et al.\textsuperscript{44} found significantly shorter labour when combined spinal-epidural analgesia was used. No effect on labour duration was found by the other investigators.\textsuperscript{45,46} Combined spinal-epidural analgesia when compared with intravenous opioids was associated with significantly shorter labour in one study and longer labour in the other\textsuperscript{20,47} (Table 3). The major limitation of these trials was absence of length of labour as a primary outcome.

**Continuous spinal analgesia during labour**

Throughout this review, discussion of neuraxial analgesia was limited to the two most commonly used methods, continuous lumbar epidural and combined spinal-epidural analgesia. Again, there is renewed interest in continuous spinal analgesia during labour. Although interest is primarily in establishing safety and efficacy, it was incidentally noted that women experience acceleration of cervical dilatation with this method. Although accelerated labour has been observed, a significant proportion (42%) of women also had severe, transient headaches related to dural puncture that limited this technique’s popularity.\textsuperscript{48} Additionally, some women developed debilitating cauda equina syndrome.\textsuperscript{59} These sequelae were attributed to excessive diameter needles and micro-catheters using the ‘through-the-needle’ approach. These issues have been surmounted during the early 2000s with the redesign of the needles, larger diameter catheters, and use of the ‘over-the-needle’ technique. Although Arkoosh et al.\textsuperscript{50} randomised 429 women to continuous spinal versus conventional epidural analgesia during labour, they found no difference in rate of complications or side effects. However, continuous spinal analgesia remains largely investigational. Moreover, this group did not study the effects of continuous spinal analgesia on labour progression.

**The Future**

Significant progress has been made in establishing the safety and efficacy of neuraxial analgesia for labour and

<table>
<thead>
<tr>
<th>Study</th>
<th>CSE (mean ± SD)</th>
<th>IV analgesia (mean ± SD)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wong, 2005\textsuperscript{30}</td>
<td>4.91</td>
<td>6.42</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Gambling, 1998\textsuperscript{47}</td>
<td>5.0 ± 3.3</td>
<td>4.0 ± 3.1</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

CSE, combined spinal-epidural; IV, intravenous. Length of first stage of labour, reported in hours (mean ± SD).
delivery. Currently, the continuous lumbar epidural is the most widely used mode of pain control for labour and delivery, and is generally considered safe and effective. Combined spinal-epidural analgesia, being equally as safe, is gaining popularity because of its ability to provide rapid analgesia with the potential benefit of shortening labour. However, current evidence lacks conviction as to whether or not it shortens labour, rendering the findings suggestive at best. Accordingly, adequately powered randomised control trials are encouraged, preferably with length of labour being a primary outcome.

Continuous spinal analgesia offers rapid-onset pain relief and could possibly hasten the time to delivery; however, this method is not well studied. But with redesign of equipment and subsequent modification of technique, future studies establishing its safety and efficacy are now possible and should also be performed.

Combined spinal-epidural analgesia and continuous spinal analgesia may be the future of pain management in labour and delivery. Future studies could yield positive results that would have significant personal, societal and economic benefits on labour progression and perhaps change the practice of pain relief in obstetrics.

Disclosure of interest
The authors have no conflicts of interest to disclose.

Contribution to authorship
EG performed extensive literature review, prepared the manuscript, and has approved the final manuscript. WT, MC, DM and KL assisted with manuscript preparation and approved the final manuscript.

Details of ethics approval
This study is institutional review board exempt being a review article.

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