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

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Abstract

Approximately 60% of women who labor receive some form of neuraxial analgesia, but concerns have been raised regarding whether it negatively impacts the labor and delivery process. In this review, we attempt to clarify what has been established as truths, falsities, and uncertainties regarding the effects of this form of pain relief on labor progression, negative and/or positive. Additionally, although the term “epidural” has become synonymous with neuraxial analgesia, we discuss two other techniques, combined spinal-epidural and continuous spinal analgesia, that are gaining popularity, as well as their effects on labor progression.

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Keywords

Labour; analgesia; neuraxial; epidural

Background

Although there is a recent decline in the number of births in the United States, the cesarean birth rate has risen steadily over the past 14 years, and as of 2010, has reached 32.8% of all women delivered in the United States. This represents a 60% increase since 1996[1]. Epidural analgesia for labor and delivery was introduced in 1938, but began gaining popularity in the 1970's[2,3], such that approximately 61% of women delivered in the United States receive such analgesia[4] (Figure 1).

This concomitant increase has prompted some to question whether the rise in cesarean 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 cesarean is dystocia, diagnosed when labor is ineffective, and that epidural analgesia reportedly prolongs labor, specifically the second stage.

The most popular techniques for neuraxial analgesia during labor 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 A third less popular technique, continuous spinal analgesia, was withdrawn from the US market in the 1990's due to technical problems leading to neurological sequelae. With the advent of new equipment and procedural changes, there is renewed interest.

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

Labor Progression

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

The American College of Obstetricians and Gynecologists (ACOG) has defined *normal labor* 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 labor* remains difficult to define. Importantly, frequent interventions such as the use of epidural analgesia have been reported to alter normal labor, further complicating its meaning[11]. On the other hand dystocia, *difficult labor*, is characterized by abnormally slow labor progress and arises from four distinct abnormalities: 1) expulsive forces, 2) presentation, position, or fetal development, 3) maternal bony pelvis, and 4) soft tissues of the reproductive tract that form an obstacle in fetal descent. The abnormalities can be 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 dilation much slower than previously thought. Another finding showed that epidural analgesia was associated with slower labor[11,13]. Therefore, these authors proposed re-examining the definitions of normal and abnormal labor. One such suggestion would be allowing labor to continue longer than what is currently practiced, possibly resulting in a reduction in cesarean rates.

Pain and Dystocia

There are reports on the association between the intensity of labor pain and dystocia. Although these studies do not establish a cause and effect relationship, they strongly suggest that greater labor pain is associated with obstructed labor[14,15]. It is well documented that there is a correlation between endogenous plasma epinephrine and cortisol levels with labor progression[16]. Indeed, women in labor who request epidural analgesia have significantly higher cortisol levels than of 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 alpha- and beta-adrenergic receptor stimulation may enhance uterine perfusion leading to a more effectual contraction pattern[19,20]. This is likely due to 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 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 labor by subdividing the topics to include generally accepted facts, falsities, areas where uncertainty exist, and the future direction of epidural, combined spinal-epidural, and continuous spinal analgesia.

Facts

Epidural analgesia is associated with prolonged labor

The effect of epidural analgesia on the progress of labor has been extensively studied. For example, Anim-Souman and colleagues[19] performed a Cochrane review of epidural analgesia effects in labor using 38 trials involving 9658 parturients. Although there were no significant differences in the length of the first stage of labor, second stage was lengthened by an average 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 randomized trials (N=7935) were analyzed comparing operative (forceps or vacuum-assist) deliveries in relation to epidural analgesia. Operative vaginal delivery was linked to epidural analgesia (RR 1.42; 95%CI 1.28–1.57)[19]. Several theories of possible etiologies include local anesthetic agents and narcotics interference with normal expulsive efforts via suppression of the bear-down reflex[20] and failure of appropriate time to allow internal rotation of the fetal head[21].

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[22].

Fallacies

Early epidural placement slows labor progression and increases risk of cesarean delivery

Based upon prior studies[23,24], epidural analgesia initiation before 4 cm cervical dilation was associated with slower labor progression. Several groups of investigators have concluded that this is indeed not the case[25–29]. These studies included women who either demonstrated cervical change indicating spontaneous labor, were at least 3 cm dilated, or made no mention of minimum cervical dilation. Wong[30] and Wang[31] on the other hand, demonstrated in 2 large randomized control trials that even prior to 2 cm cervical dilation, neuraxial placement had no effect on labor progression. Furthermore, these investigators observed no effects of early labor analgesia on operative vaginal or cesarean birth rates. More recently, a systematic review of 6 studies (N=15,399) showed no increased risk of cesarean (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 3 cm or less) in comparison with late epidural placement[32].

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*."[33]

Ambulatory epidural analgesia hastens labor

Maternal ambulation has been reported to enhance pelvic diameters, increase coordination of uterine contraction intensity and frequency, and shorten stage I labor[24,34]. The "walking epidural", typically described as a low-concentration local analgesic[35] or opioid-only technique that minimizes motor blockade of the lower extremities, was thought to hold promise for hastening labor by allowing for ambulation. In the three randomized control studies[35–37], there was no effect on labor 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 cesarean delivery

The authors of the previously described Cochrane Review analyzed 27 trials on the effects of epidural analgesia on cesarean rates and found no effect on the overall risk of cesarean delivery[19]. Similarly, combined spinal-epidural was not found to increase cesarean delivery rates[22].

Uncertainties

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

Some investigators have theorized that epidural analgesia lengthens labor 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[38]. Other investigators have directly analyzed uterine activity with and without epidural analgesia and found that such analgesia did not influence uterine activity in the first stage of labor. However, there was a lower level of uterine contraction, frequency, and intensity in the second stage[39]. It was hypothesized that the observed decrease in uterine activity during the second stage may contribute to the increased operative vaginal delivery rate[40].

Neuraxial analgesia cause fetal malposition[31]

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

Routine use of epidural analgesia during labor

A recent study by Wassen et al[42] assessed the effects of routine epidural analgesia during labor 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, 10.6)) or via cesarean (3.6% (95%CI: −3.1, 10.3) did not reach statistical significance. Also, adverse labor outcomes such as incidence of shoulder dystocia, postpartum hemorrhage, manual placenta extraction, and third/fourth degree perineal lacerations; and neonatal outcomes were no different. However, maternal hypotension and motor blockade was significant in the routine epidural analgesia group.

Combined spinal-epidural analgesia shortens labor

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

Specifically, Tsen and colleagues[43] and Frigo and colleagues[44] found significantly shorter labor when combined spinal-epidural analgesia was used. No effect on labor duration was found by the other investigators[45,46]. Combined spinal-epidural analgesia when compared to intravenous opioids was associated with significantly shorter labor in one study and longer labor in the other[30,47] (Table 3). The major limitation of these trials was absence of length of labor as a primary outcome.

Continuous spinal analgesia during labor

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 labor. Although interest is primarily in establishing safety and efficacy, it was incidentally noted that women experience acceleration of cervical dilation with this method. Although accelerated labor has been observed, a significant portion (42%) of women also had severe, transient headaches related to dural puncture that limited this technique's popularity[48]. Additionally, some women developed debilitating cauda equina syndrome[49]. 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 2000's with the redesign of the needles, larger diameter catheters, and use of the "over-the-needle" technique. Although Arkoosh and colleagues[50] randomized 429 women to continuous spinal versus conventional epidural analgesia during labor, 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 labor progression.

The Future

Significant progress has been made in establishing the safety and efficacy of neuraxial analgesia for labor and delivery. Currently, the continuous lumbar epidural is the most widely used mode of pain control for labor and delivery, and is generally considered safe and effective. Combined spinal-epidural analgesia, being equally as safe[51], is gaining popularity because of its ability to provide rapid analgesia with the potential benefit of shortening labor. However, current evidence lacks conviction to whether or not it shortens labor, rendering the findings suggestive at best. Accordingly, adequately powered randomized control trials are encouraged, preferably with length of labor 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 be performed as well.

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

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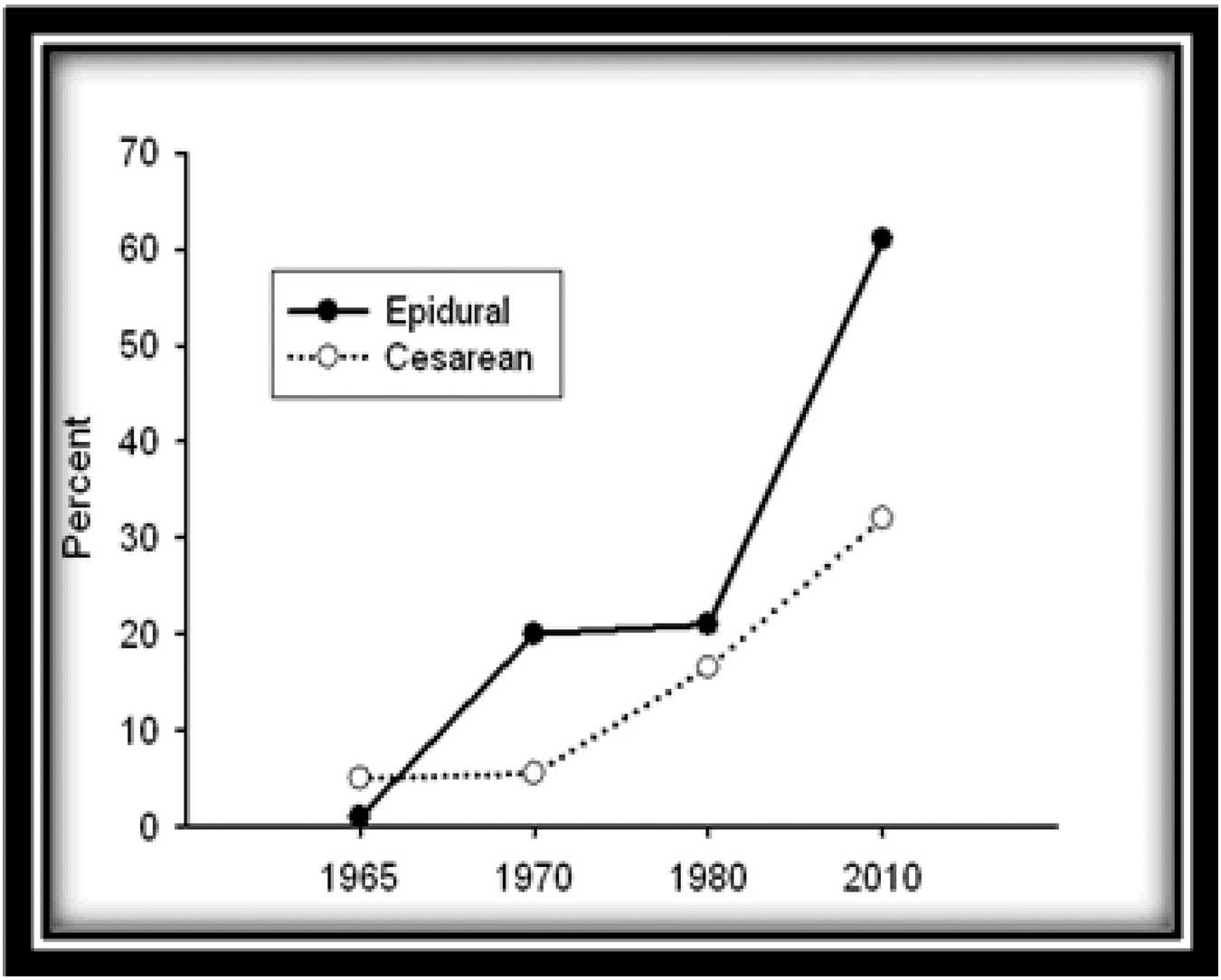

Figure 1.
Rate of epidural analgesia use during childbirth in the United States with concomitant cesarean birth rates.

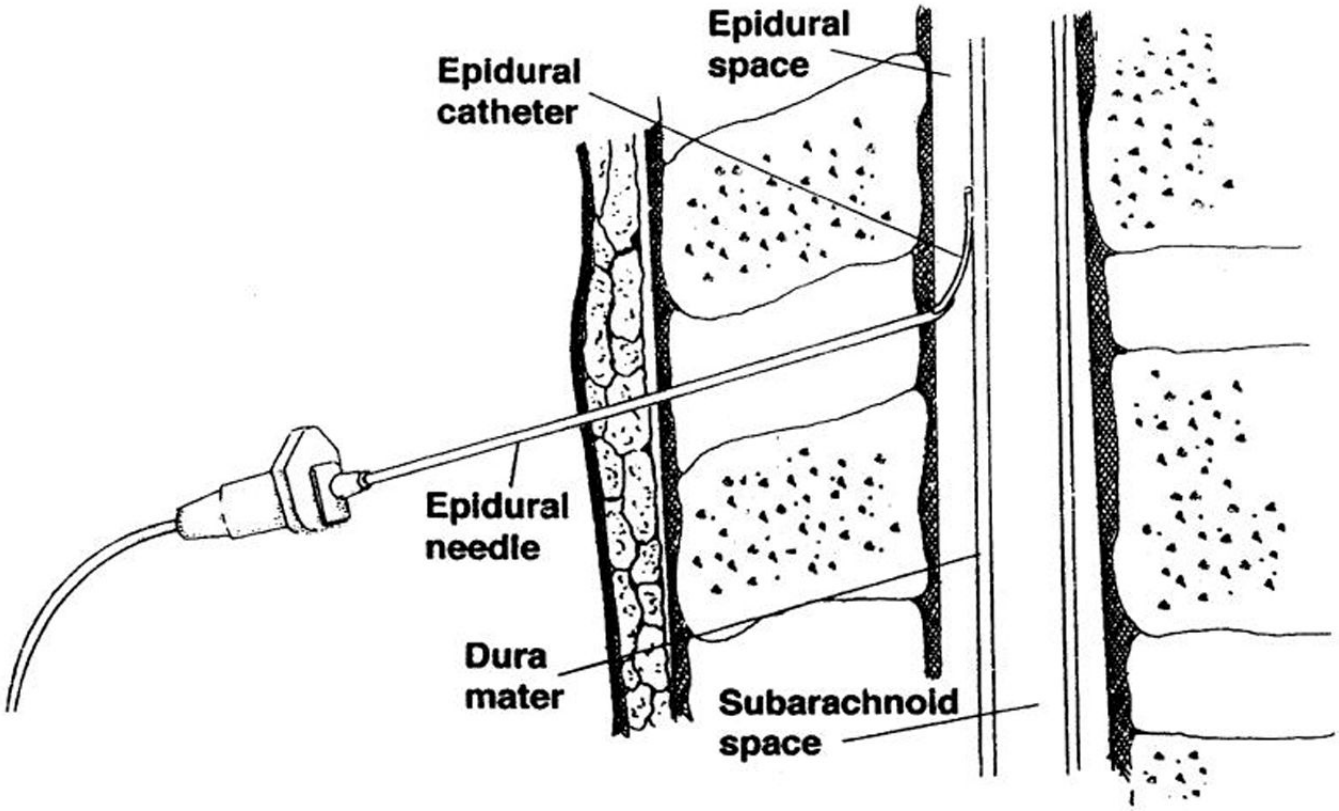

Figure 2.
Catheter being threaded into the epidural space[5].

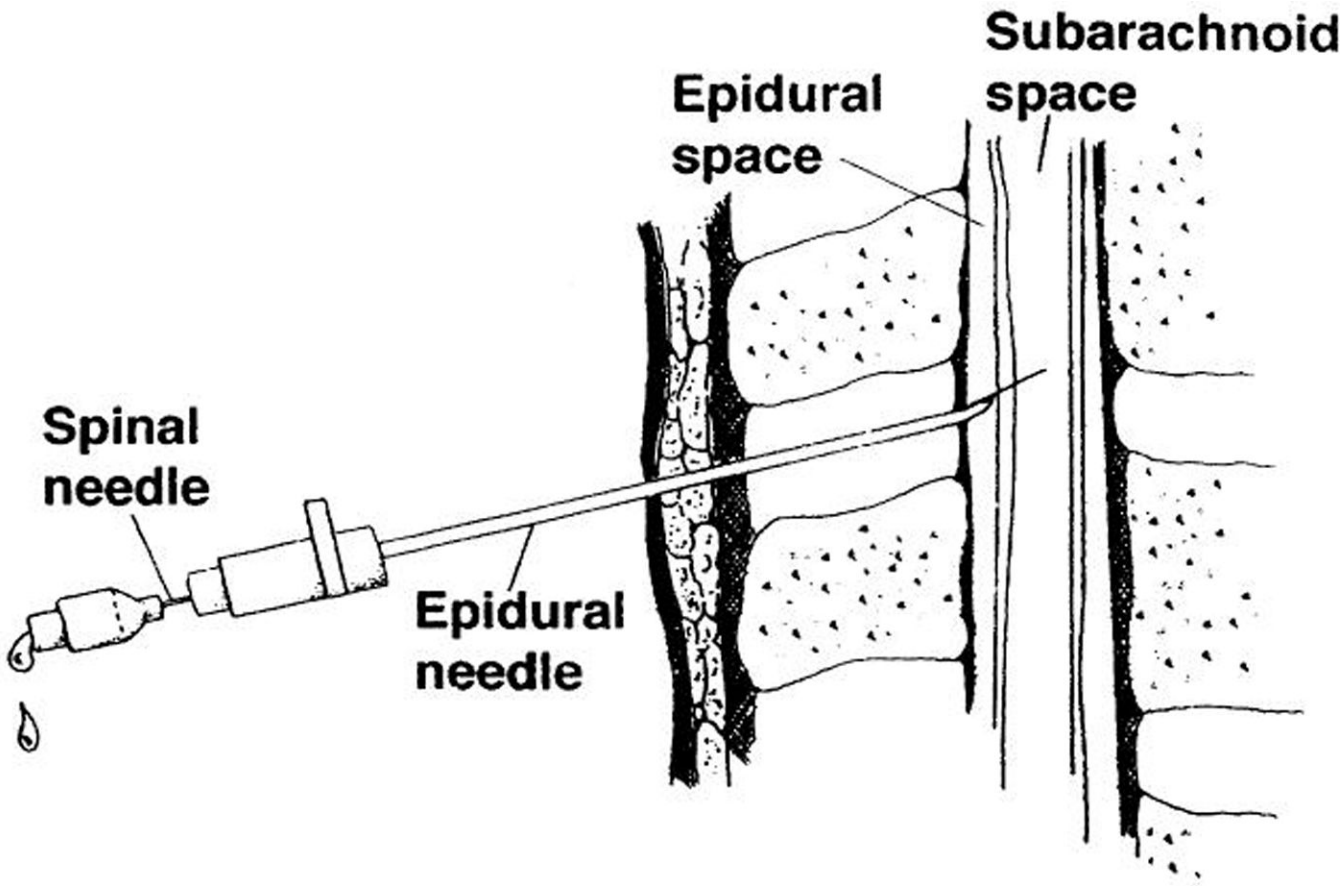

Figure 3.

Spinal needle inserted through epidural needle to penetrate dura, confirm cerebrospinal fluid, and inject medications prior to threading catheter into epidural space[5].

Table 1

Three labor disorders based upon Friedman labor curves

Labor Pattern	Nulliparous	Multiparous
Prolongation Disorder		
Prolonged latent phase	> 20 hours	> 14 hours
Protraction Disorders		
Protracted active-phase dilation	< 1.2 cm/hour	< 1.5 cm/hour
Protracted descent	< 1 cm/hour	< 2 cm/hour
Arrest Disorders		
Prolonged deceleration phase	> 3 hours	> 1 hour
Secondary arrest of dilation	> 2 hours	> 2 hours
Arrest of descent	> 1 hour	> 1 hour

Table 2

Duration first stage of labor

Study	CSE	Epidural	*P*-value
Tsen, 1999	3.8 ± 2.6	5.1 ± 2.6	*P* <0.05
Norris, 2001	10.0	9.8	NS
Cortes, 2007	1.5	1.55	0.90
Frigo, 2011	4.01 ± 1.43	4.60 ± 1.39	0.043

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

Table 3

Comparison of combined spinal-epidural to intravenous analgesia. Length of First Stage of Labor

Study	CSE	IV Analgesia	*P*-value
Wong, 2005	4.91	6.42	<.0001
Gambling, 1998	5.0 ± 3.3	4.0 ± 3.1	0.0001

Reported in hours (mean ± SD) CSE=combined spinal-epidural