Original article

# Impact of epidural analgesia on labor progression and maternal-fetal outcomes: a comparative observational study

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**Abstract**

**Background:** Epidural analgesia (EA) is widely considered the gold standard for pain relief during labor. This study aimed to evaluate the impact of EA on labor progression and maternal-neonatal outcomes in women undergoing vaginal delivery. **Methods:** A prospective cohort study was conducted from June 2024 to February 2025. Term pregnant women in spontaneous labor with singleton, cephalic fetuses ($37^0$–$41^6$ gestational weeks) were enrolled and categorized by parity (nulliparous or multiparous) and EA status. Labor progress was monitored using the World Health Organization (WHO) Labor Care Guide (LCG) (2018), focusing on the active phase of the first stage and the second stage. Primary outcomes included duration of labor stages, maternal complications, and neonatal outcomes. **Results:** In nulliparous women, EA significantly prolonged both the active phase of the first and second stages of labor compared to those without EA ($p$ < 0.05). EA initiated at < 5 cm cervical dilation was associated with a longer second stage (37.7 ± 30.4 vs. 25.9 ± 22.6 minutes, $p$ = 0.022). In multiparous women, the duration of labor did not differ significantly between the EA and control groups ($p$ > 0.05). EA use was not associated with increased rates of severe perineal lacerations, postpartum hemorrhage, uterotonic use, or low APGAR scores in either group. **Conclusions:** Epidural analgesia provides effective pain relief during labor without increasing the risk of adverse maternal or neonatal outcomes. However, it may prolong labor duration in nulliparous women, especially when initiated early (< 5 cm cervical dilation). Individualized counseling and careful monitoring are recommended to ensure safety and optimize outcomes.

***Key words:*** *Epidural analgesia; Labor pain; Labor duration; Maternal outcomes; Neonatal outcomes.*

## BACKGROUND

Epidural analgesia (EA) has become one of the most significant advances in modern obstetrics, providing safe and effective pain relief for women during labor [1, 2]. The World Health Organization (WHO) is the gold standard for labor analgesia, recommending its use when clinically indicated, especially in cases of preterm birth or other obstetric complications [1, 3]. Similarly, the American College of Obstetricians and Gynecologists (ACOG) emphasizes that EA does not increase the rate of cesarean delivery and has no adverse effect on neonatal outcomes when properly administered and properly monitored [2].

Despite its benefits, the increasing use of EA has raised concerns about its potential adverse effects. Several large-scale studies have reported associations between EA and complications such as maternal hypotension, fever, and, notably, prolonged labor [4]. For instance, Cheng et al. (2014) found that EA was associated with an increase of more than two hours in the second stage of labor for both nulliparous and multiparous women. A Cochrane review also concluded that EA may prolong the second stage and increase the need for oxytocin due to reduced uterine contractility and a diminished urge to push [5-8]. However, other studies such as Wang et al. (2017) and D. Luo et al. (2021) suggest that EA does not affect labor duration, and may even shorten labor time [9, 10]. These conflicting findings highlight the need for further research, particularly in varied clinical contexts.

In Vietnam, where the use of EA during labor is becoming increasingly common, limited data exist regarding its impact on labor progression and maternal-neonatal outcomes. This study aimed to evaluate the effects of epidural analgesia on labor duration, maternal complications, and neonatal outcomes among women undergoing vaginal delivery in a Vietnamese obstetric population.

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## 2. METHODS

### Study design and Participants

This prospective cohort study was conducted at the Department of Obstetrics and Gynecology, Hue Central Hospital, Vietnam, between June 2024 and February 2025.

Eligible participants were term pregnant women admitted in spontaneous labor with a singleton fetus in cephalic presentation at a gestational age between 37 weeks 0 days and 41 weeks 6 days. Exclusion criteria included previous cesarean section, fetal abnormalities, maternal comorbidities affecting labor progression, or severe medical conditions.

The sample size was calculated to compare the duration of labor between women who received EA and those who did not, using the formula for comparing two independent means. 226 participants were enrolled, including 107 in the EA group, meeting the minimum sample size for statistical validity.

### Study procedure

Demographic and obstetric information were collected upon enrollment, including maternal age, parity, body mass index (BMI, kg/$m^2$), medical history, and gestational age. Participants were categorized as nulliparous or multiparous, and each group was subdivided based on EA status. The EA protocol followed national and international guidelines (National Institute for Health and Care Excellence - NICE and Vietnamese Society of Anesthesiologists), using a combination of 0.1% Bupivacaine and two µg/mL Fentanyl [11].

#### *Labor monitoring*

Labor progression was monitored using the WHO Labor Care Guide (2018). EA was offered for pain relief and administered upon maternal request. The study variables were recorded during the active phase of the first stage (stage Ib) and the second stage (stage II) of labor. According to the WHO (2018), stage Ib was defined as starting from 5 cm cervical dilation to full dilation, and stage II was from full dilation to delivery [1]. Uterine activity was assessed using cardiotocography, and pain level was evaluated using the Visual Analog Scale (VAS) during stage Ib and stage II of labor. The VAS is a 10-point scale ranging from 0 (no pain) to 10 (worst possible pain) [12].

#### *Delivery and postpartum monitoring*

Delivery outcomes included mode of delivery (spontaneous or assisted vaginal delivery), estimated blood loss (ml), degree of perineal laceration, postpartum use of oxytocin and carbetocin (Duratocin), complications related to EA. Perineal lacerations were classified according to Sultan classification, which was endorsed by the Royal College of Obstetricians and Gynaecologists (RCOG) [13],[14]. Postpartum hemorrhage was defined as blood loss of ≥ 500 ml within the first 24 hours after vaginal delivery, following WHO and RCOG guidelines [15], [16]. Carbetocin (Duratocin 100 mcg/mL) was used for the prevention and management of postpartum hemorrhage secondary to uterine atony [17].

Neonatal outcomes included birth weight (g), APGAR scores at 1 and 5 minutes, and admission to the Neonatal Intensive Care Unit (NICU) if required.

#### *Data analysis*

Data were entered and analyzed using SPSS version 20.0, Inc., Chicago, IL, US. Results are presented as frequencies (n), percentages (%), means, and standard deviations (SD). Group comparisons were performed using the Mann–Whitney U test for continuous variables and the Chi-square test for categorical variables. A $p$-value < 0.05 was considered statistically significant.

### Ethical approval and consent to participate

The Ethical Committee in Biomedical Research approved the ethical approval of Hue University of Medicine and Pharmacy (No. H2023/160), with institutional consent from Hue Central Hospital. Participants received complete study information, confidentiality was assured, and all provided written informed consent before inclusion.

## 3. RESULTS

From June 2024 to February 2025, a total of 226 women who delivered vaginally at Hue Central Hospital were enrolled in the study. Of these, 107 (47.3%) received EA during labor. Nulliparous women comprised most of the study population (N = 156, 69.0%).

**Table 1.** Anthropometric characteristics of the two groups of women in labor.

| Study sample | Nulliparous (N = 156) | | | Multiparous (N = 70) | | |
|---|---|---|---|---|---|---|
| | EA | No EA | *p*-value | EA | No EA | *p*-value |
| | n = 91 (%) | n = 65 (%) | | n = 15 (%) | n = 55 (%) | |
| Maternal age (years) | | | | | | |
| 18 - 24 | 27 (29.7) | 26 (40.0) | | - | 3 (5.5) | |
| 25 - 29 | 47 (51.6) | 34 (52.3) | | 6 (40.0) | 16 (29.1) | |
| 30 - 34 | 15 (16.5) | 5 (7.7) | | 9 (60.0) | 20 (36.4) | |
| ≥ 35 | 2 (2.2) | - | | - | 16 (29.1) | |
| Mean ± SD | 26.2 ± 3.8 | 25.2 ± 3.8 | 0.118 | 30.1 ± 2.9 | 31.6 ± 5.2 | 0.296 |
| BMI (kg/m$^2$) | | | | | | |
| < 18.5 | 17 (44.7) | 21 (55.3) | | 4 (26.7) | 13 (23.6) | |
| 18.5 - 22.9 | 68 (63) | 40 (37) | | 10 (66.7) | 39 (70.9) | |
| 23.0 – 24.9 | 5 (71.4) | 2 (28.6) | | 1 (6.7) | 3 (5.5) | |
| ≥ 25.0 | 2 (66.7) | 1 (33.3) | | - | - | |
| Mean ± SD | 20.2 ± 2.1 | 19.4 ± 2.1 | 0.023 | 19.6 ± 2.0 | 19.8 ± 1.9 | 0.688 |
| Medical history | | | | | | |
| CV disease | 1 (1.6) | 3 (3.3) | | - | - | |
| Diabetes | 2 (2.2) | - | | - | - | |
| Thyroid disease | 2 (2.2) | 2 (3.1) | - | 1 (100.0) | - | - |
| Asthma | 3 (3.3) | 1 (1.6) | | 2 (100.0) | - | |
| Other | 10 (10.9) | 9 (14.1) | | 6 (100.0) | - | |
| Gestational ages (weeks) | | | | | | |
| 37 | 17 (18.5) | 4 (6.3) | | 1 (6.7) | 6 (10.9) | |
| 38 | 26 (28.3) | 16 (25.0) | | 4 (26.7) | 13 (23.6) | |
| 39 | 40 (43.5) | 29 (45.3) | | 8 (53.3) | 23 (41.8) | |
| ≥ 40 | 9 (9.8) | 15 (23.4) | | 1 (6.7) | 13 (23.6) | |
| Mean ± SD | 38.5 ± 0.9 | 38.9 ± 0.9 | 0.007 | 38.8 ± 0.9 | 38.8 ± 0.9 | 0.947 |

*Abbreviations: BMI, Body Mass Index; CV, Cardiovascular; EA, Epidural Analgesia; SD, Standard Deviation.*

Among nulliparous women, the mean maternal age was 26.2 ± 3.8 years in the EA group and 25.2 ± 3.8 years in the control group. The mean gestational age at delivery was 38.5 ± 0.9 and 38.9 ± 0.9 days, respectively. Among multiparous parturients, the mean maternal age in the study and control groups was 30.1 ± 2.9 and 31.6 ± 5.2 years, and the mean gestational age was 38.8 ± 0.9 and 38.8 ± 0.9 days, respectively. There was no significant difference in gestational age at delivery or maternal age between groups.

Body mass index (BMI) was also comparable between groups. In nulliparous women, the mean BMI was 20.2 ± 2.1 kg/m² in the EA group and 19.4 ± 2.1 kg/m² in the control group ($p < 0.05$). For multiparous women, the values were 19.6 ± 2.0 and 19.8 ± 1.9 kg/m², respectively. Comorbidities were uncommon in both nulliparous and multiparous women. Asthma and thyroid disease were the most common in the study population. Other conditions recorded included HBV infection and allergies.

**Table 2**. Labor characteristics in nulliparous and multiparous women

| Characteristics | Nulliparous (N = 156) | | | Multiparous (N = 70) | | |
|---|---|---|---|---|---|---|
| | EA (n = 91) | No EA (n = 65) | *p*-value | EA (n = 15) | No EA (n = 55) | *p*-value |
| VAS score (Mean ± SD) | | | | | | |
| Stage Ib | 4.3 ± 3.0 | 7.7 ± 1.4 | < 0.001 | 4.6 ± 2.8 | 6.5 ± 1.3 | 0.021 |
| Stage II | 4.3 ± 2.0 | 8.5 ± 1.1 | < 0.001 | 4.1 ± 2.1 | 7.3 ± 1.3 | < 0.001 |
| Uterine contraction intensity (mmHg, Mean ± SD) | | | | | | |
| Stage Ib | 71.1 ± 18.3 | 69.4 ± 18.6 | 0.567 | 72.7 ± 19.8 | 71.2 ± 16.6 | 0.783 |
| Stage II | 79.1 ± 14.4 | 82.2 ± 13.3 | 0.172 | 80.7 ± 17.1 | 77.6 ± 17.7 | 0.551 |
| Uterine contraction frequency (per 10 mins, Mean ± SD) | | | | | | |
| Stage Ib | 2.9 ± 0.7 | 2.5 ± 0.7 | < 0.001 | 3.0 ± 0.8 | 2.6 ± 0.8 | 0.064 |
| Stage II | 3.5 ± 0.7 | 3.4 ± 0.7 | 0.374 | 3.4 ± 0.5 | 3.4 ± 0.7 | 0.921 |
| Oxytocin IV administration (n, %) | | | | | | |
| Yes | 3 (3.3) | 2 (3.1) | 1.000 | - | 1 (1.8) | 0.599 |
| No | 88 (96.7) | 63 (96.9) | | 15 (100.0) | 54 (98.2) | |

*Abbreviations: VAS, Visual Analogue Scale; EA, Epidural Analgesia; SD, Standard Deviation; IV, Intravenous.*

The effectiveness of EA was demonstrated by significantly lower VAS scores in the intervention group compared to the control group during stage Ib and stage II of labor, in both nulliparous and multiparous women.

The intensity of uterine contractions did not differ significantly between the groups during either stage Ib or stage II of labor. However, in nulliparous women, the frequency of uterine contractions during stage Ib was significantly higher in the EA group compared to the control group (2.9 ± 0.7 vs. 2.5 ± 0.7 contractions per 10 minutes, $p < 0.001$). Contraction frequency during stage II was comparable between groups. Most cases requiring oxytocin during labor were in nulliparous parturients, and there was no association between EA and oxytocin use in these groups.

**Figure 1.** Labor duration in nulliparous women.

| Time (minutes) | No EA | EA | | | *p*1-value | *p*2-value | *p-value* |
|---|---|---|---|---|---|---|---|
| | | EA < 5 cm | EA ≥ 5 cm | Overall | | | |
| Stage Ib | 196.2 ± 171 | 246.2 ± 128.8 | 250.5 ± 138.6 | 248.5 ± 133.3 | 0.105 | 0.074 | 0.034 |
| Stage II | 25.9 ± 22.6 | 37.7 ± 30.4 | 30.3 ± 23.4 | 33.8 ± 27.0 | 0.022 | 0.32 | 0.049 |
| Total | 222.1 ± 173.9 | 284 ± 134.1 | 280.8 ± 140.9 | 282.3 ± 137.0 | 0.051 | 0.058 | 0.017 |

*Abbreviations: EA, Epidural Analgesia; EA < 5 cm, EA at < 5 cm cervical dilation; EA ≥ 5 cm, EA at ≥ 5 cm cervical dilation; p1, p2, and p represent the associations between the No EA group and the EA < 5 cm group, the No EA group and the EA ≥ 5 cm group, and the No EA group and the overall EA group, respectively.*

**Figure 2.** Labor duration in multiparous women.

| Time (minutes) | No EA | EA | | | *p*1-value | *p*2-value | *p-value* |
|---|---|---|---|---|---|---|---|
| | | EA < 5 cm | EA ≥ 5 cm | Overall | | | |
| Stage Ib | 136.2 ± 129.2 | 207.9 ± 103.3 | 143.9 ± 100.3 | 173.7 ± 103.4 | 0.164 | 0.873 | 0.304 |
| Stage II | 18.3 ± 17.8 | 27.1 ± 21.8 | 14.9 ± 20.9 | 20.6 ± 21.5 | 0.233 | 0.618 | 0.677 |
| Total | 154.5 ± 137.5 | 235 ± 100.3 | 158.8 ± 106.3 | 194.3 ± 107.3 | 0.141 | 0.934 | 0.304 |

*Abbreviations: EA, Epidural Analgesia; EA < 5 cm, EA at < 5 cm cervical dilation; EA ≥ 5 cm, EA at ≥ 5 cm cervical dilation; p1, p2, and p represent the associations between the No EA group and the EA < 5 cm group, the No EA group and the EA ≥ 5 cm group, and the No EA group and the overall EA group, respective.*

In nulliparous women, administering EA when cervical dilation was < 5 cm significantly prolonged the stage Ib of labor duration compared to the control group (37.7 ± 30.4 minutes vs. 25.9 ± 22.6 minutes, $p < 0.05$). No statistically significant differences were observed in the total duration of labor or stage Ib duration between the EA and non-EA groups in nulliparous and multiparous women.

**Table 3.** Delivery and maternal-infant outcomes.

| Characteristics | Nulliparous (N = 156) | | | Multiparous (N = 70) | | |
|---|---|---|---|---|---|---|
| | **EA** | **No EA** | ***p*-value** | **EA** | **No EA** | ***p*-value** |
| | **n = 91 (%)** | **n = 65 (%)** | | **n = 15 (%)** | **n = 55 (%)** | |
| Mode of delivery | | | | | | |
| Spontaneous vaginal delivery | 87 (95.6) | 65 (100.0) | 0.141 | 15 (100.0) | 55 (100.0) | - |
| Assisted vaginal delivery | 4 (4.4) | - | | - | - | |
| Blood loss (ml) | | | | | | |
| Mean ± SD | 151.3 ± 122.3 | 146.6 ± 96.1 | 0.797 | 116 ± 29.2 | 135.5 ± 101 | 0.216 |
| Min - Max | 50 - 800 | 50 - 600 | | 50 - 150 | 50 - 500 | |
| Perineal laceration grading | | | | | | |
| Grade 1 - 2 | 68 (74.7) | 48 (73.8) | 0.901 | 15 (100) | 54 (98.2) | 1.000 |
| Grade 3 - 4 | 23 (25.3) | 17 (26.2) | | - | 1 (1.8) | |
| Dosage of oxytocin administration after delivery | | | | | | |
| 10 UI | 43 (47.3) | 29 (44.6) | 0.665 | 5 (33.3) | 27 (49.1) | 1.000 |
| 10 - 20 UI | 47 (51.6) | 34 (52.3) | | 10 (66.7) | 26 (47.3) | |
| > 20 UI | 1 (1.1) | 2 (3.1) | | - | 2 (3.6) | |
| Duratocin administration | 10 (11) | 2 (3.1) | 0.067 | - | 4 (7.3) | 0.357 |
| Adverse effects of EA | 2 (2.2) | - | | - | - | |
| Neonate weight (g) | | | | | | |
| < 2,500 | 7 (7.7) | 5 (7.7) | | - | - | |
| 2,500 - 2,999 | 37 (40.7) | 30 (46.2) | | 5 (33.3) | 17 (30.9) | |
| 3,000 - 3,499 | 44 (48.4) | 29 (44.6) | | 8 (53.3) | 29 (52.7) | |
| ≥ 3,500 | 3 (3.3) | 1 (1.5) | | 2 (13.3) | 9 (16.4) | |
| Mean ± SD | 3,037 ± 306 | 3,023 ± 339 | 0.784 | 3,173 ± 395 | 3,205 ± 328 | 0.749 |
| APGAR score | | | | | | |
| IA 1 mins < 7 | 2 (2.2%) | - | | - | - | |
| IA 5 mins < 7 | 1 (1.1%) | - | | - | - | |
| NICU admission | 6 (6.6) | 5 (7.8) | 0.771 | 1 (6.7) | 3 (5.5) | 0.858 |

*Abbreviations: EA, Epidural Analgesia, SD, Standard Deviation; NICU, Neonatal Intensive Care Unit.*

Our data showed that the rate of assisted vaginal delivery in nulliparous women who received EA was 4.4%. Other adverse perinatal outcomes, including increased use of Oxytocin and Duratocin after delivery, severe perineal lacerations (grades 3 - 4), estimated blood loss, low Apgar scores, and NICU admission, did not differ significantly between the EA and control groups in both nulliparous and multiparous women. Most newborns had a birth weight within the normal range of 2,500 - 3,500 grams.

## 4. DISCUSSION

**The impact of epidural analgesia on labor duration**

Our study results showed that EA increases the duration of stage Ib and stage II labor in nulliparous women ($p < 0.05$). In the multiparous group, statistical analysis showed that the mean labor duration with EA was longer than in the control group, but this difference was not statistically significant ($p > 0.05$). These results are consistent with some international studies, such as Zhang et al. (2023), which also showed that EA significantly prolonged stage I and II of labor, with a mean increase of about 201 minutes in stage I and 22 minutes in stage II compared to the non-EA group [5]. Deepak et al. (2022) evaluated the impact of EA on labor in nulliparous women. They found that the rate of prolonged second-stage labor was significantly higher in the EA group, while the prolonged active phase increased but was not statistically significant [6]. Other studies, such as Anwar, S. et al. (2015), found that EA only affected the duration of the second stage of labor and not the active phase [18]. However, some studies have shown that EA may reduce or not affect labor duration. Deying et al. (2021) found that the duration of stage I labor was decreased significantly in the EA group, while there was no difference in stage II labor duration [9]. M. Shivanagappa (2021) also concluded that EA did not affect labor duration [19].

We propose that EA may prolong the active phase of the first and second stages of labor compared to the control group. Subgroup analysis indicated that administration of EA when cervical dilation was < 5 cm was associated with a longer second stage of labor. However, these findings vary across studies, likely due to differences in EA protocols, timing of administration, criteria for defining the active phase, and methods of labor assessment.

***Impact of epidural analgesia on delivery mode and maternal-neonatal outcomes***

Our study found that the instrumental delivery rate in nulliparous women with EA was higher than in the control group. Still, the number of instrumental deliveries in our study was too small to confirm the impact of EA on delivery mode. Many studies, such as Khatun et al. (2024) and Deepak et al. (2022), also found that EA did not increase the rate of instrumental delivery compared to controls [6, 20].

Regarding the degree of perineal tears, statistical analysis in our study showed that the rate of severe perineal tears (grades 3 and 4) was not different between the study and control groups when analyzed separately in nulliparous and multiparous parturients. Similar results were reported in a large cohort study by Loewenberg-Weisband (2014), which found no correlation between EA and severe perineal tears when analyzed by parity [21]. In addition, the study of M. Denini et al. (2024) found that EA was a protective factor for perineal tears [22].

Regarding blood loss and neonatal weight, our study found no significant differences between groups, and neonatal Apgar scores were all maximal, similar to the report by F. Ambrosetti et al., which showed that EA did not adversely affect neonatal outcomes [23]. This report is consistent with WHO recommendations and significant obstetric associations such as the American College of Obstetricians and Gynecologists, which state that EA does not increase the rate of neonatal complications when performed with proper indications and close monitoring [1, 2].

***Overall evaluation and clinical implications***

Our research findings, along with the latest international studies, indicate that EA is an effective pain relief method that improves the labor experience for parturients without increasing the rate of adverse pregnancy outcomes or negatively affecting neonatal outcomes. However, EA can prolong the duration of labor, especially in the first and second stages for nulliparous parturients, and may increase the instrumental delivery rate. Therefore, careful consideration is needed when selecting an appropriate parturient, and close monitoring during labor is essential to minimize complications.

Individualizing the administration of EA according to the recommendations of ACOG and ASA, as well as extending access to EA for high-risk parturients, can contribute to reducing severe maternal complications and improving the quality of obstetric care.

***Strengths and limitations of the study***

Our study has the advantage of a comparative observational cohort design, meticulous monitoring of labor parameters and maternal-fetal outcomes, appropriate statistical analysis methods, and a clear comparison between the study and control groups. However, the limitations include the small sample size in the multiparous parturient group and the limited number of instrumental deliveries, which affects the reliability of the analysis of EA's effects in these groups. Furthermore, due to the nature of observational research, it is unattainable to completely control for confounding factors such as anesthesia techniques, drug dosages, and other medical interventions during labor.

## 5. CONCLUSION

In this prospective cohort study of nulliparous women, epidural analgesia administered before 5 cm cervical dilation was associated with a longer duration of the first stage of labor and a higher rate of cesarean delivery. However, no significant differences were observed in neonatal outcomes. These findings support the consideration of cervical dilation at the time of epidural initiation as a modifiable factor in labor management. In low-resource settings, where optimizing cesarean section rates is critical, individualized counseling and judicious timing of epidural analgesia may improve maternal outcomes without compromising neonatal safety.

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