

CLINICAL ARTICLE

Obstetrics

Early versus late epidural analgesia in nulliparous women: Impact on labor duration and maternal–neonatal outcomes in Central Vietnam

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Funding information

Hue University, Grant/Award Number: DHH2024-04-226 and NCTB. DHH.2025.07

Abstract

Objectives: The timing of epidural analgesia (EA) initiation during labor remains a topic of clinical debate, particularly regarding its impact on labor progression and maternal and neonatal outcomes. This study aimed to evaluate the association between the timing of EA administration and the duration of labor, as well as key maternal and neonatal outcomes.

Methods: This prospective observational study included 297 primiparous women with singleton term pregnancies (37–42 weeks of gestation) who received EA for labor analgesia at the Obstetrics and Gynecology Centre, Hue Central Hospital, between April 2022 and June 2024. Participants were stratified into two groups based on cervical dilation at the time of EA initiation: <5 cm (group EA1) and ≥5 cm (group EA2). Labor durations were compared using Kaplan–Meier survival analysis. The association between EA timing and first-stage labor duration was calculated using Pearson's correlation coefficient. Maternal and neonatal outcomes were analyzed descriptively.

Results: Initiation of EA at cervical dilation <5 cm was significantly associated with a longer active phase of the first stage of labor (206.9 ± 122.1 min, 95% confidence interval [CI] 183.84–229.91) compared to initiation at ≥5 cm (138.5 ± 108.3 min, 95% CI 114.31–162.82, $P < 0.001$). A moderate negative correlation was identified between EA timing and the length of the first stage ($r = -0.30$, $P < 0.001$). The cesarean delivery rate was higher in group EA1 (22.4%) than in group EA2 (12.6%) ($P = 0.039$). No significant differences were found between the groups regarding the second stage of labor, oxytocin augmentation, perineal trauma, EA-related side effects, Apgar scores, or neonatal intensive care unit admissions.

Conclusion: Late epidural analgesia administered at cervical dilation ≥5 cm was associated with a shorter active phase of the first stage of labor and a lower cesarean delivery rate without increasing adverse maternal or neonatal outcomes. These findings suggest a potential benefit to delaying EA administration until at least 5 cm cervical dilation; however, further randomized controlled trials are necessary to confirm these results.

KEYWORDS

epidural analgesia, labor stage, maternal and neonatal outcomes, nulliparous

1 | INTRODUCTION

Effective pain management during labor is critical in improving the childbirth experience. Approximately 60% of pregnant women consider labor pain to be severe or extremely severe, which can lead to chronic pain and postpartum depression syndrome and affect both psychological wellbeing and the recovery of bodily functions. Epidural analgesia (EA), first introduced in the early 20th century and utilized in obstetrics since 1946, has emerged as the most prevalent method for pain relief during labor in developed countries. Its usage has consistently increased over the past two decades.¹ In developed countries, the prevalence of EA among nulliparous women is high, reaching 83% in Finland, 82% in Belgium, 79% in the USA, and 64% in Ireland.² In contrast, with limited data, rates remain low in low- and middle-income countries; for example, only 2.2% of hospitalized pregnant women in South Africa received EA.³

The optimal timing for EA administration, whether during the latent or active phase of labor, remains a topic of debate. The definition of the active phase has also evolved. The World Health Organization's Labor Care Guide (WHO LCG) (2020) redefined the active phase beginning at 5 cm of cervical dilation. In contrast, the American College of Obstetricians and Gynecologists considers it to start at 6 cm.^{4,5} Several studies have evaluated the effect of EA timing on labor outcomes. For instance, Zha et al. (2021) reported that initiating EA before 6 cm of cervical dilation was associated with a prolonged first and second stage of labor ($P < 0.001$).⁶ A Cochrane systematic review (2014) reported that the second stage of labor was longer in women receiving early EA, while the duration of the first stage of labor was not meta-analyzed because of inconsistencies in the data, including varying cut-offs for cervical dilation, ranging from 2 to 5 cm. Despite this variation, no significant differences were found in cesarean section rates, assisted vaginal deliveries, neonatal Apgar scores, or umbilical cord pH between the two groups.⁷

In Vietnam, EA was first introduced in obstetrics in 1987. However, data on the prevalence of EA and its impact on labor stages remain limited. This study aimed to evaluate the effect of EA timing on labor progression and maternal-neonatal outcomes among nulliparous women, providing evidence relevant to clinical practice in Central Vietnam and contributing to the global discourse.

2 | MATERIALS AND METHODS

2.1 | Study design and participants

This initial observational study was conducted at the Centre of Obstetrics and Gynecology, Hue Central Hospital (Central Vietnam), from April 2022 to June 2024. Eligible participants included primiparous women with live singleton term pregnancies (gestational age 37–42 weeks) who received EA for labor pain management.

The exclusion criteria were as follows: (i) abnormal fetal presentation or obstetric emergencies such as placental abruption or bleeding placenta previa; (ii) conditions associated with a high risk of cesarean delivery, including suspected macrosomia, oligohydramnios, hydramnios, or fetal growth restriction; and (iii) pre-existing significant cardiovascular diseases (e.g., mitral stenosis or history of congenital/acquired heart surgery) or severe systemic conditions (e.g., renal failure, Graves' disease or coagulation disorders); (4) known allergy to local anesthetic agents; and (5) contraindications to EA.

Participants were divided into two groups based on cervical dilation at the time of EA initiation during the first stage of labor:

- Group EA1. EA initiated at a cervical dilation of < 5 cm
- Group EA2. EA initiated at a cervical dilation of ≥ 5 cm.

2.2 | Sample size

The sample size was determined based on the formula for estimating a single population proportion:⁸

$$n \geq \frac{Z_{1-\alpha/2}^2 (1-p)p}{d^2}$$

Using an estimated vaginal delivery rate (p) of 0.81, based on Yancey et al. (2000),⁹ a 95% confidence level ($Z = 1.96$), and a desired margin of error (d), the minimum required sample size was determined to be 237 participants. In this study, 297 women were enrolled and analyzed.

2.3 | Research procedures

After administration of EA by the attending anesthesiologist, eligible participants were enrolled in the study. The obstetric team recorded the exact timing of EA initiation. Labor was monitored continuously from the time of EA initiation. Full labor monitoring using the WHO Labor Care Guide (WHO-LCG) was applied starting from cervical dilation of 5 cm or greater. Primary maternal and neonatal outcomes were then systematically recorded. Finally, the collected data were compiled for statistical analysis. The EA protocol followed national and international guidelines (the National Institute for Health and Care Excellence–NICE and VSA), using a combination of 0.1% bupivacaine and 2 μ g/mL fentanyl.¹

2.4 | Study variables

The primary variables related to labor progression included the duration of the active phase of the first and second stages of labor, as well as uterine contraction intensity. According to the WHO LCG (2020), the active phase of labor begins at 5 cm of cervical

dilation and continues until full dilation is achieved. The second stage was defined as the period from complete cervical dilation to the neonate's birth.⁵ Uterine contractions were assessed by external tocodynamometry, considered the most common non-invasive assessment method in obstetric practice. Uterine contraction intensity (mmHg) was recorded as the maximum intrauterine pressure measured on cardiotocography at the following time points: immediately before EA, 15 min after EA, during the first stage of labor, and during the second stage of labor.

The primary pregnancy outcomes included mode of delivery (spontaneous vaginal delivery, assisted vaginal delivery, and cesarean section), the use of oxytocin, epidural-related side effects, uterine atony, postpartum hemorrhage, Apgar scores, birth weight, and admission to the neonatal intensive care unit (NICU). In accordance with WHO guidelines, postpartum hemorrhage was defined as estimated blood loss of ≥ 500 mL following vaginal delivery and ≥ 1000 mL after cesarean section.¹⁰ The Apgar score is evaluated 1 and 5 min after birth using the following criteria: appearance, pulse, grimace, activity, and respiration. Infants with a 5-min score of ≤ 7 or those needing resuscitation are subjected to additional assessments every 5 min to track their adaptation. A score of 7–10 is considered normal.¹¹ The assessment of women's satisfaction was based on the effectiveness of pain relief following epidural analgesia (EA). Pain intensity was measured using the visual analog scale (VAS). A VAS score of <4 was considered indicative of satisfactory pain relief, and thus, the patient was classified as satisfied. Conversely, a score ≥ 4 was categorized as not satisfied.

2.5 | Statistical analysis

Data input and statistical analysis were conducted with the Statistical Package for the Social Sciences (SPSS) version 27.0 (SPSS, Chicago, IL, USA). Continuous variables were presented as mean $\pm$ standard deviation (SD) or median (interquartile range, IQR). Between-group comparisons of continuous variables were conducted using independent samples *t*-tests or the Mann–Whitney *U*-test, as appropriate. Categorical variables were expressed as frequencies and percentages (*n*, %) and analyzed using the χ^2 -test.

Labor duration was assessed using Kaplan–Meier survival analysis, and group comparisons were performed using the log-rank test. The correlation between EA initiation timing and the duration of the active phase of the first stage of labor was assessed using Pearson's correlation coefficient. Odds ratios (OR) with 95% confidence intervals (95% confidence intervals [CI]) were reported. A two-sided *P*-value of <0.05 was considered statistically significant.

2.6 | Ethical approval and consent to participate

The Ethical Committee in Biomedical Research of Hue University of Medicine and Pharmacy provided ethical approval (no. H2024/009), with institutional consent from Hue Central Hospital. Participants

received complete study information, and confidentiality was assured; all participants provided written informed consent before being included.

3 | RESULTS

3.1 | Study population and baseline characteristics

A total of 297 primiparous women with live singleton-term pregnancies who received EA were included in the study. Among them, 170 (57.2%) participants received EA at cervical dilation of <5 cm (Group EA1), while 127 (42.8%) participants received EA at cervical dilation ≥ 5 cm (Group EA2).

Table 1 shows a significant difference in uterine contraction intensity between the two groups, pre-EA ($P=0.015$) and 15 min post-EA ($P=0.001$). Other characteristics, including maternal age, gestational age, and body mass index, were comparable between the two groups.

3.2 | Duration of the first and second stages of labor

Figure 1 illustrates the correlation between cervical dilation at the time of EA initiation and the duration of labor stages. A significant negative correlation was observed between cervical dilation at EA initiation and the combined duration of the first and second stages ($r=-0.21$, $P<0.001$; $R^2=0.04$). This correlation was stronger when analyzing the first stage alone ($r=-0.30$, $P<0.001$; $R^2=0.09$), suggesting that earlier administration of EA was associated with a longer first stage. In contrast, no significant correlation was found between cervical dilation at EA initiation and the duration of the second stage ($r=-0.09$, $P=0.206$; $R^2=0.01$).

Figure 2 compares the duration of the first and second stages between the two groups. The mean duration of the first stage was significantly longer in group EA1 (206.9 ± 122.1 min, 95% CI 183.84–229.91) compared to group EA2 (138.5 ± 108.3 min, 95% CI 114.31–162.82) ($P<0.001$). In contrast, the average length of the second stage was similar between group EA1 (24.8 ± 15.7 min, 95% CI 21.49–28.10) and group EA2 (21.5 ± 10.9 min, 95% CI 19.29–24.81) ($P=0.079$). Kaplan–Meier survival analysis further supported these findings, showing a significantly shorter first stage in Group EA2 compared to Group EA1 (log-rank $P<0.001$, Figure 2). However, there was no significant difference between groups in the duration of the second stage based on the log-rank test ($P=0.055$).

3.3 | Maternal and neonatal outcomes

Primary maternal and neonatal outcomes, including mode of delivery and labor-related complications, are summarized in Table 2. The

TABLE 1 Characteristics of the study population.^a

Characteristics	EA1 (n = 170)	EA2 (n = 127)	Z	P-value
Maternal age, years	26 (23–28)	23 (22–25)	−0.578	0.563
18–24	68 (40.0%)	54 (41.7%)		
25–29	80 (47.1%)	60 (47.2%)		
30–34	20 (11.8%)	12 (9.4%)		
≥35	2 (1.2%)	2 (1.6%)		
BMI at delivery, kg/m ²	19.6 (18.2–21.8)	20.3 (18.8–22.9)	−1.949	0.051
<18.5	48 (28.2%)	26 (20.5%)		
18.5–23.0	97 (57.1%)	72 (56.7%)		
23–25	14 (8.2%)	14 (11.0%)		
25–30	11 (6.5%)	15 (11.8%)		
Gestational age, weeks	39.4 ± 0.9	39.3 ± 0.9		0.284
37	2 (1.2%)	5 (3.9%)		
38	26 (15.3%)	22 (17.3%)		
39	59 (34.7%)	43 (33.9%)		
40	71 (41.8%)	48 (37.8%)		
41	12 (7.1%)	19 (7.1%)		
Uterine contraction intensity, mmHg				
Pre-EA	39.0 (37.0–42.0)	39.0 (38.0–60.0)	−2.443	0.015
15 min post-EA	44.0 (41.0–50.0)	45.0 (43.0–60.0)	−3.982	0.001
The first stage of labor	79.0 (76.0–80.0)	80.0 (76.0–82.0)	−1.590	0.112
The second stage of labor	97.0 (91.0–99.0)	96.0 (90.0–99.0)	−1.007	0.314

Note: Uterine contractions are assessed by external tocodynamometry, which is considered a common method in obstetric practice. Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by the square of height in meters); EA1, epidural analgesia initiated at a cervical dilation of <5 cm; EA2, epidural analgesia initiated at a cervical dilation of ≥5 cm.

^aData are presented as mean ± standard deviation or median (interquartile range) or as number (percentage).

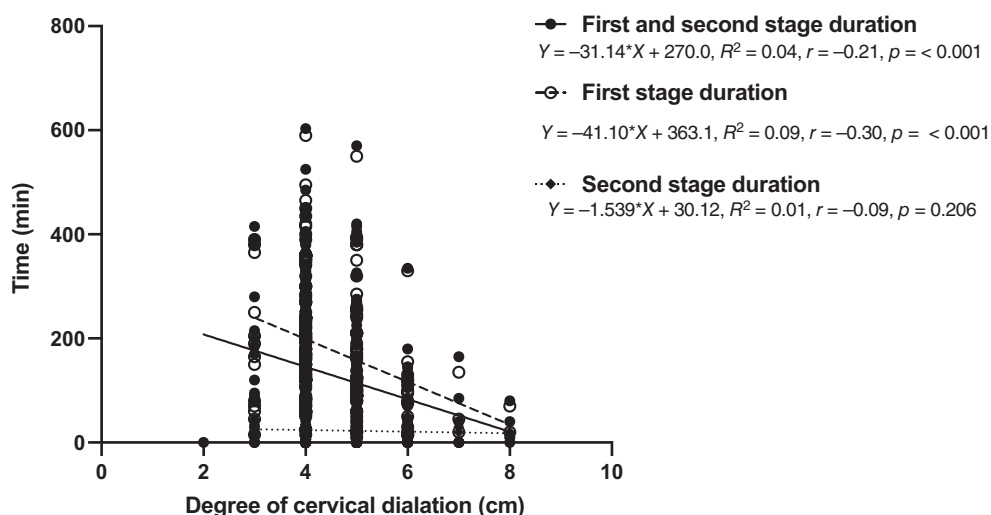


FIGURE 1 Correlation between the degree of cervical dilatation at the time of EA and the time to delivery (Pearson's correlation test, $P < 0.05$). The timing of EA was correlated with the duration of both the first and second stages of labor ($r = -0.21$, $P < 0.001$; $R^2 = 0.04$), with a stronger correlation observed for the first stage ($r = -0.30$, $P < 0.001$; $R^2 = 0.09$). EA1, epidural analgesia initiated at a cervical dilation of <5 cm; EA2, epidural analgesia initiated at a cervical dilation of ≥5 cm.

cesarean section rate was 22.4% in the EA1 group and 12.6% in the EA2 group, with a statistically significant difference between the two groups ($P = 0.039$).

There were no significant differences between the two groups in terms of other adverse maternal outcomes, including the use of oxytocin ($P = 0.905$), epidural-related side effects ($P = 0.473$), uterine

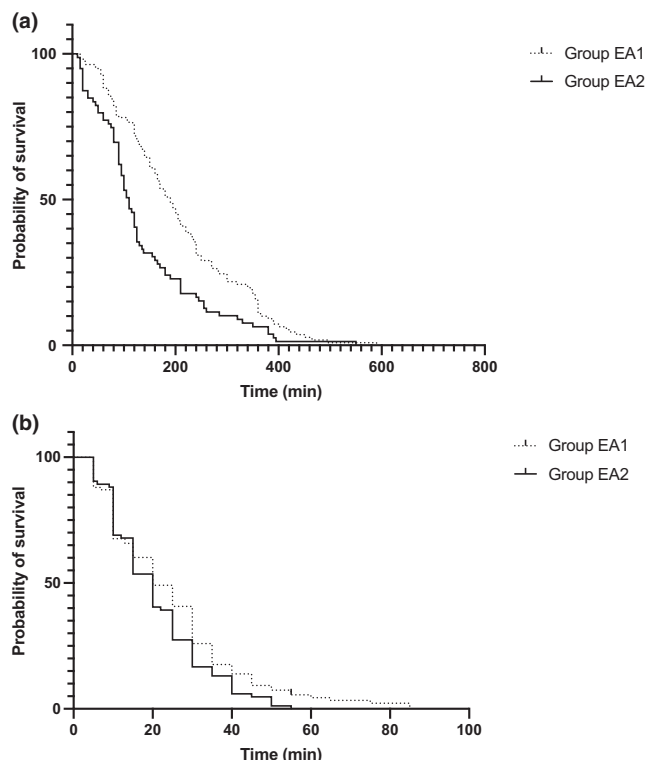


FIGURE 2 Survey of the relationship between labor time between EA1 and EA2 groups in the first stage of labor (a) and the second stage of labor (b). Kaplan-Meier survival curves were constructed and compared using log-rank tests, $P < 0.05$. The results in Figure 2a showed that the mean duration of the first stage was significantly longer in group EA1 (206.9 ± 122.1 min, 95% CI 183.84–229.91) compared to group EA2 (138.5 ± 108.3 min, 95% CI 114.31–162.82) ($P < 0.001$). CI, confidence interval; EA1, epidural analgesia initiated at a cervical dilation of < 5 cm; EA2, epidural analgesia initiated at a cervical dilation of ≥ 5 cm.

atony ($P = 0.292$), estimated blood loss ($P = 0.973$), and complex perineal lacerations ($P > 0.99$). The majority of parturients were satisfied with the EA service, with satisfaction rates of 89.4% in the EA1 group and 88.2% in the EA2 group, respectively ($P = 0.852$).

Regarding neonatal outcomes, the mean birth weight was similar between group EA1 (3098.2 ± 298.1 g) and group EA2 (3062.9 ± 282.1 g) ($P = 0.306$). One infant (0.6%) in Group EA1 had an Apgar score < 7 at 5 min and required NICU admission; no infants in Group EA2 met these criteria.

4 | DISCUSSION

Epidural analgesia is the most effective and widely used analgesic technique in developed countries. However, in some Asian countries and low- and middle-income countries (LMICs), including Vietnam, the use of this technique remains limited due to resource constraints and concerns related to maternal sociodemographic and psychological factors, as well as potential risks.¹²

The main findings of our study indicated that early administration of EA significantly prolonged the mean duration of the active phase

of the first stage but not the second stage of labor. Regarding maternal and neonatal outcomes, the cesarean section rate in the early EA group was higher than in the late EA group (22.4% vs. 12.6%, respectively, $P = 0.039$). Other adverse outcomes, including oxytocin administration, EA-related side effects, uterine atony, complex perineal lacerations, 1-min and 5-min Apgar scores < 7 , and NICU admission, were not statistically different between the two groups.

The impact of optimal timing of EA on labor duration varies across studies. A systematic review by Anim-Somuah et al. (2018) suggested that EA increased the duration of the first stage by 32 min and the second stage by 15 min.¹³ Rahm et al. found that EA during labor may suppress the release of oxytocin into plasma, potentially explaining the prolonged duration of labor.¹⁴ Similarly, Behrens et al. concluded that EA inhibits the release of prostaglandin $F_{2\alpha}$ (PGF $_{2\alpha}$), which may reduce uterine activity and prolong the first stage of labor.¹⁵ Conversely, Nielsen et al. reported no significant changes in uterine contraction patterns before and after EA administration using bupivacaine in women experiencing spontaneous labor.¹⁶ In a randomized study of 310 nulliparous women, Craig et al. (2015) found no significant prolongation of the second stage when using low-concentration bupivacaine with fentanyl.¹⁷ This evidence indicates that the effect of EA on labor duration remains controversial due to inconsistencies in data, clinical protocols, study populations, and definitions of the active phase.

In terms of the impact of EA on the mode of delivery, Penuela et al. identified EA as an independent risk factor for both instrumental deliveries (odds ratio [OR] = 3.27, 95% CI 2.93–4.61) and cesarean sections (OR = 1.19, 95% CI 1.10–1.29).¹⁸ Nevertheless, Olszynska et al. (2023) reported no increase in cesarean delivery rates among women who received EA.¹⁹ Furthermore, Sng et al. (2014) summarized nine studies' outcomes, stating that the timing of EA (early vs. late) did not significantly affect the risk of cesarean section.⁷

Moreover, some observational studies reported increased adverse maternal and neonatal outcomes among women who received EA for pain relief during labor. A Cochrane review (2018) reported a higher frequency of side effects in both EA and opioid groups.¹³ Deshmukh (2018) noted common but manageable effects such as nausea, vomiting, chills, pruritus, and hypotension.²⁰ Several studies suggest that increased oxytocin use in such cases reduces labor duration moderately but does not provide additional clinical benefits. Therefore, oxytocin should be considered cautiously.²¹ According to Kurakazu's study, combined spinal-epidural analgesia resulted in higher blood loss ($P < 0.01$), meconium-stained amniotic fluid, reduced Apgar scores at 1 min, and umbilical artery pH levels below 7.15. However, the rates of assisted vaginal delivery and low Apgar scores at 5 min were not significantly different.²² Similarly, Liu et al. (2021) found that although EA was associated with longer labor durations, it did not affect the mode of delivery, episiotomy rates, or other adverse maternal or neonatal outcomes.²³

This study highlights the impact of EA timing on labor duration and delivery outcomes. One strength of this study is its prospective design and detailed analysis of labor progression and the timing of EA. However, a limitation of the study was its small sample

TABLE 2 Maternal and perinatal outcomes.^a

Characteristics	EA1 (n = 170)	EA2 (n = 127)	p-value
Mode of delivery			
Spontaneous vaginal delivery	130 (76.4%)	107 (84.3%)	
Assisted vaginal delivery	2 (1.2%)	4 (3.1%)	0.311
Cesarean section	38 (22.4%)	16 (12.6%)	0.039
Oxytocin administration			
No	159 (93.5%)	118 (92.9%)	0.834
Yes	11 (6.5%)	9 (7.1%)	
Side effects			
No	161 (94.7%)	117 (92.1%)	0.473
Yes	9 (5.3%)	10 (7.9%)	
Arterial hypotension	7 (4.1%)	6 (4.7%)	
Nausea, vomiting	1 (0.6%)	1 (0.8%)	
Chills	–	2 (1.6%)	
Urinary retention	1 (0.6%)	1 (0.8%)	
Uterine atony			
No	167 (98.2%)	122 (96.1%)	0.294
Yes	3 (1.8%)	5 (3.9%)	
Total blood loss, mL	148.1 ± 60.4	147.8 ± 81.1	0.973
Perineal injury			
Grade 1–2	129 (97.7%)	109 (98.2%)	1.000
Grade 3–4	3 (2.3%)	2 (1.8%)	
Birth weight, g	3098.2 ± 298.1	3062.9 ± 282.1	0.306
<2500	5 (2.9%)	5 (3.9%)	
2501–3000	77 (45.3%)	57 (44.9%)	
3001–3500	77 (45.3%)	59 (46.5%)	
>3500	11 (6.5%)	6 (4.7%)	
1 min Apgar score <7	1 (0.6%)	–	–
5 min Apgar score <7	1 (0.6%)	–	–
NICU admission	1 (0.6%)	–	–
Maternal satisfaction			
Satisfied	152 (89.4%)	112 (88.2%)	0.852
Unsatisfied	18 (10.6%)	15 (11.8%)	

Abbreviations: EA1, epidural analgesia initiated at a cervical dilation of <5 cm; EA2, epidural analgesia initiated at a cervical dilation of ≥5 cm; NICU, neonatal intensive care unit.

^aData are presented as mean ± standard deviation or as number (percentage).

size, which might have affected the generalizability of the results. Additionally, because the study was conducted at a single center, the findings might not reflect broader clinical practices or settings.

Further research should focus on multi-center trials to confirm the findings and explore the impact of other factors on labor progression and maternal and neonatal outcomes. Long-term follow-up studies could also assess the effects of EA on postpartum recovery and the psychological outcomes for women who receive EA during labor.

In conclusion, the timing of EA plays a significant role in labor progression. Delaying EA until a cervical dilation of ≥5 cm was associated with a shorter first stage of labor and a lower cesarean section

rate without increasing the risk of adverse maternal or neonatal outcomes. These results support considering later EA initiation as a potentially favorable approach in clinical practice.

AUTHOR CONTRIBUTIONS

T.D.T., X.A.P.N., L.H.V., Q.H.V.N., and M.T.L. developed the study concept and designed the study; T.D.T., X.A.P.N., and L.H.V. acquired the data for analysis; HNDT performed the statistical analysis; T.D.T., L.H.V., and M.T.L. drafted the first manuscript; all authors contributed to the interpretation of the data and provided critical revision for important intellectual content and approved the final manuscript.

ACKNOWLEDGMENTS

The authors would like to express their sincere gratitude to Hue University and the University of Medicine and Pharmacy, Hue University, for approving the study protocol and providing financial support for this research. We also gratefully acknowledge Hue Central Hospital for allowing the study to be conducted at the Obstetrics and Gynecology Centre. Finally, we thank all the participants and medical staff who contributed to the successful implementation of this study.

FUNDING INFORMATION

This work was supported by the Hue University project funding (grant number DHH2024-04-226) and the Core Research Program of Hue University (Research Group on Reproductive Medicine—under grant number NCTB.DHH.2025.07). The grantors did not influence the content of the publication.

CONFLICT OF INTEREST STATEMENT

The authors have no competing interests to declare.

DATA AVAILABILITY STATEMENT

The data supporting this study's findings are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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How to cite this article: Tran TD, Nguyen XAP, Vo LH, Nguyen QHV, Le MT. Early versus late epidural analgesia in nulliparous women: Impact on labor duration and maternal-neonatal outcomes in Central Vietnam. *Int J Gynecol Obstet*. 2025;00:1-7. doi:10.1002/ijgo.70438