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Article

Impact of Labor Analgesia on Delivery Outcomes in Parturients With Gestational Diabetes Mellitus

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Abstract

Aims/Background: Although the efficacy of labor analgesia in pain relief is well-established, its impact on labor progression and maternal-neonatal outcomes remains inconclusive, particularly in parturients with gestational diabetes mellitus (GDM). This study aimed to examine the effects of labor analgesia on labor progression, delivery mode, and neonatal outcomes in parturients with GDM, thereby providing evidence to optimize clinical intervention strategies. **Methods**: A total of 201 GDM parturients meeting inclusion criteria at Beilun District People's Hospital of Ningbo City between 1 January 2023 and 31 December 2024, were retrospectively analyzed. Participants were allocated to the observation group (labor analgesia, n = 111) or the control group (routine delivery, n = 90) based on whether they received labor analgesia. Maternal clinical data, delivery mode, labor duration, maximum intrapartum temperature, postpartum hemorrhage, neonatal Apgar scores, and other obstetric outcomes were compared and analyzed retrospectively. Statistical analyses included independent sample t-tests, Mann–Whitney U test, Chi-squared tests, and Chi-squared correction. **Results**: Among the 111 parturients receiving labor analgesia, the 2-hour capillary blood glucose variation during labor was significantly higher in the epidural analgesia (EP) group compared with the combined spinal-epidural analgesia (CSEA) group ($p < 0.001$). The postpartum fasting plasma glucose (FPG) difference was also significantly greater ($p < 0.001$). The numerical rating scale (NRS) score after EP in the observation group was markedly lower than the pre-analgesia score ($p < 0.001$). The observation group demonstrated longer first and second stages of labor ($p < 0.05$), lower 2-hourly glucose fluctuations, higher maximum intrapartum temperature ($p < 0.05$) and soft tissue lacerations ($p < 0.05$), and increased rates of oxytocin use and episiotomy ($p < 0.05$). Furthermore, urinary ketone positivity, FPG difference, and 2-hour postprandial blood glucose (2hPBG) difference were lower in the observation group ($p < 0.05$), whereas postpartum day 1 C-reactive protein (CRP) levels were higher ($p < 0.05$). No significant differences were observed in delivery mode, postpartum urinary retention, postpartum hemorrhage, neonatal clavicle fracture, neonatal transfer, or incidence of patent foramen ovale and ductus arteriosus ($p > 0.05$). **Conclusion**: Labor analgesia effectively alleviates labor pain and stabilizes intrapartum blood glucose fluctuations without increasing the risk of cesarean delivery or adverse maternal-neonatal outcomes. However, it may prolong labor duration, elevate intrapartum temperature, and increase oxytocin use, as well as the rates of episiotomy and soft birth canal lacerations. For GDM parturients receiving labor analgesia, close monitoring and management of blood glucose, uterine contractions, and labor progression are essential to minimize potential risks associated with vaginal delivery.

Keywords: pregnancy; analgesia; gestational diabetes mellitus; obstetrics; pregnancy outcome; newborn; obstetric anesthesia

1. Introduction

Vaginal delivery remains a common mode of childbirth that provides benefits to both mother and newborn. Clinically, it is generally recommended for parturients without medical indications for a cesarean section [1,2]. However, labor-induced uterine contractions often cause severe pain, significantly impacting the physiological and psychological well-being of parturients [3]. With advances in anesthesia techniques, neuraxial labor analgesia has been widely implemented in clinical practice. This central nerve block approach has been shown to effectively alleviate labor pain and enhance delivery comfort [4,5]. Nevertheless, its influence on maternal and neonatal outcomes remains controversial.

Most studies suggest that labor analgesia does not increase the risk of adverse outcomes. For example, Mao et al. [6] investigated 60 parturients undergoing vaginal delivery and found that analgesia alleviated pain, lowered adverse event rates, and improved satisfaction. Liu et al. [7] demonstrated that labor analgesia effectively alleviated pain without raising the risks of maternal or neonatal complications. Fan et al. [8] demonstrated that ropivacaine combined with dexmedetomidine or sufentanil significantly reduced maternal visual analog scale (VAS) scores with a favorable safety profile. Additionally, Kearns et al. [9] re-

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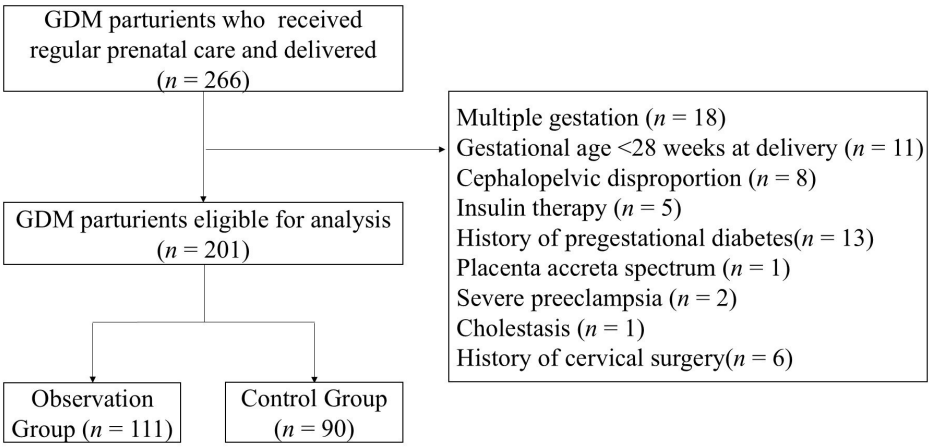

Fig. 1. Flowchart of patient selection. Abbreviation: GDM, gestational diabetes mellitus.

vealed that labor analgesia reduced the risk of severe maternal morbidity (SMM) and advocated its use for high-risk parturients to safeguard maternal health.

Gestational diabetes mellitus (GDM) is defined as glucose metabolism abnormalities first identified or occurring during pregnancy and is considered a major obstetric risk factor [10]. Recent epidemiological studies reveal that the global prevalence of GDM is increasing, affecting more than 10% of pregnancies worldwide. The International Association of the Diabetes and Pregnancy Study Groups (IADPSG) recommends that all women without pre-existing diabetes undergo a 75-g oral glucose tolerance test (OGTT) at 24–28 weeks of gestation.

Labor pain triggers neuroendocrine stress responses, leading to physiological alterations such as elevated blood glucose. In GDM patients, unstable glycemic control during vaginal delivery may heighten the risk of adverse maternal and neonatal outcomes [11,12,13]. Therefore, evaluating the efficacy and safety of labor analgesia in this population is clinically important. However, existing research on its impact on GDM parturients remains limited and inconclusive. Kuitunen et al. [14] found comparable analgesic efficacy between GDM and normoglycemic parturients. Li et al. [15] reported that labor analgesia increased the risk of neonatal hypoglycemia requiring neonatal intensive care unit (NICU) transfer. Conversely, Sana et al. [16] suggested that analgesia improved metabolic stability and immune function in GDM patients. Similarly, Chen et al. [17], in a study of 816 GDM parturients, observed that analgesia reduced NICU transfers and neonatal hypoglycemia but prolonged labor duration and increased maternal postpartum fever.

Although the efficacy of labor analgesia for pain relief is well-established, its effects on labor progression and maternal-neonatal outcomes remain inconclusive, especially among GDM parturients. Given the rising incidence of GDM and the increasing clinical demand for analgesia in this population, it is essential to evaluate its efficacy and safety. To address this, we conducted a retrospective analysis of electronic medical records from 201 GDM parturients, aiming to assess the impact of labor analgesia on glycemic control, labor progression, and maternal-neonatal outcomes. This study aimed to provide evidence-based insights for optimizing labor management, improving maternal and neonatal outcomes, and reducing long-term health risks associated with GDM.

2. Methods

2.1 Study Population

This retrospective analysis included 201 GDM parturients who received routine prenatal care and delivered at Beilun District People's Hospital of Ningbo City between 1 January 2023 and 31 December 2024. A flow chart of patient selection is summarized in Fig. 1.

2.2 Inclusion Criteria

(a) Diagnosis of GDM according to established criteria [18];

(b) Singleton cephalic pregnancy;

(c) Regular prenatal visits, gestational age $\geq$28 weeks at delivery;

(d) No contraindications for vaginal delivery (e.g., cephalopelvic disproportion);

(e) Stable glycemic control during pregnancy without insulin therapy;

(f) Normal prenatal fetal heart monitoring;

(g) Complete clinical records.

2.3 Exclusion Criteria

(a) History of pregestational diabetes;

(b) Severe psychiatric disorders;

(c) Other obstetric complications (placenta accreta spectrum, severe preeclampsia, cholestasis);

(d) History of cervical surgery;

(e) Abnormal birth canal (pelvic deformity, obstructive tumors, müllerian anomalies);

(f) Acute critical illness or hematologic diseases (sepsis, coagulopathy);

(g) Major organ dysfunction (New York Heart Association class III–IV heart failure with left ventricular ejection fraction <40%, estimated glomerular filtration rate <45 mL/min/1.73 m^2 or dialysis).

2.4 Grouping and Analgesia Protocol

Based on electronic medical records, parturients were divided into an observation group (receiving labor analgesia, $n = 111$) and a control group (no analgesia, $n = 90$).

Analgesia protocol: Upon admission, fetal heart rate, uterine contractions, and vital signs were monitored, cervical status was assessed, and intravenous access was established. When cervical dilation reached 1–6 cm, parturients were placed in the left lateral position with knees flexed toward the chest and head bent forward. After disinfection and draping, analgesia was initiated by the anesthesiologist during regular contractions upon maternal request.

Epidural block: A tuohy needle was inserted at the L2–3 or L3–4 interspace (midline or paramedian). After confirming loss of resistance, the epidural catheter was advanced 3–5 cm. An initial dose of 3 mL of 0.1% ropivacaine + 2 µg/mL fentanyl was administered, followed by maintenance doses of 7–10 mL as required.

Combined spinal-epidural analgesia (CSEA): The subarachnoid initial bolus consisted of 2–3 mg ropivacaine hydrochloride (National Drug Approval No. H20173027; Hebei Yipin Pharmaceutical Co., Ltd., Shijiazhuang, China) mixed with 2–5 µg sufentanil citrate (National Drug Approval No. H20054172; Yichang Humanwell Pharmaceutical Co., Ltd., Yichang, China), prepared as a small-volume injectate for intrathecal injection. After intrathecal drug administration and epidural catheter placement, 10–12 mL of 0.08% ropivacaine hydrochloride supplemented with 0.3 µg/mL sufentanil citrate was administered as the epidural loading dose. Maintenance (post-bolus): Catheter secured and connected to a patient-controlled epidural analgesia (PCEA) pump; continuous infusion at 8–10 mL/h; patient-controlled bolus 5–8 mL; lockout interval for 20 minutes; maximum hourly dose of 30–40 mL.

Vital signs were continuously monitored, and analgesia efficacy was assessed hourly using the numerical rating scale (NRS) scores. Blood glucose was measured every 2 hours.

2.5 Data Collection and Biochemical Measurements

Baseline and clinical parameters were recorded, including maternal-related indicators as follows: (1) Baseline clinical characteristics: Extracted from electronic medical records, including age, weight, height, pre-pregnancy body mass index (BMI), pre-delivery BMI, education level, place of residence, ethnic group, family history of diabetes, payment method, gravidity, parity, gestational age at delivery, conception method, history of adverse pregnancy, tocolysis history, onset of labor, and premature rupture of membranes; (2) Analgesia details (observation group): Data included type of analgesia, timing of administration, and NRS scores before and after analgesia [19]. The NRS scores (measured pre- and post-analgesia) used a 0–10 scale, where patients selected a number corresponding to pain intensity (0: no pain; 1–3: mild pain; 4–6: moderate pain; 7–10: severe pain); (3) Intrapartum general parameters: Duration of the first and second stages of labor, 2-hourly fingertip blood glucose fluctuations during labor, maximum intrapartum temperature, fetal monitoring type, oxytocin use, occurrence of shoulder dystocia, episiotomy, soft birth canal laceration, amniotic fluid volume, neonatal birth weight, sex, and Apgar scores at one and five minutes; (4) Maternal biochemical markers (measured $\leq$1 week pre-delivery): White blood cell (WBC) count, red blood cell (RBC) count, hemoglobin (Hb), serum creatinine (SCr), total cholesterol (TC), triglycerides (TG), high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), total bile acids (TBA), serum potassium ion concentration (K^+), C-reactive protein (CRP), D-dimer (D-D), fibrinogen (Fib), thyroid-stimulating hormone (TSH), free thyroxine (FT4), urine ketones, urine glucose, hemoglobin A1c (HbA1c), intrapartum and postpartum fasting plasma glucose (FPG) fluctuation range (difference), 2-hour postprandial blood glucose (2hPBG) fluctuation range (difference), and CRP on postpartum day 1; (5) Neonatal biochemical markers: Transcutaneous bilirubin (TCB) levels measured morning and evening on postpartum days 1 and 2, and neonatal blood glucose concentration (measured within 1 hour post-birth); (6) Delivery outcomes: Mode of delivery, postpartum urinary retention, postpartum hemorrhage, neonatal clavicular fracture, transfer to a specialized department, patent foramen ovale, and patent ductus arteriosus. In this study, the fluctuation range (difference) of fasting plasma glucose (FPG) and 2-hour postprandial blood glucose (2hPBG) was defined as the difference between the maximum and minimum values of all corresponding venous blood glucose measurements obtained during the intrapartum and postpartum period of hospitalization. A larger difference indicates more pronounced glycemic fluctuation.

Primary outcomes: 2-hourly intrapartum glucose fluctuations, NRS scores (observation group), duration of labor stages, neonatal Apgar scores, HbA1c, postpartum FPG and 2hPBG fluctuations, neonatal blood glucose, mode of delivery, and neonatal transfer.

2.6 Statistical Analysis

Data were analyzed using SPSS 27.0 (IBM Corp., Armonk, NY, USA). Normality was assessed using the Shapiro–Wilk test. Normally distributed variables were expressed as mean $\pm$ standard deviation (SD) and compared using independent sample *t*-tests or paired-sample *t*-tests, as appropriate. Non-normally distributed variables were ex-

pressed as median [25th percentile (P25), 75th percentile (P75)] and analyzed with the Mann–Whitney U test. Categorical variables were expressed as frequencies and percentages [n (%)] and compared using the Chi-square test, or the corrected Chi-square test and Fisher's exact test when necessary. A two-tailed p-value < 0.05 was considered statistically significant.

3. Results

3.1 Comparison of Baseline Clinical Characteristics

No statistically significant differences were observed between the two groups in baseline maternal characteristics, including age, weight, height, pre-pregnancy BMI, pre-delivery BMI, education level, residence, ethnicity, family history of diabetes, payment method, gravidity, parity, gestational age at delivery, conception method, history of adverse pregnancy, tocolysis history, onset of labor, or premature rupture of membranes ($p > 0.05$; Table 1).

3.2 Effect of Analgesic Methods on Blood Glucose Levels

Post-analgesia NRS scores in the observation group (1.63 ± 0.50) were significantly reduced compared with pre-analgesia scores (6.75 ± 0.87) ($t = 53.719$, $p < 0.001$).

By the analgesic method, subgroup analysis compared the epidural analgesia (EP) and CSEA groups. The EP group showed significantly greater 2-hourly intrapartum fingertip glucose fluctuations and higher postpartum FPG fluctuation than the CSEA group ($Z = –3.314$, $–4.481$, both $p < 0.001$). No significant difference was observed in 2hPBG fluctuation ($Z = –0.510$, $p = 0.610$) (Table 2).

3.3 Effect of Analgesic Timing on Blood Glucose Levels

Analgesia was initiated at cervical dilations of 1 cm ($n = 1$), 1.5 cm ($n = 6$), 2 cm ($n = 47$), 2.5 cm ($n = 9$), 3 cm ($n = 32$), 3.5 cm ($n = 1$), 4 cm ($n = 9$), 5 cm ($n = 4$), and 6 cm ($n = 2$). For analysis, participants were grouped as <3 cm ($n = 63$) and ≥ 3 cm ($n = 48$). Comparisons of 2-hourly intrapartum fingertip glucose fluctuations, FPG fluctuation, and 2hPBG fluctuations between the two maternal groups during labor revealed no statistically significant differences ($Z = –0.036$, $–0.248$, $–1.644$; $p = 0.971$, 0.804, 0.100, respectively).

3.4 Comparison of Intrapartum Parameters

The observation group demonstrated longer first and second stages of labor ($p < 0.05$), lower 2-hourly glucose fluctuations, higher maximum intrapartum temperature ($p < 0.05$), higher incidence of soft tissue laceration, and higher rates of oxytocin use and episiotomy ($p < 0.05$). No significant differences were observed in other intrapartum parameters [$p > 0.05$; Table 3 (Ref. [20])].

3.5 Comparison of Maternal and Neonatal Biochemical Markers

No statistically significant differences were observed between the two groups in maternal WBC count, RBC count, Hb, SCr, TC, TG, HDL-C, LDL-C, TBA, potassium ion concentration, CRP, D-D, Fib, TSH, FT4, urine glucose, HbA1c, or neonatal TCB (measured morning and evening on postpartum days 1 and 2) and immediate postnatal blood glucose (all $p > 0.05$). However, the observation group exhibited significantly lower rates of positive urine ketones, lower FPG fluctuations, and lower 2hPBG fluctuations compared to the control group (all $p < 0.05$), alongside higher postpartum day 1 CRP levels ($p < 0.05$; Table 4).

3.6 Comparison of Delivery Outcomes

No statistically significant differences were observed in delivery mode, postpartum urinary retention, postpartum hemorrhage, neonatal clavicular fracture, neonatal transfer, or incidence of patent foramen ovale/ductus arteriosus between the two groups ($p > 0.05$; Table 5).

4. Discussion

Labor analgesia, as a major breakthrough in obstetric medicine, is now widely applied in parturients for effective pain relief with a low risk of complications. Its significant role in reducing non-medically indicated cesarean deliveries underscores its value as a crucial intervention for promoting vaginal delivery. GDM, the most common pregnancy complication, may increase maternal and neonatal risks during labor due to hyperglycemia. This study compared GDM parturients receiving labor analgesia with those not receiving analgesia, revealing that the analgesia significantly reduced NRS scores in the observation group. Additionally, the observation group exhibited lower rates of positive urine ketones, reduced 2-hourly intrapartum fingertip glucose fluctuations, and decreased FPG and 2hPBG fluctuations. However, they also experienced longer first and second stages of labor, higher maximum intrapartum temperatures, greater oxytocin use, increased episiotomy and birth canal laceration rates, and elevated postpartum day 1 CRP levels. No significant differences were observed in delivery modes, other intrapartum parameters, or maternal-neonatal outcomes.

EP and CSEA are currently recognized worldwide as the most effective and widely used labor analgesia techniques. Compared with alternative methods, they provide the most comprehensive and controllable analgesic effects. Therefore, investigating their impact on women with GDM yields findings with the strongest clinical relevance and practical guidance. In contrast, intravenous analgesia and other approaches yield weaker analgesic effects, are associated with more pronounced side effects (such as sedation, nausea, and vomiting), and are supported by lower levels of evidence regarding their influence on labor progression

Table 1. Comparison of baseline clinical characteristics between the two groups.

Variable	Observation group (n = 111)	Control group (n = 90)	$\chi^2/t/Z$	p-value
Age (years)	31.74 ± 5.23	33.04 ± 4.10	–1.935	0.054
Weight (kg)	71.48 ± 10.01	69.91 ± 9.93	1.113	0.267
Height (m)	1.61 ± 0.05	1.60 ± 0.05	1.849	0.066
Pre-pregnancy BMI (kg/m^2)	22.87 ± 3.27	23.41 ± 3.82	–1.063	0.289
Pre-delivery BMI (kg/m^2)	27.56 ± 3.63	27.40 ± 3.70	0.298	0.766
Education level [n (%)]			0.667	0.414
Primary/junior high/secondary	43 (38.74)	40 (44.44)		
High school or above	68 (61.26)	50 (55.56)		
Residence [n (%)]			0.018	0.894
Urban	98 (88.29)	80 (88.89)		
Rural	13 (11.71)	10 (11.11)		
Ethnicity [n (%)]			0.070	0.791
Han Chinese	104 (93.69)	86 (95.56)		
Other	7 (6.31)	4 (4.44)		
Family history of diabetes [n (%)]			1.103	0.294
Yes	9 (8.11)	4 (4.44)		
No	102 (91.89)	86 (95.56)		
Payment method [n (%)]			0.865	0.352
Medical insurance	91 (81.98)	69 (76.67)		
Self-pay	20 (18.02)	21 (23.33)		
Gravidity (times)	3.00 (1.00, 4.00)	2.00 (2.00, 3.00)	–0.544	0.587
Parity (times)	1.00 (0.00, 1.00)	1.00 (0.00, 1.00)	–1.770	0.077
Gestational age at delivery (weeks)	38.88 ± 1.01	38.64 ± 1.63	1.257	0.210
Conception method [n (%)]			-	0.066
Natural conception	106 (95.50)	90 (100.00)		
IVF/ovulation induction	5 (4.50)	0 (0.00)		
History of adverse pregnancy [n (%)]			0.397	0.529
Yes	17 (15.32)	11 (12.22)		
No	94 (84.68)	79 (87.78)		
History of tocolysis [n (%)]			1.080	0.299
Yes	18 (16.22)	10 (11.11)		
No	93 (83.78)	80 (88.89)		
Onset of labor [n (%)]			3.570	0.059
Induced	58 (52.25)	35 (38.89)		
Spontaneous	53 (47.75)	55 (61.11)		
Premature rupture of membranes [n (%)]			0.608	0.436
Yes	26 (23.42)	17 (18.89)		
No	85 (76.58)	73 (81.11)		

Abbreviations: BMI, body mass index; IVF, *in vitro* fertilization.

Table 2. Comparison of blood glucose levels in parturients between the EP and CSEA groups.

Variable	EP group (n = 70)	CSEA group (n = 41)	Z	p-value
2-hourly intrapartum fingertip glucose fluctuations (mmol/L)	2.20 (1.00, 2.93)	0.70 (0.50, 1.90)	–3.314	<0.001
Postpartum FPG fluctuation (mmol/L)	0.95 (0.60, 1.50)	0.50 (0.25, 0.65)	–4.481	<0.001
2hPBG fluctuation (mmol/L)	3.45 (2.20, 4.30)	3.20 (2.40, 4.50)	–0.510	0.610

Abbreviations: EP, epidural analgesia; CSEA, combined spinal-epidural analgesia; FPG, fasting plasma glucose; 2hPBG, 2-hour postprandial blood glucose.

and maternal-neonatal outcomes. To maintain statistical power and ensure the reliability of study results, it is essential to appropriately control research variables. GDM itself represents a relevant confounding factor that requires focused consideration. Including multiple analgesia techniques would inevitably demand a substantially larger sample size to achieve adequate statistical power for each subgroup. Within the constraints of limited resources and time, we therefore focused on the two most prominent labor analgesia techniques.

Table 3. Comparison of intrapartum parameters between the two groups.

Variable	Observation group (n = 111)	Control group (n = 90)	$\chi^2/t/Z$	p-value
First stage duration (min)	360.00 (235.00, 510.00)	157.50 (83.75, 222.50)	–8.256	<0.001
Second stage duration (min)	44.00 (18.00, 86.00)	15.00 (9.00, 25.25)	–6.125	<0.001
2-hourly fingertip glucose fluctuation (mmol/L)	1.40 (0.70, 2.80)	2.40 (1.90, 3.20)	–3.971	0.001
Maximum intrapartum temperature (°C)	37.40 ± 0.51	37.01 ± 0.38	6.071	<0.001
Fetal monitoring type [n (%)]			0.855	0.355
Category I	80 (72.07)	70 (77.78)		
Category II/III	31 (27.93)	20 (22.22)		
Oxytocin use [n (%)]			18.874	<0.001
Yes	58 (52.25)	20 (22.22)		
No	53 (47.75)	70 (77.78)		
Shoulder dystocia [n (%)]			0.080	0.777
Yes	3 (2.70)	4 (4.44)		
No	108 (97.30)	86 (95.56)		
Episiotomy [n (%)]			12.649	<0.001
Yes	44 (39.64)	15 (16.67)		
No	67 (60.36)	75 (83.33)		
Soft tissue laceration [n (%)]			11.991	0.001
Yes	92 (82.88)	55 (61.11)		
No	19 (17.12)	35 (38.89)		
Amniotic fluid volume (mL)	460.00 (400.00, 500.00)	400.00 (350.00, 500.00)	–1.509	0.131
Neonatal weight (g)	3413.96 ± 378.58	3311.22 ± 444.07	1.770	0.078
Neonatal sex [n (%)]			0.436	0.509
Male	57 (51.35)	42 (46.67)		
Female	54 (48.65)	48 (53.33)		
1-min Apgar score	9.92 ± 0.47	9.90 ± 0.43	0.296	0.767
5-min Apgar score	9.98 ± 0.19	9.99 ± 0.11	–0.309	0.758

Notes: Fetal monitoring categories were classified according to the National Institute of Child Health and Human Development three-tier system [20]: Category I (normal: baseline fetal heart rate 110–160 bpm, moderate variability, accelerations present, no decelerations), Category II (indeterminate: requires continued evaluation; e.g., minimal variability or recurrent decelerations), and Category III (abnormal: mandates immediate intervention, e.g., absent variability with recurrent decelerations or bradycardia).

Regarding pain relief, after administration of labor analgesia, the NRS scores of parturients in the observation group decreased from 6.75 ± 0.87 to 1.63 ± 0.50, falling within the tolerable mild pain range. This represents the most direct advantage of labor analgesia. Luo et al. [21], in a study of non-GDM primiparas, also concluded that labor analgesia significantly lowers NRS scores. Another critical question is whether analgesia influences delivery mode. Fieni et al. [22] reported that parturients receiving labor analgesia during delivery exhibited significantly higher cesarean section rates. Similarly, Bannister-Tyrrell et al. [23] and Djaković et al. [24] concluded that analgesia use significantly increases the proportion of emergency cesarean deliveries. Conversely, Olszynska et al. [25] found that labor analgesia does not increase but rather reduces emergency cesarean risk, a conclusion corroborated by Vaajala et al. [26] in twin pregnancies. In our study, no significant difference in delivery mode was observed between groups, indicating that labor analgesia does not elevate emergency cesarean risk, consistent with the findings of Zhang et al. [27] and Ambrosetti et al. [28].

Labor analgesia may also influence the duration of labor [29,30]. In this study, both the first and second stages of labor were prolonged in the observation group compared to the control group, a finding consistent with previous reports. Branecka-Woźniak et al. [31] conducted a retrospective analysis of 300 parturients receiving labor analgesia and observed prolonged durations of both labor stages, suggesting that analgesia may disrupt the natural rhythm of childbirth. This effect has been attributed to skeletal muscle relaxation associated with pain relief during analgesia, which reduces maternal expulsive force. The higher oxytocin use rate observed in our study further supports this mechanism. Although Liu et al. [7] reported that labor analgesia during spontaneous vaginal delivery does not increase episiotomy risk, our findings revealed higher rates of both episiotomy and birth canal lacerations in the observation group. Bodner-Adler et al. [32] similarly proposed that labor analgesia elevates episiotomy and oxytocin (uterotonic agent) use, both of which may contribute to prolonged labor.

For GDM parturients undergoing spontaneous vaginal delivery, unstable glycemic control directly influences maternal and neonatal outcomes [13,33], highlighting the value of investigating the glycemic effects of labor analgesia. Our study demonstrated lower positive urine ketone rates, reduced 2-hourly intrapartum fingertip glucose fluctuations, and decreased FPG and 2hPBG fluctuations in the

Table 4. Comparison of maternal and neonatal biochemical markers.

Variable	Observation group (n = 111)	Control group (n = 90)	$\chi^2/t/Z$	p-value
WBC count (10^9/L)	8.35 ± 2.18	8.27 ± 2.47	0.234	0.816
RBC count (10^{12}/L)	4.05 ± 0.38	4.03 ± 0.47	0.254	0.800
Hb (g/L)	123.86 ± 11.24	122.13 ± 10.00	1.140	0.256
SCr (μmol/L)	42.86 ± 7.33	43.02 ± 6.59	–0.158	0.874
TC (mmol/L)	6.17 ± 1.51	5.93 ± 1.03	1.318	0.189
TG (mmol/L)	4.09 ± 1.59	4.25 ± 1.80	–0.671	0.503
HDL-C (mmol/L)	1.83 ± 0.38	1.83 ± 0.39	0.054	0.957
LDL-C (mmol/L)	2.99 (2.35, 3.84)	2.90 (2.37, 3.41)	–1.171	0.242
TBA (μmol/L)	3.00 (2.00, 4.00)	2.00 (2.00, 3.25)	–0.591	0.554
Potassium (mmol/L)	3.98 ± 0.22	3.97 ± 0.24	0.239	0.812
CRP (mg/L)	4.20 (2.30, 7.20)	4.85 (2.60, 8.32)	–0.783	0.434
D-D (μg/LFEU)	1621.00 (1254.00, 2076.00)	1613.50 (1192.00, 2516.25)	–0.205	0.838
Fib (g/L)	4.53 ± 0.63	4.61 ± 0.66	–0.976	0.330
TSH (mIU/L)	2.17 (1.52, 2.74)	2.34 (1.53, 3.25)	–1.214	0.225
FT4 (pmol/L)	11.90 (10.70, 13.40)	12.60 (10.67, 14.00)	–1.066	0.287
Urine ketones [n (%)]			5.004	0.025
Positive	5 (4.50)	12 (13.33)		
Negative	106 (95.50)	78 (86.68)		
Urine Glucose [n (%)]			0.002	0.963
Positive	6 (5.41)	5 (5.56)		
Negative	105 (94.59)	85 (94.44)		
HbA1c (%)	5.49 ± 0.40	5.47 ± 0.40	0.262	0.794
FPG fluctuation (mmol/L)	0.70 (0.40, 1.20)	1.10 (0.60, 1.53)	–3.460	<0.001
2hPBG fluctuation (mmol/L)	3.40 (2.30, 4.30)	3.75 (2.78, 4.85)	–2.320	0.020
Postpartum day 1 CRP (mg/L)	48.60 (24.90, 71.20)	23.80 (17.15, 37.00)	–6.126	<0.001
Neonatal TCB (mg/dL)				
Day 1 morning	4.50 (3.10, 5.90)	4.50 (2.98, 5.80)	–0.545	0.586
Day 1 evening	5.50 (4.50, 6.70)	5.50 (4.50, 7.00)	–0.082	0.935
Day 2 morning	8.40 (7.50, 9.60)	8.35 (7.00, 9.93)	–0.588	0.557
Day 2 evening	9.10 (7.80, 10.50)	9.00 (7.58, 10.23)	–1.296	0.195
Blood glucose (mmol/L)	4.10 (3.65, 4.60)	4.05 (3.60, 4.63)	–0.262	0.793

Abbreviations: WBC, white blood cell; RBC, red blood cell; Hb, hemoglobin; SCr, serum creatinine; TC, total cholesterol; TG, triglycerides; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; TBA, total bile acids; CRP, C-reactive protein; D-D, D-dimer; LFEU, lysis fibrinogen equivalent units; Fib, fibrinogen; TSH, thyroid-stimulating hormone; FT4, free thyroxine; HbA1c, hemoglobin A1c; TCB, transcutaneous bilirubin.

observation group compared with controls, indicating that analgesia mitigates intrapartum glucose variability, consistent with the findings of Sana et al. [16]. This effect can be explained by the fact that labor pain triggers stress responses, leading to counterregulatory hormone secretion, increased peripheral insulin resistance, and reduced insulin release, thereby impairing glucose uptake and elevating intrapartum blood glucose. By alleviating pain-induced stress responses, labor analgesia attenuates stress-induced hyperglycemia and stabilizes glucose levels. Although our study found no significant differences in neonatal glucose levels or transfer rates, previous reports suggest that analgesia may either increase or decrease neonatal hypoglycemia risk in GDM [15,17]. Such discrepancies may reflect differences in analgesic regimens, maternal metabolic profiles, or interindividual variation across populations and ethnic groups. Clinically, analgesics and protocols should therefore be tailored to individual parturient profiles, with close maternal and neonatal glucose monitoring to ensure safety.

Our findings also revealed higher maximum intrapartum temperatures in the observation group compared with the control group. It is speculated that maternal temperature elevation associated with labor analgesia may result from incomplete heat dissipation during labor due to sympathetic blockade [34]. Additionally, a study suggests that labor analgesia may be associated with non-infectious inflammatory mechanisms [35]. The elevated postpartum day 1 CRP levels observed in the observation group further indicate an inflammatory response. Yuan et al. [36] reported that maternal intrapartum fever during labor anal-

Table 5. Comparison of delivery outcomes.

Variable	Observation group (n = 111)	Control group (n = 90)	χ^2	p-value
Delivery mode [n (%)]			2.680	0.262
Spontaneous vaginal	103 (92.79)	88 (97.78)		
Cesarean section	3 (2.70)	1 (1.11)		
Forceps-assisted	5 (4.50)	1 (1.11)		
Postpartum urinary retention [n (%)]			0.858	0.354
Yes	13 (11.71)	7 (7.78)		
No	98 (88.29)	83 (92.22)		
Postpartum hemorrhage [n (%)]			1.482	0.223
Yes	7 (6.31)	10 (11.11)		
No	104 (93.69)	80 (88.89)		
Neonatal clavicular fracture [n (%)]			0.000	1.000
Yes	2 (1.80)	1 (1.11)		
No	109 (98.20)	89 (98.89)		
Neonatal transfer [n (%)]			0.958	0.328
Yes	26 (23.42)	16 (17.78)		
No	85 (76.58)	74 (82.22)		
Incidence of patent foramen ovale/ ductus arteriosus [n (%)]			1.475	0.225
Yes	29 (26.13)	17 (18.89)		
No	82 (73.87)	73 (81.11)		

gesia is a common phenomenon, while Zhao et al. [37] and He and Wang [38] both demonstrated associations between labor analgesia, prolonged labor duration, and maternal intrapartum fever. Ren et al. [39] also confirmed that analgesia increases maternal intrapartum fever risk without affecting neonatal outcomes. Our study is the first to confirm this conclusion in GDM parturients.

Further subgroup analysis revealed that FPG fluctuations were significantly higher in the EP subgroup than in the CSEA subgroup, indicating smaller fluctuations in 2-hourly intrapartum fingertip glucose and FPG levels among CSEA recipients compared to EP recipients. These observations may be related to differences in onset speed: CSEA provides rapid analgesia within 5–10 minutes through subarachnoid injection of local anesthetics or opioids, thereby significantly reducing sympathetic excitability and stress hormone release, which in turn inhibits gluconeogenesis and insulin resistance. This mechanism supports early stabilization of glucose levels. In contrast, EP requires approximately 30–45 minutes to achieve full effect after a single injection. Inadequate analgesia during this initial period may contribute to larger glucose fluctuations. Moreover, EP typically requires higher doses of local anesthetics to maintain analgesic efficacy, potentially exerting a greater impact on insulin secretion and glucose utilization.

Based on the above findings, the authors propose the following recommendations to optimize delivery outcomes for GDM parturients receiving labor analgesia: First, labor management should be strengthened by carefully selecting the timing of analgesia administration to avoid premature intervention leading to uterine inertia. Simultaneously, non-pharmacological interventions such as breathing and relaxation techniques may be combined with pharmacological analgesia to reduce overall analgesic drug dosage and minimize impacts on labor progression. To address potential sweat suppression and temperature elevation induced by analgesia, delivery room temperature and maternal attire should be appropriately adjusted, with cold towel compresses applied to major vascular areas (forehead, axillae, neck, groin) when necessary to facilitate heat dissipation. Additionally, during late pregnancy, parturients may enhance muscle elasticity through perineal massage and pelvic floor muscle exercises to reduce episiotomy rates and laceration risks.

It is important to acknowledge that this study still has limitations. First, the sample size was relatively small, and as a single-center retrospective study, it may have inherent selection bias affecting the generalizability of the findings. Second, all observation indicators in this study were short-term, lacking long-term follow-up on maternal and neonatal outcomes. Third, this study adopted the range, calculated as the difference between maximum and minimum blood glucose values, to quantify fluctuations in fasting plasma glucose and 2-hour postprandial blood glucose. However, this index is determined merely by two extreme values and is strongly affected by outliers. It may overestimate or underestimate the true glycemic variability, thereby introducing potential bias into our findings. Additionally, analgesic efficacy in GDM parturients may be influenced by additional factors such as psychological status, dietary habits, and physical activity during pregnancy. Therefore, future studies should include multicenter prospective cohorts with larger sample sizes, extend follow-up to evaluate long-term outcomes, and integrate psychosocial variables to optimize labor analgesia strategies for GDM parturients.

5. Conclusion

Labor analgesia contributes to glycemic stabilization during labor in GDM parturients and does not significantly impact delivery mode or maternal-neonatal outcomes. However, it prolongs labor duration, elevates intrapartum temperature, and increases rates of oxytocin use, episiotomy, and birth canal lacerations. These findings suggest that labor analgesia exerts a positive impact on improving the metabolic status of GDM parturients, likely by alleviating labor pain-induced stress and optimizing energy metabolism pathways to promote glycemic stability. Although the extended labor duration and higher intervention requirements may reflect the potential influence of analgesia on uterine dynamics, these factors do not significantly compromise maternal and neonatal outcomes. Therefore, in clinical practice, the application of labor analgesia should be based on a thorough assessment of the individual parturient, balancing its metabolic benefits in glycemic management against potential risks of prolonged labor and increased intervention needs, thereby supporting individualized delivery management.

Key Points

• Labor analgesia stabilizes intrapartum glucose in GDM parturients, with CSEA superior to EP.

• Labor analgesia does not increase cesarean rates in GDM parturients and has no adverse impact on maternal-neonatal outcomes.

• Labor analgesia prolongs labor duration and elevates intrapartum temperature in GDM parturients.

• Labor analgesia increases rates of oxytocin use, episiotomy, and birth canal lacerations in GDM parturients.

Availability of Data and Materials

The data in the current study are available from the corresponding authors on reasonable request.

Author Contributions

YZ and YSZ designed the research study and wrote the first draft. MYS and XYL performed the research. MW and ZC analyzed the data. All authors contributed to the important editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

This study has been approved by the Ethics Review Committee of Beilun District People's Hospital of Ningbo City (Approval No. 2025-030) and strictly adheres to the Declaration of Helsinki. All participants provided written informed consent.

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Conflict of Interest

The authors declare no conflict of interest.

References

[1] Dimassi K, Melki M, Chebbi A, Rafrafi R. The autonomous choice of delivery mode: A survey of Tunisian women. La Tunisie Medicale. 2021; 99: 903–910.

[2] Evans K, Fraser H, Uthman O, Osokogu O, Johnson S, Al-Khudairy L. The effect of mode of delivery on health-related quality-of-life in mothers: a systematic review and meta-analysis. BMC Pregnancy and Childbirth. 2022; 22: 149. https://doi.org/10.1186/s12884-022-04473-w

[3] Tabatabaeichehr M, Mortazavi H. The Effectiveness of Aromatherapy in the Management of Labor Pain and Anxiety: A Systematic Review. Ethiopian Journal of Health Sciences. 2020; 30: 449–458. https://doi.org/10.4314/ejhs.v30i3.16

[4] Lam KK, Leung MKM, Irwin MG. Labour analgesia: update and literature review. Hong Kong Medical Journal. 2020; 26: 413–420. https://doi.org/10.12809/hkmj208632

[5] Such TL, Denny DL. Comfort and Satisfaction Among Women Who Used Different Options for Analgesia During Labor and Birth. Journal of Obstetric, Gynecologic, and Neonatal Nursing. 2021; 50: 691–702. https://doi.org/10.1016/j.jogn.2021.07.001

[6] Mao L, Zhang X, Zhu J. Analgesic Effects, Birth Process, and Prognosis of Pregnant Women in Normal Labor by Epidural Analgesia Using Sufentanil in Combination with Ropivacaine: A Retrospective Cohort Study. Computational Intelligence and Neuroscience. 2022; 2022: 1228006. https://doi.org/10.1155/2022/1228006

[7] Liu X, Zeng R, Chen Q, Ke D, Zhu Z. The effect of epidural analgesia on maternal-neonatal outcomes: a retrospective study. Ginekologia Polska. 2021; 10.5603/GP.a2021.0007. https://doi.org/10.5603/GP.a2021.0007

[8] Fan M, Li J, Cao R, Hu L, Lu S. Efficacy and safety of dexmedetomidine-ropivacaine versus sufentanil-ropivacaine for epidural labor analgesia: a randomized controlled trial. Annals of Palliative Medicine. 2022; 11: 1410–1420. https://doi.org/10.21037/apm-22-264

[9] Kearns RJ, Kyzayeva A, Halliday LOE, Lawlor DA, Shaw M, Nelson SM. Epidural analgesia during labour and severe maternal morbidity: population based study. BMJ (Clinical Research Ed.). 2024; 385: e077190. https://doi.org/10.1136/bmj-2023-077190

[10] Sweeting A, Wong J, Murphy HR, Ross GP. A Clinical Update on Gestational Diabetes Mellitus. Endocrine Reviews. 2022; 43: 763–793. https://doi.org/10.1210/endrev/bnac003

[11] Moon JH, Jang HC. Gestational Diabetes Mellitus: Diagnostic Approaches and Maternal-Offspring Complications. Diabetes & Metabolism Journal. 2022; 46: 3–14. https://doi.org/10.4093/dmj.2021.0335

[12] Ugwudike B, Kwok M. Update on gestational diabetes and adverse pregnancy outcomes. Current Opinion in Obstetrics & Gynecology. 2023; 35: 453–459. https://doi.org/10.1097/GCO.0000000000000901

[13] Zehravi M, Maqbool M, Ara I. Correlation between obesity, gestational diabetes mellitus, and pregnancy outcomes: an overview. International Journal of Adolescent Medicine

and Health. 2021; 33: 339–345. https://doi.org/10.1515/ijamh-2021-0058
[14] Kuitunen I, Vähä-Tuisku S, Huttunen T. Gestational diabetes mellitus and labor analgesia: nationwide register-based analysis in Finland. Acta Diabetologica. 2022; 59: 1515–1517. https://doi.org/10.1007/s00592-022-01944-6
[15] Li G, Qi X, Tan X, Wu M, Wang H, Wen P, et al. Effect of epidural labor analgesia on maternal and infant outcomes in parturients with gestational diabetes mellitus-A prospective cohort study. Frontiers in Pediatrics. 2022; 10: 1022291. https://doi.org/10.3389/fped.2022.1022291
[16] Sana SRGL, Lv Y, Chen G, Guo L, Li E. Analysis of the volatile organic compounds of epidural analgesia-ameliorated metabolic disorder in pregnant women with gestational diabetes mellitus based on untargeted metabolomics. Frontiers in Endocrinology. 2023; 14: 1009888. https://doi.org/10.3389/fendo.2023.1009888
[17] Chen Y, Ye X, Wu H, Yuan X, Yu X, Wu H, et al. Delivery, maternal and neonatal outcomes in nulliparous women with gestational diabetes undergoing epidural labour analgesia: a propensity score-matched analysis. BMJ Open. 2022; 12: e060245. https://doi.org/10.1136/bmjopen-2021-060245
[18] Kautzky-Willer A, Winhofer Y, Kiss H, Falcone V, Berger A, Lechleitner M, et al. Gestational diabetes mellitus (Update 2023). Wiener Klinische Wochenschrift. 2023; 135: 115–128. https://doi.org/10.1007/s00508-023-02181-9
[19] Hartrick CT, Kovan JP, Shapiro S. The numeric rating scale for clinical pain measurement: a ratio measure? Pain Practice. 2003; 3: 310–316. https://doi.org/10.1111/j.1530-7085.2003.03034.x
[20] Macones GA, Hankins GDV, Spong CY, Hauth J, Moore T. The 2008 National Institute of Child Health and Human Development workshop report on electronic fetal monitoring: update on definitions, interpretation, and research guidelines. Obstetrics and Gynecology. 2008; 112: 661–666. https://doi.org/10.1097/AOG.0b013e3181841395
[21] Luo D, Yuan Y, Guo L, Chen Z. A comparative study of epidural labor analgesia and natural delivery without analgesia. American Journal of Translational Research. 2021; 13: 7015–7021.
[22] Fieni S, di Pasquo E, Formisano D, Basevi V, Perrone E, Ghi T. Epidural analgesia and the risk of operative delivery among women at term: A propensity score matched study. European Journal of Obstetrics, Gynecology, and Reproductive Biology. 2022; 276: 174–178. https://doi.org/10.1016/j.ejogrb.2022.07.028
[23] Bannister-Tyrrell M, Ford JB, Morris JM, Roberts CL. Epidural analgesia in labour and risk of caesarean delivery. Paediatric and Perinatal Epidemiology. 2014; 28: 400–411. https://doi.org/10.1111/ppe.12139
[24] Djaković I, Sabolović Rudman S, Košec V. Effect of epidural analgesia on mode of delivery. Wiener Medizinische Wochenschrift (1946). 2017; 167: 390–394. https://doi.org/10.1007/s10354-016-0511-9
[25] Olszynska A, Di Martino Z, Pawlowska A, Feduniw S, Modzelewski J, Kajdy A, et al. Epidural analgesia: effect on labor duration and delivery mode - a single-center cohort study. Ginekologia Polska. 2023; 94: 733–740. https://doi.org/10.5603/GP.a2023.0048
[26] Vaajala M, Kekki M, Mattila VM, Kuitunen I. The association between epidural labor analgesia and the fetal outcome and mode of delivery of the second twin: a nationwide register-based cohort study in Finland. International Journal of Obstetric Anesthesia. 2023; 56: 103924. https://doi.org/10.1016/j.ijoa.2023.103924
[27] Zhang J, Yancey MK, Klebanoff MA, Schwarz J, Schweitzer D. Does epidural analgesia prolong labor and increase risk of cesarean delivery? A natural experiment. American Journal of Obstetrics and Gynecology. 2001; 185: 128–134. https://doi.org/10.1067/mob.2001.113874
[28] Ambrosetti F, Grandi G, Petrella E, Sampogna V, Donno L, Rinaldi L, et al. The impact of epidural analgesia on delivery mode in Robson class 1 women: a retrospective cohort study. AJOG Global Reports. 2023; 3: 100207. https://doi.org/10.1016/j.xagr.2023.100207
[29] Poma S, Scudeller L, Verga C, Mirabile G, Gardella B, Broglia F, et al. Effects of combined spinal-epidural analgesia on first stage of labor: a cohort study. The Journal of Maternal-Fetal & Neonatal Medicine. 2019; 32: 3559–3565. https://doi.org/10.1080/14767058.2018.1467892
[30] Miyamoto K, Komatsu H, Nagata H, Nagira K, Motomura E, Shimizu N, et al. Prolonged second stage of labor in delivery using epidural analgesia is a risk factor for postpartum urinary retention. The Journal of Obstetrics and Gynaecology Research. 2024; 50: 424–429. https://doi.org/10.1111/jog.15867
[31] Branecka-Woźniak D, Józefowicz A, Cymbaluk-Płoska A, Kurzawa R. Effects of epidural analgesia on the course of labor. European Review for Medical and Pharmacological Sciences. 2023; 27: 2522–2534. https://doi.org/10.26355/eurrev_202303_31786
[32] Bodner-Adler B, Bodner K, Kimberger O, Wagenbichler P, Kaider A, Husslein P, et al. The effect of epidural analgesia on the occurrence of obstetric lacerations and on the neonatal outcome during spontaneous vaginal delivery. Archives of Gynecology and Obstetrics. 2002; 267: 81–84. https://doi.org/10.1007/s00404-001-0280-5
[33] Ye W, Luo C, Huang J, Li C, Liu Z, Liu F. Gestational diabetes mellitus and adverse pregnancy outcomes: systematic review and meta-analysis. BMJ (Clinical Research Ed.). 2022; 377: e067946. https://doi.org/10.1136/bmj-2021-067946
[34] Lu R, Rong L, Ye L, Xu Y, Wu H. Effects of epidural analgesia on intrapartum maternal fever and maternal outcomes: an updated systematic review and meta-analysis. The Journal of Maternal-Fetal & Neonatal Medicine. 2024; 37: 2357168. https://doi.org/10.1080/14767058.2024.2357168
[35] Zhao W, Wang LZ, Chang XY, Zhang YF, Xiao F, Xia F. Maternal serum C-reactive protein and white blood cell count at hospital admission as predictors of intrapartum maternal fever: a retrospective case-control study in women having epidural labor analgesia. International Journal of Obstetric Anesthesia. 2022; 50: 103537. https://doi.org/10.1016/j.ijoa.2022.103537
[36] Yuan J, Jin A, Shen J, Chen Y, Huang Q, Xiang H. Maternal intrapartum fever during epidural labour analgesia: Incidence and influencing factors. International Journal of Nursing Practice. 2024; 30: e13188. https://doi.org/10.1111/ijn.13188
[37] Zhao B, Li B, Wang Q, Song X. The relationship between epidural analgesia and intrapartum maternal fever and the consequences for maternal and neonatal outcomes: a prospective observational study. The Journal of Maternal-Fetal & Neonatal Medicine. 2022; 35: 5354–5362. https://doi.org/10.1080/14767058.2021.1879042
[38] He FY, Wang S. Epidural analgesia for labor: effects on length of labor and maternal and neonatal outcomes. European Review for Medical and Pharmacological Sciences. 2023; 27: 130–137. https://doi.org/10.26355/eurrev_202301_30863
[39] Ren J, Wang T, Yang B, Jiang L, Xu L, Geng X, et al. Risk Factors and Safety Analyses for Intrapartum Fever in Pregnant Women Receiving Epidural Analgesia During Labor. Medical Science Monitor. 2021; 27: e929283. https://doi.org/10.12659/MSM.929283