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Original Research

Incidence of Severe Postpartum Hemorrhage and Factors Influencing Labor Induction in Patients with Hypertension and Non-Severe Preeclampsia during Full-Term Pregnancy

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Abstract

Background: At present, postpartum hemorrhage (PPH) is still one of the main causes of global incidence rate and mortality of pregnant women, especially in term pregnancy with hypertension. Among them, non-severe preeclampsia is increasingly considered to have the potential to lead to adverse maternal outcomes, including severe postpartum hemorrhage. This study aims to conduct a survey on the incidence of severe PPH in patients with hypertension and non-severe preeclampsia during full-term pregnancy, and analyze the factors influencing severe PPH in these patients. **Methods**: This retrospective study analyzed 300 full-term patients with gestational hypertension and non-severe preeclampsia who underwent labor induction at our hospital between November 2021 and November 2023. According to the occurrence of severe postpartum hemorrhage, patients were divided into two groups: 250 cases in the mild postpartum bleeding group (control group) and 50 cases in the severe postpartum bleeding group (experimental group). The two groups were compared, and statistically significant factors were included in the subsequent analyses to investigate the factors influencing severe PPH in patients with full-term gestational hypertension and non-severe preeclampsia. **Results**: Intraoperative and 24-hour postoperative hemorrhage were significantly lower in patients with non-severe hemorrhage compared to those with severe hemorrhage ($p < 0.05$). However, no statistically significant differences were observed between the two groups in several parameters, including the number of births, age, systolic blood pressure, early preeclampsia, diastolic blood pressure, mode of labor induction, hemoglobin levels at admission, gestational age, and newborn body weight ($p > 0.05$). In contrast, statistically significant differences were observed between the two groups in terms of the use of oxytocin during labor, the mode of delivery, and the duration between labor induction and the onset of delivery ($p < 0.05$). Furthermore, a lower incidence of postpartum urinary retention was observed in the non-severe hemorrhage group compared to the severe hemorrhage group, with a statistically significant difference ($p < 0.05$). Logistic regression analysis identified the use of oxytocin during labor, mode of delivery, time between the start of induction and delivery, and postpartum urinary retention as independent factors influencing the incidence of severe PPH in patients with non-severe preeclampsia ($p < 0.05$). **Conclusions**: The occurrence of severe PPH in patients with hypertension and non-severe preeclampsia at full-term gestation and labor induction is attributed to the multifactorial effects of vaginal delivery, instrumental delivery, and the use of oxytocin during labor. Proactive and effective management is essential to reduce hemorrhage during labor induction.

Keywords: hypertension in full-term pregnancy; non-severe preeclampsia; induction of labor; hemorrhage; delivery method; induced labour

1. Introduction

Hypertension in pregnancy encompasses a spectrum of disorders, including gestational hypertension and preeclampsia, each with distinct diagnostic criteria. Gestational hypertension is defined as elevated blood pressure (≥140/90 mmHg) occurring after 20 weeks of gestation without proteinuria or signs of organ dysfunction. In contrast, mild preeclampsia is characterized by hypertension accompanied by proteinuria (≥300 mg/24 h) or other systemic abnormalities, such as thrombocytopenia or impaired liver function. As pregnancy progresses, the risk of Preeclampsia worsening increases, potentially leading to severe complications that threaten both maternal and fetal health [1,2]. Preeclampsia, particularly in its non-severe form, can progress undetected, making timely diagnosis and management crucial. The induction of labor is commonly employed in clinical settings to manage hypertensive disorders in full-term pregnancies. While this approach aims to mitigate maternal and fetal complications, it may also introduce risks such as labor dystocia, increased cesarean section rates, and postpartum hemorrhage. Severe postpartum hemorrhage (PPH) remains one of the leading causes of maternal morbidity and mortality worldwide, necessitating a deeper understanding of its incidence and contributing factors in hypertensive pregnancies [3,4]. The pathophysiology of severe PPH in patients with hypertension and non-severe preeclampsia is complex and involves multiple interrelated mechanisms. Vascular en-

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dothelial dysfunction, often seen in pre-eclamptic patients, leads to increased vascular permeability and reduced vascular tone, which can impair hemostasis during and after delivery [5]. Inadequate placental perfusion further contributes to abnormal placental implantation and separation, raising the risk of hemorrhage. Additionally, coagulation disturbances—ranging from platelet dysfunction to altered fibrinolytic activity—heighten bleeding risks [6]. The use of labor-inducing agents such as oxytocin or prostaglandins, while necessary for timely delivery, can increase the likelihood of uterine overstimulation and atony, particularly in this vulnerable group [7]. Although existing studies have indicated that patients with severe preeclampsia face a higher risk of severe postpartum hemorrhage, most current literature primarily focuses on the clinical characteristics and treatment strategies of these severe cases. There is comparatively less attention on the risks and labor induction factors associated with patients suffering from non-severe preeclampsia and gestational hypertension, resulting in a significant research gap regarding the pathological mechanisms and clinical intervention strategies for this group. Given the large number and diverse clinical presentations of non-severe patients, an in-depth investigation into the incidence and influencing factors of severe postpartum hemorrhage is crucial for improving obstetric management, optimizing delivery mode selection, and enhancing maternal and neonatal safety [8]. Understanding whether the mechanisms and risk profiles in this subgroup differ significantly is critical, especially since these patients may not receive the same level of clinical vigilance.

Additionally, maternal hemodynamic changes during the puerperium play a critical role in determining postnatal outcomes. The peak of blood pressure between 3 and 6 days postpartum, commonly observed in hypertensive patients, can lead to delayed recognition and management of excessive blood loss. This delayed intervention may contribute to poor maternal recovery, prolonged hospitalization, and increased healthcare burdens on families and medical institutions. Despite the significant clinical implications, there is a lack of comprehensive research analyzing the incidence and risk factors associated with severe PPH in this subset of patients. To address this gap, a retrospective study was conducted on 300 full-term pregnant women diagnosed with hypertension and non-severe preeclampsia who underwent labor induction at our hospital between November 2021 and November 2023. The study aimed to determine the incidence of severe PPH in this cohort and identify the factors influencing hemorrhagic outcomes. The findings of this study will provide valuable insights for clinicians in optimizing labor management strategies and improving maternal outcomes.

2. Materials and Methods

2.1 General Data

This study retrospectively collected data from 300 patients with full-term gestational hypertension and non-severe preeclampsia who underwent labor induction at our hospital between November 2021 and November 2023. The patients were divided into two groups based on the occurrence of severe postpartum hemorrhage: 250 patients in the postpartum mild hemorrhage group (control group) and 50 patients in the postpartum severe hemorrhage group (experimental group). This study was approved by the Ethics Committee of Nanjing Lishui People's Hospital (2025KY0117-01).

2.2 Inclusion Criteria and Exclusion Criteria

Inclusion criteria: ① Patients who met the diagnostic criteria for pregnancy-induced hypertension and non-severe preeclampsia [9]; ② Primiparous and multiparous women; ③ Provide informed consent forms for patients participating in the study.

Exclusion criteria: ① Patients with serious heart, liver, and kidney disease; ② Patients with a history of heart surgery; ③ Patients with neurological diseases; ④ Patients who did not complete the study; ⑤ Patients with speech and hearing disorders; ⑥ Patients with combined organic lesions of internal organs or bleeding tendency; ⑦ Patients with combined immune or nutritional metabolic abnormalities; ⑧ Women diagnosed with gestational diabetes mellitus (GDM) are excluded. GDM refers to glucose intolerance first recognized during pregnancy, affecting maternal and fetal outcomes; ⑨ Patients with known coagulation disorders are excluded.

2.3 Methods

(1) Diagnostic criteria: Maternal urine protein test was negative after 20 weeks of gestation, and the first symptoms of hypertension were diastolic blood pressure $\geq$90 mmHg and systolic blood pressure $\geq$140 mmHg. Severe preeclampsia [10]: ① Persistent and uncontrollable rise in maternal blood pressure; ② Persistent pain in the upper abdomen and liver rupture, etc.; ③ Persistent high rise in blood alanine aminotransferase or aspartate aminotransferase indices; ④ Abnormalities of central nervous system function and obvious symptoms of headache in the mother; ⑤ Abnormalities of hematological system performance: platelet count was less than 125×10^9/L and decreased consistently, manifesting anemia, and the indicator of blood lactate dehydrogenase; ⑥ urine protein was $>$2.0 g/24 h, while 1 h urine volume was less than 17 mL; ⑦ Cardiopulmonary function abnormalities; ⑧ Mothers with low amniotic fluid, fetal growth restriction, placental abruption, and other adverse reactions. (2) Mothers with symptoms of urinary retention in the postpartum period: the situation of urinary incontinence occurred in the postpartum period due to individual factors, and the symptoms were serious, with

the urine volume reaching 500 mL, necessitating the reinsertion of the urinary catheter. (3) Serious postpartum hemorrhage: Hemoglobin (Hb) drops of 10 g/L, and the bleeding volume reached 1000 mL within 24 hours after the delivery of the fetus. (4) The whole process from the start of instrumental or pharmacological induction of labor to the delivery of the placenta was considered the time required from the start of labor induction to the delivery of the baby. Induction of labor was based on the maternal obstetric examination and the cervical Bishop score, and relevant drugs were selected to promote uterine ripening (water capsule, dinoprostenol, or contraction). (5) Data collection: The data of the enrolled mothers were collected from the hospital's electronic medical record system and checked for consistency upon completion.

2.4 Observational Indicators

The differences in the data of the two groups of patients were determined. The items with statistically significant differences were utilized in the analysis of the occurrence of severe postpartum hemorrhage in patients with hypertension and non-severe preeclampsia in full-term pregnancy and induced labor and the factors affecting it.

2.5 Statistical Analysis

The data was analyzed using SPSS software 26.0 (IBM Corp., Armonk, NY, USA), *t*-test was used for quantitative data, and variance test was used for categorical data. $p < 0.05$ is considered statistically significant. For the normality test of continuous variables, Shapiro-Wilk test or Kolmogorov-Smirnov test were used, and SPSS software 26.0 was used. If the *p*-value is greater than 0.05, it is considered to follow a normal distribution; Otherwise, nonparametric methods will be used for subsequent analysis.

3. Results

3.1 Variable Analysis of Severe Postpartum Hemorrhage in Patients with Full-Term Pregnancy Induced Hypertension and Non-Severe Preeclampsia

Comparison of age, systolic blood pressure, diastolic blood pressure, early-onset preeclampsia, number of deliveries, mode of labor induction, Hb at admission, the week of gestation, and the body mass of the newborn between the two groups of patients revealed no statistically significant differences ($p > 0.05$), while the use of uterotonics during labor, the mode of delivery, and the time between the commencement of labor induction and delivery differed significantly between the two groups ($p < 0.05$). The rate of postpartum urinary retention was significantly lower in the non-severe hemorrhage group than in the severe hemorrhage group ($p < 0.05$). In comparison to the severe bleeding group, the non-severe bleeding group had lower intraoperative bleeding and 24-h postoperative bleeding ($p < 0.05$). Refer to Table 1 for details.

3.2 Multifactorial Analysis of Severe Postpartum Hemorrhage in Patients with Hypertension and Non-Severe Preeclampsia Induced at Term Pregnancy

The logistic regression analysis revealed the use of oxytocin during labor, the mode of delivery, the time between the start of induction and delivery, and postpartum urinary retention as the independent factors influencing the induction of severe postpartum hemorrhage in patients with non-severe preeclampsia ($p < 0.05$). Refer to Table 2.

4. Discussion

Patients exhibiting elevated blood pressure accompanied by urinary protein, headaches, epigastric pain, and in severe cases, generalized spasms, are susceptible to the hypoxia of various body tissues, reduced blood circulation, and aggravated organ dysfunction. The exacerbation of this condition may lead to severe postpartum hemorrhage, which increases the risk of mortality [11–14]. Consequently, it is imperative to determine the factors contributing to severe postpartum hemorrhage in patients with hypertension and non-severe preeclampsia induced for labor at full-term gestation to support the development of targeted therapeutic measures that could promote patient prognosis and recovery.

The results of the present study revealed that intraoperative hemorrhage and 24-h postoperative hemorrhage were lower in the non-severe hemorrhage group compared to the severe hemorrhage group. Further, the rate of postpartum urinary retention was lower in the non-severe hemorrhage group than in the severe hemorrhage group. The study also identified factors that influence the risk of severe postpartum hemorrhage in patients with high blood pressure during pregnancy and in those who did not have severe preeclampsia. These factors include vaginal delivery, instrument-assisted delivery, the use of oxytocin during delivery, and the time between the start of labor induction and delivery. The reasons for this phenomenon could be as follows:

(1) The mode of delivery plays a crucial role in influencing the extent of postpartum hemorrhage. During a cesarean section, the controlled surgical environment allows for the direct administration of uterotonic agents, either through an intravenous drip or by direct injection into the uterine wall. This targeted approach enables the attending medical professionals to closely monitor intraoperative blood loss and promptly intervene when excessive hemorrhage is detected, thus ensuring the smooth progression of the operation and significantly reducing the risk of severe postnatal hemorrhage. Moreover, the controlled nature of cesarean delivery allows for immediate surgical management, such as uterine compression sutures or arterial ligation, when necessary, further minimizing blood loss. Conversely, vaginal delivery, including spontaneous and instrument-assisted births, presents greater challenges in hemorrhage management. In such cases, minor bleed-

Table 1. Variable analysis of severe postpartum hemorrhage in patients with full-term pregnancy induced hypertension and non-severe preeclampsia.

Items	Non-severe hemorrhage group (n = 250)	Severe hemorrhage group (n = 50)	χ^2/t	p
Age (years)	30.48 ± 3.78	29.82 ± 3.53	1.139	0.256
Number of births, n (%)			5.690	0.058
1 time	115 (46.00)	30 (60.00)		
2 times	120 (48.00)	15 (30.00)		
≥3 times	15 (6.00)	5 (10.00)		
Week of pregnancy, n (%)			2.857	0.091
37–38 W	70 (28.00)	20 (40.00)		
>38 W	180 (72.00)	30 (60.00)		
Mode of delivery, n (%)			82.278	<0.001
Vaginal delivery	200 (80.00)	15 (30.00)		
Assisted childbirth	30 (12.00)	5 (10.00)		
Cesarean section	20 (8.00)	30 (60.00)		
Admission Hb, n (%)			2.857	0.091
<110 g/L	80 (32.00)	10 (20.00)		
≥110 g/L	170 (68.00)	40 (80.00)		
Preeclampsia, n (%)			1.763	0.184
Yes	150 (40.00)	35 (70.00)		
No	100 (60.00)	15 (30.00)		
Systolic blood pressure (mmHg)	145.23 ± 12.26	148.75 ± 11.65	1.868	0.063
Diastolic blood pressure (mmHg)	90.36 ± 9.68	92.54 ± 8.58	1.480	0.140
Methods of inducing labor, n (%)			0.373	0.542
Oxytocin	190 (76.00)	40 (80.00)		
Water capsule or dinoprostenol	60 (24.00)	10 (20.00)		
Use of oxytocin in labor, n (%)			135.000	<0.001
Yes	230 (92.00)	10 (20.00)		
No	20 (8.00)	40 (80.00)		
Time from start of labor induction to delivery, n (%)			71.441	<0.001
<24 h	150 (60.00)	20 (40.00)		
24–48 h	85 (34.00)	5 (10.00)		
>48 h	15 (6.00)	25 (50.00)		
Body mass of newborns at birth (g)	3378.56 ± 390.12	3469.87 ± 373.68	1.521	0.129
Postpartum urinary retention, n (%)	10 (4.00)	20 (40.00)	60.000	<0.001
Intraoperative hemorrhage (mL)	122.23 ± 16.26	278.36 ± 18.68	60.413	<0.001
24 h postoperative hemorrhage (mL)	83.75 ± 6.65	105.54 ± 6.58	21.188	<0.001

Hb, Hemoglobin; W, weeks.

Table 2. Multifactorial logistic regression analysis of severe postpartum hemorrhage in patients with hypertension and non-severe preeclampsia at full-term pregnancy and induced labor.

Relevant factor	p	OR	95% confidence interval	
			Lower limit	Top limit
Mode of delivery	0.000	17.250	8.336	35.697
Use of oxytocin in childbirth	0.000	46.000	20.058	105.496
Time taken from the start of induction of labor to delivery	0.000	15.667	7.316	33.547
Postnatal urinary retention	0.000	16.000	6.848	37.385

OR, Odds Ratio.

ing episodes may go unnoticed, and medical staff may misjudge the actual volume of blood loss, particularly in cases of concealed hemorrhage. Patients are typically transferred to the general ward approximately two hours postpartum, at which point subtle signs of excessive blood loss may not be immediately evident. The issue often becomes apparent only when a significant drop in hemoglobin levels is detected or when the patient exhibits clinical symptoms

such as dizziness, tachycardia, or pallor. By the time postpartum hemorrhage is identified, urgent interventions such as additional uterotonics, fluid resuscitation, or even blood transfusion may be required to prevent further deterioration [15,16].

(2) It was hypothesized that prolonged labor, particularly exceeding 12 hours, could contribute to a higher incidence of severe postpartum hemorrhage. Extended labor puts additional strain on the uterine muscles, which may lead to uterine fatigue and reduced efficiency in contraction. This prolonged duration is often associated with an increased risk of complications such as uterine atony, a major cause of postpartum hemorrhage. Furthermore, research indicated that the use of an intrauterine device (IUD) during full-term gestation might influence the labor process [17,18]. The study suggested that the insertion of an IUD could reduce the duration of labor by promoting cervical dilation or acting as a mechanical agent during labor initiation. However, the findings also revealed potential drawbacks of IUD usage in patients with hypertension and non-severe preeclampsia. IUDs were hypothesized to induce a desensitization effect on the uterine receptors, leading to inadequate uterine contractions. In patients with hypertension, the stress and generalized pain from IUD use might trigger uterine spasms, thereby impairing uterine blood perfusion and causing hypoxia. The insufficient blood flow could further diminish the effectiveness of uterotonic agents, which are crucial for inducing strong and coordinated uterine contractions post-delivery. As a result, the weaker contractions could contribute to the occurrence of postpartum hemorrhage by hindering the proper expulsion of the placenta and reducing the uterine muscle's ability to contract and seal off blood vessels [19,20].

(3) The time interval between the commencement of labor induction and delivery, as well as the specific method used for induction, plays a crucial role in influencing the outcomes of labor, particularly in patients with hypertension and non-severe preeclampsia. The method of labor induction is typically chosen based on the uterine maturity, which is an important factor in determining the success of induction [21]. When uterine maturity is insufficient, the induction process tends to take longer, leading to an increased risk of prolonged labor. This prolonged labor not only raises the likelihood of labor induction failure but also heightens the risk of severe PPH, which can have serious implications for both maternal and fetal health. In patients with hypertension and non-severe preeclampsia during full-term gestation, the uterine blood supply is often compromised. This reduced perfusion results in decreased metabolic activity within the uterine myocytes, impairing their ability to contract effectively. One of the key factors in this impairment is the inhibition of calcium channel opening, which is essential for initiating and sustaining uterine contractions. As a consequence, uterine contractions become weaker and less frequent, prolonging the induction process and increasing the time needed for delivery [22]. This extended duration of labor exacerbates the risk of labor induction failure and contributes to the development of uterine atony, a major cause of postpartum hemorrhage. Moreover, the absence or insufficiency of uterine contractions during labor not only delays delivery but also directly influences the occurrence of severe postpartum hemorrhage [23]. Without strong and effective contractions, the uterus cannot properly expel the placenta, leading to retained placental fragments and unsealed blood vessels, which are primary contributors to excessive postpartum bleeding.

(4) The impact of severe PPH on the maternal body is a critical factor in evaluating the overall health outcomes for affected patients. Severe hemorrhage can lead to a series of complications, one of which is urinary retention, a condition that can significantly hinder the recovery process. Urinary retention, which occurs due to the uterus's inability to contract effectively after delivery, often results in bladder overdistension, discomfort, and the need for medical intervention such as catheterization. This can delay recovery, increase the risk of infections, and further complicate the patient's hospital stay [24]. In the current study, the degree of hemorrhage was assessed by measuring the decline in Hb levels, a reliable and widely accepted method for evaluating blood loss. The Hb decline serves as an objective indicator of the volume of blood lost, helping clinicians assess the severity of postpartum hemorrhage and take timely measures to address it. This approach, when accurately implemented, has the potential to reduce the occurrence and severity of postpartum bleeding by enabling early detection and intervention [25]. However, this study has several notable limitations that may affect the generalizability and applicability of its findings. First, the relatively small sample size limits the statistical power to detect associations between variables, potentially resulting in the underestimation of certain influencing factors. Second, the short observation period, which only covers labor and the immediate postpartum phase, prevents assessment of the long-term maternal and neonatal outcomes associated with labor induction, particularly regarding the prolonged impact on postpartum hemorrhage. Additionally, the study lacks comparison with other representative clinical studies or multicenter datasets, which restricts its ability to provide a broader perspective on the effectiveness and safety of different induction interventions and reduces the external validity of the results. Finally, the insufficient control of potential confounding variables, such as previous obstetric history, placental factors, and specific medication protocols, may have introduced bias into the study conclusions [26]. Additionally, while the study focused on the incidence of postpartum hemorrhage, the specific effects of various bleeding factors, such as uterine tone, coagulation disorders, and the duration of labor, on the induction process in full-term patients with hypertension and non-severe preeclampsia were not thoroughly analyzed.

Cases of hypertension during pregnancy accompanied by Intrauterine Growth Restriction (IUGR) are often closely related to placental dysfunction. Inadequate placental blood supply can lead to fetal malnutrition, hypoxia, and other issues, thereby increasing the risk of preterm birth or fetal distress. Patients with placental insufficiency, particularly hypertensive pregnant women with IUGR, may require more careful monitoring and intervention, as the placenta in these cases cannot effectively support fetal growth, leading to intrauterine growth restriction. In such cases, the timing and method of delivery become crucial, as both premature and delayed deliveries can result in serious maternal and fetal complications. The mode of delivery may vary depending on the manifestation of fetal growth restriction. For hypertensive patients with IUGR, if the fetus shows clear signs of hypoxia or distress, cesarean section may be necessary to ensure maternal and fetal safety. In contrast, for hypertensive patients without fetal growth restriction, vaginal delivery is usually more feasible, but decisions about induction should still depend on factors such as maternal blood pressure control and uterine contractions. Therefore, determining whether the fetus is growth-restricted can provide a more accurate basis for clinical decision-making, aiding in the development of a personalized delivery plan.

This study has certain limitations. It is mainly a retrospective study with a limited sample size, which may lead to selection bias and affect the generalizability and generalizability of the results; Some clinical variables may not be fully recorded, which affects the accuracy of the analysis; In addition, long-term follow-up data has not been included, making it difficult to evaluate long-term maternal and infant outcomes, and subsequent multicenter prospective studies are needed for verification.

5. Conclusions

In conclusion, the following factors were identified as contributors to the occurrence of severe postpartum hemorrhage in patients with hypertension and non-severe preeclampsia during full-term pregnancy and induced labor: vaginal delivery, instrument-assisted delivery, the use of oxytocin during labor, and the time between the start of labor induction and delivery. A clinical assessment of the physical condition of the mother and an appropriate induction of labor are, therefore, important to reduce bleeding and promote recovery in these patients.

Availability of Data and Materials

All data reported in this paper will also be shared by the lead contact upon request. x

Author Contributions

YS and RX designed the research study. MY performed the research. YY provided help and advice on acquisition of data, YS analyzed the data. RX, MY, and YY wrote the manuscript and revised it critically for important intellectual content. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript. All authors agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

The study was approved by the Ethics Committee of Nanjing Lishui People's Hospital (Ethic Approval Number: 2025KY0117-01) in accordance with the principles of the Declaration of Helsinki, and all of the participants provided signed informed consent.

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Conflict of Interest

The authors declare no conflict of interest.

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