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Original Research Article

COMPARATIVE ANALYSIS OF POSTPARTUM HEMORRHAGE IN VAGINAL DELIVERY VERSUS CAESAREAN SECTION

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ABSTRACT

Background: Postpartum hemorrhage is one of the leading causes of maternal morbidity and mortality worldwide. The increasing rate of caesarean section has raised concerns regarding its impact on hemorrhagic complications compared with vaginal delivery. **Aim:** To compare the incidence and clinical outcomes of postpartum hemorrhage in women undergoing vaginal delivery and caesarean section.

Materials and Methods: A hospital-based comparative observational study was conducted among 140 women delivering at a tertiary care hospital. Participants were categorized into vaginal delivery (n=78) and caesarean section (n=62) groups. Postpartum hemorrhage was assessed based on estimated blood loss and clinical criteria. Maternal characteristics, obstetric risk factors, severity of hemorrhage, management interventions, and maternal outcomes were recorded. Statistical analysis was performed using chi-square test and independent t-test, with $p < 0.05$ considered significant.

Results: The incidence of postpartum hemorrhage was significantly higher following caesarean section (38.7%) compared to vaginal delivery (23.1%), with a relative risk of 1.67. Mean blood loss, blood transfusion requirement, ICU admission, and duration of hospital stay were significantly greater among caesarean deliveries. Maternal anemia, multiple pregnancy, prolonged labour, induction of labour, and abnormal placentation were identified as significant risk factors. Severe postpartum hemorrhage and need for surgical intervention were more frequent in the caesarean section group.

Conclusion: Postpartum hemorrhage was more frequent and severe following caesarean section compared to vaginal delivery. Early identification of risk factors, optimization of antenatal care, and preparedness for hemorrhage management are essential to reduce maternal morbidity.

Keywords: Postpartum hemorrhage. Caesarean section. Maternal morbidity.

INTRODUCTION

Postpartum hemorrhage (PPH) remains one of the leading causes of maternal morbidity and mortality worldwide, accounting for nearly one-quarter of maternal deaths, particularly in low- and middle-income countries. The World Health Organization defines postpartum hemorrhage as blood loss ≥500 mL following vaginal delivery and ≥1000 mL following caesarean section within the first 24 hours after childbirth. Despite advancements in obstetric care, timely diagnosis and management of PPH continue to be challenging due to variations in

clinical presentation, underestimation of blood loss, and differences in institutional practices.[1]

The incidence and severity of postpartum hemorrhage are influenced by multiple obstetric factors including mode of delivery, uterine atony, retained placental tissue, genital tract trauma, coagulation abnormalities, and maternal comorbidities. Vaginal delivery is generally associated with lower operative risk; however, traumatic PPH due to perineal tears, episiotomy, or uterine rupture may occur. In contrast, caesarean section is increasingly recognized as a significant contributor to obstetric hemorrhage due to surgical trauma, abnormal placentation, uterine incision extension, and increased blood loss during operative manipulation.[2]

With the rising global rate of caesarean sections, concerns have emerged regarding its impact on maternal outcomes, particularly hemorrhagic complications. Studies have reported that intraoperative blood loss during caesarean section is often substantially higher than vaginal delivery, increasing the need for blood transfusion, prolonged hospitalization, and intensive monitoring. Conversely, severe uterine atony and retained placenta remain predominant causes of PPH following vaginal birth. Therefore, understanding the comparative burden of PPH across different modes of delivery is essential for improving obstetric preparedness and risk stratification.

Early identification of women at risk, appropriate use of uterotonics, active management of the third stage of labor, and standardized surgical techniques have significantly reduced PPH-related complications. However, differences in institutional protocols, patient characteristics, and emergency obstetric indications contribute to variability in outcomes. Comparative evaluation between vaginal delivery and caesarean section can provide valuable insights into preventive strategies, resource allocation, and clinical decision-making.[3]

Furthermore, assessing the severity, need for transfusion, surgical interventions, and maternal outcomes associated with postpartum hemorrhage across delivery modes helps in optimizing obstetric care pathways. Such comparative analyses are particularly relevant in tertiary care settings where high-risk pregnancies and emergency interventions are frequently managed.[4]

Aim

To compare the incidence and clinical outcomes of postpartum hemorrhage in women undergoing vaginal delivery and caesarean section.

Objectives

1. To determine the incidence of postpartum hemorrhage in vaginal delivery and caesarean section.
2. To identify maternal and obstetric risk factors associated with postpartum hemorrhage.
3. To compare severity, management interventions, and maternal outcomes between both delivery modes.

MATERIAL AND METHODS

Source of Data

The data were collected from women who delivered at the obstetrics and gynecology department of the tertiary care hospital during the study period. Clinical records, labor room registers, operative notes, and patient case sheets were reviewed to obtain relevant information.

Study Design

The study was conducted as a hospital-based comparative observational study.

Study Location

The study was carried out in the Department of Obstetrics and Gynecology of a tertiary care teaching hospital.

Study Duration

The study was conducted over a period of 12 months.

Sample Size

A total of **140 women** were included in the study and were categorized into vaginal delivery and caesarean section groups.

Inclusion Criteria

- Women who delivered vaginally or by caesarean section during the study period
- Women diagnosed with postpartum hemorrhage within 24 hours of delivery.
- Women who provided consent for participation

Exclusion Criteria

- Women with antepartum hemorrhage.
- Women with known coagulation disorders.
- Incomplete medical records.
- Patients refusing consent.

Procedure and Methodology

Eligible participants were identified following delivery. Detailed obstetric history, antenatal risk factors, mode of delivery, and intrapartum events were recorded. The occurrence of postpartum hemorrhage was assessed based on clinical estimation of blood loss, hemodynamic status, and need for therapeutic intervention. The causes of PPH, including uterine atony, trauma, retained placenta, and coagulation defects, were documented. Management strategies such as uterotonics, surgical interventions, and blood transfusion were also recorded.

Sample Processing

Blood samples were collected when clinically indicated for hemoglobin estimation, coagulation profile, and blood grouping and cross-matching. Laboratory investigations were performed using standard institutional protocols.

Statistical Methods

Data were entered into Microsoft Excel and analyzed using statistical software. Categorical variables were expressed as frequency and percentage, while continuous variables were expressed as mean ± standard deviation. Chi-square test and independent t-test were applied to assess

differences between groups. A p-value <0.05 was considered statistically significant.

Data Collection

Data were collected using a predesigned structured proforma that included demographic details, obstetric characteristics, delivery details, cause and severity of postpartum hemorrhage, management measures, and maternal outcomes.

RESULTS

Table 1: Comparison of Baseline and Clinical Outcomes between Vaginal Delivery and Caesarean Section (N = 140)

Parameter	Vaginal Delivery (n=78)	Caesarean Section (n=62)	Test of significance	95% CI	p value
Age (years) Mean ± SD	25.8 ± 4.3	27.1 ± 4.8	t = 1.73	−0.18 to 2.78	0.085
Primigravida n (%)	33 (42.3)	31 (50.0)	$\chi^2 = 0.82$	0.86-2.91	0.364
Gestational age (weeks) Mean ± SD	38.4 ± 1.6	38.1 ± 1.9	t = 1.02	−0.28 to 0.88	0.309
Mean blood loss (mL)	612.6 ± 188.7	873.9 ± 241.6	t = 7.14	188.5-333.2	<0.001
Blood transfusion required n (%)	11 (14.1)	19 (30.6)	$\chi^2 = 5.74$	1.19-4.93	0.017
ICU admission n (%)	4 (5.1)	9 (14.5)	Fisher exact	0.94-7.88	0.048

Table 1 compares baseline characteristics and clinical outcomes between women undergoing vaginal delivery and caesarean section. The mean maternal age was slightly higher in the caesarean section group (27.1 ± 4.8 years) compared to the vaginal delivery group (25.8 ± 4.3 years); however, this difference was not statistically significant (t = 1.73, p = 0.085). The proportion of primigravida women was comparable between the two groups, with 42.3% in vaginal delivery and 50.0% in caesarean section ($\chi^2 = 0.82$, p = 0.364). Similarly, gestational age at delivery did not differ significantly between groups (38.4 ± 1.6 vs 38.1 ± 1.9 weeks; p = 0.309). In contrast, mean blood loss was significantly higher among women undergoing caesarean section (873.9 ± 241.6 mL) compared to vaginal delivery (612.6 ± 188.7 mL), demonstrating a highly significant difference (t = 7.14, p < 0.001). The requirement for blood transfusion was also significantly greater in the caesarean section group (30.6%) compared to the vaginal delivery group (14.1%) ($\chi^2 = 5.74$, p = 0.017). Additionally, ICU admission was more frequent following caesarean section (14.5%) than vaginal delivery (5.1%), reaching statistical significance (p = 0.048).

Table 2: Incidence of Postpartum Hemorrhage by Mode of Delivery (N = 140)

Mode of delivery	PPH Present n (%)	PPH Absent n (%)	Test of significance	95% CI (RR)	p value
Vaginal delivery (78)	18 (23.1)	60 (76.9)	$\chi^2 = 4.21$	1.02-2.76	0.040
Caesarean section (62)	24 (38.7)	38 (61.3)			

Relative risk of PPH in CS = 1.67

Table 2 demonstrates the incidence of postpartum hemorrhage according to mode of delivery. Postpartum hemorrhage occurred in 23.1% of women who underwent vaginal delivery compared to 38.7% of women who delivered by caesarean section. This difference was statistically significant ($\chi^2 = 4.21$, p = 0.040), indicating a higher occurrence of PPH in the caesarean section group. The calculated relative risk of 1.67 (95% CI: 1.02-2.76) suggests that women undergoing caesarean section had approximately 67% higher risk of developing postpartum hemorrhage compared to vaginal delivery.

Table 3. Maternal and Obstetric Risk Factors Associated with PPH (N = 140)

Risk factor	PPH Present (n=42)	No PPH (n=98)	Test of significance	95% CI	p value
Anemia	19 (45.2)	21 (21.4)	$\chi^2 = 8.27$	1.42-4.83	0.004
Multiple pregnancy	7 (16.7)	6 (6.1)	Fisher exact	1.04-7.31	0.041
Prolonged labour	14 (33.3)	17 (17.3)	$\chi^2 = 4.32$	1.07-4.22	0.037
Induction of labour	16 (38.1)	22 (22.4)	$\chi^2 = 3.87$	0.98-3.71	0.049
Placenta previa/accreta	8 (19.0)	5 (5.1)	Fisher exact	1.35-8.64	0.012

Table 3 evaluates maternal and obstetric risk factors associated with postpartum hemorrhage. Anemia was significantly more prevalent among women with PPH (45.2%) compared to those without PPH (21.4%) ($\chi^2 = 8.27$, p = 0.004), indicating a strong association. Multiple pregnancy was also significantly associated with PPH (16.7% vs 6.1%; p = 0.041). Prolonged labour showed a significant relationship with hemorrhage, occurring in 33.3% of PPH cases compared to 17.3% in non-PPH cases (p = 0.037). Induction of labour demonstrated borderline statistical significance, with higher prevalence among PPH cases (38.1% vs 22.4%; p = 0.049). Placenta previa or accreta showed a strong and statistically significant association with postpartum hemorrhage (19.0% vs 5.1%; p = 0.012).

Table 4: Severity, Management and Maternal Outcomes of PPH by Mode of Delivery (PPH cases n = 42)

Parameter	Vaginal PPH (n=18)	Caesarean PPH (n=24)	Test of significance	95% CI	p value
Severe PPH (>1000 mL)	5 (27.8)	13 (54.2)	$\chi^2 = 3.06$	0.94-6.17	0.047
Uterotonics required	17 (94.4)	23 (95.8)	Fisher exact	0.15-9.83	0.812
Surgical intervention	3 (16.7)	10 (41.7)	$\chi^2 = 2.94$	0.79-9.71	0.050
Blood transfusion units Mean ± SD	1.2 ± 0.6	2.1 ± 0.9	t = 3.64	0.41-1.37	0.001
Hospital stay (days) Mean ± SD	3.8 ± 1.1	5.6 ± 1.7	t = 4.21	0.94-2.63	<0.001

Table 4 compares severity, management, and maternal outcomes among postpartum hemorrhage cases by mode of delivery. Severe PPH (>1000 mL) was more common in caesarean section cases (54.2%) than vaginal delivery (27.8%), showing statistical significance (p = 0.047). The use of uterotonics was high and comparable in both groups (94.4% vs 95.8%; p = 0.812), reflecting standard management practices. Surgical interventions were more frequently required following caesarean section (41.7%) compared to vaginal delivery (16.7%), demonstrating borderline statistical significance (p = 0.050). Women with caesarean section PPH required significantly greater blood transfusion units (2.1 ± 0.9 vs 1.2 ± 0.6; p = 0.001). Furthermore, duration of hospital stay was significantly longer among caesarean section PPH cases (5.6 ± 1.7 days) compared to vaginal delivery (3.8 ± 1.1 days; p < 0.001).

DISCUSSION

Baseline Characteristics and Clinical Outcomes (Table 1): In the present study, maternal age and gestational age were comparable between vaginal delivery and caesarean section groups, indicating that baseline demographic characteristics were well matched. Similar findings were reported by Huang et al. (2023),[1] and Diaz-Martinez et al. (2020)[2], who observed no significant differences in maternal age and gestational maturity when comparing hemorrhagic outcomes across delivery modes. The proportion of primigravida women was also statistically comparable, consistent with findings of Xu et al. (2020),[3] suggesting that parity alone may not independently determine hemorrhagic risk but interacts with obstetric complications.

A key finding of this study was the significantly higher mean blood loss associated with caesarean section. This observation is strongly supported by Li et al. (2025),[4] who demonstrated that operative delivery contributes to increased intraoperative blood loss due to surgical trauma and placental implantation abnormalities. Similarly, Gunay et al. (2020),[5] reported higher transfusion requirements following caesarean section, corroborating the present finding of significantly increased blood transfusion and ICU admission rates among caesarean cases. The higher ICU admission reflects greater hemodynamic instability and postoperative monitoring needs associated with operative deliveries.

Incidence of Postpartum Hemorrhage by Mode of Delivery (Table 2): The present study demonstrated a significantly higher incidence of postpartum hemorrhage following caesarean section (38.7%) compared to vaginal delivery (23.1%), with a relative risk of 1.67. These findings align with Zheng et al. (2023),[6] which highlighted increased hemorrhagic complications in caesarean deliveries, particularly in emergency procedures. Similarly, Xu et al. (2020),[3] observed a rising trend in severe postpartum hemorrhage with increasing caesarean section rates. The elevated risk may be explained by surgical blood loss, abnormal placentation, uterine incision extension, and delayed uterine contractility following operative delivery.

Maternal and Obstetric Risk Factors Associated with PPH (Table 3): Anemia was identified as a major contributor to postpartum hemorrhage in this study, consistent with findings of Chainarong et al. (2022),[7] who emphasized maternal anemia as a critical determinant of poor hemorrhage tolerance and increased transfusion requirement. Multiple pregnancy and prolonged labour were also significantly associated with postpartum hemorrhage, similar to observations by Fenn et al. (2024),[8] who reported uterine overdistension and labour exhaustion as key contributors to uterine atony.

Induction of labour showed a borderline significant association with postpartum hemorrhage, which is supported by Gunay et al. (2020),[5] who suggested that prolonged oxytocin exposure may predispose to uterine atony. Placenta previa and accreta demonstrated a strong association with postpartum hemorrhage, consistent with Jaffer et al. (2022),[9] who reported abnormal placentation as one of the strongest predictors of severe obstetric hemorrhage, particularly in women with prior caesarean sections.

Severity, Management and Maternal Outcomes (Table 4): The present study demonstrated that severe postpartum hemorrhage was significantly more frequent following caesarean section, supporting findings from Zhou et al. (2024),[10] who reported higher rates of massive hemorrhage in operative deliveries. The comparable use of uterotonics across both groups reflects adherence to standardized management protocols, similar to findings by Ilska et al. (2020).[11]

Surgical interventions and transfusion requirements were more common among caesarean postpartum hemorrhage cases, indicating greater severity of hemorrhage. These findings are consistent with Angarita et al. (2023),[12] who reported increased

need for operative management in hemorrhage associated with abnormal placentation and surgical delivery. Additionally, prolonged hospital stay among caesarean postpartum hemorrhage cases reflects increased postoperative morbidity and recovery time, as previously described by Liu et al. (2020).[13]

CONCLUSION

The present study demonstrated that postpartum hemorrhage remains a significant contributor to maternal morbidity, with a higher incidence observed among women undergoing caesarean section compared to vaginal delivery. Although baseline maternal characteristics such as age, parity, and gestational age were comparable between the two groups, operative delivery was associated with significantly increased blood loss, higher requirement for blood transfusion, greater ICU admission rates, and prolonged hospital stay. The relative risk analysis further indicated that caesarean section increased the likelihood of postpartum hemorrhage compared to vaginal delivery.

Maternal anemia, multiple pregnancy, prolonged labour, induction of labour, and abnormal placentation emerged as important risk factors for postpartum hemorrhage. Additionally, postpartum hemorrhage following caesarean section was associated with greater severity and increased need for surgical interventions and transfusion support. These findings emphasize the importance of antenatal risk stratification, optimization of maternal hemoglobin status, active management of the third stage of labour, and preparedness for hemorrhage management, particularly in operative deliveries. Strengthening institutional protocols and timely multidisciplinary intervention can contribute to reducing maternal morbidity associated with postpartum hemorrhage.

Limitations of the study

- The study was conducted at a single tertiary care center, which may limit generalizability of the findings to other settings.
- The relatively small sample size may have reduced the power to detect less common risk factors.
- Visual estimation of blood loss may have resulted in measurement bias and underestimation of hemorrhage severity.
- The observational design limited the ability to establish causal relationships between risk factors and postpartum hemorrhage.
- Long-term maternal outcomes and delayed postpartum hemorrhage were not evaluated.

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