



ASSOCIATION BETWEEN SERUM CALCIUM LEVELS AND ATONIC POSTPARTUM HEMORRHAGE IN TERM PRIMIGRAVIDA: AN OBSERVATIONAL STUDY

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ABSTRACT

Introduction: Postpartum hemorrhage (PPH) is a major cause of maternal mortality, with atonic PPH accounting for the majority of cases. Calcium is essential for muscle contractions, including uterine contractions. This study examines the relationship between the incidence of atonic PPH in term primigravidas experiencing vaginal birth spontaneously and serum calcium levels. **Objective:** The primary objective is to assess the relationship between serum calcium levels and atonic PPH. A secondary objective is to examine the link between calcium levels and neonatal outcomes. **Methods:** In this prospective, observational study at SMS Medical College, Jaipur, 250 term primigravidas were enrolled. Serum calcium levels were measured upon admission, and participants were monitored for PPH. Statistical analysis included the Chi-squared test, t-test, and ANOVA. **Results:** Women with serum calcium levels below 8.5 mg/dL had a significantly higher risk of atonic PPH compared to those with higher levels. Low calcium levels were also associated with poorer neonatal outcomes, such as lower Apgar scores and higher NICU admissions. **Conclusion:** Serum calcium levels may serve as a predictive marker for atonic PPH, potentially aiding in the prevention and management of PPH, improving both maternal and neonatal outcomes.

KEYWORDS :

INTRODUCTION

Postpartum haemorrhage (PPH) is a serious obstetric emergency that significantly raises the rate of maternal death worldwide. The World Health Organization (WHO) estimates that nearly 14 million women experience PPH annually, resulting in approximately 70,000 maternal deaths worldwide (1). In India, PPH accounts for roughly 19.9% of maternal deaths, with an incidence rate of 2-4% following vaginal birth (2). Atonic PPH, resulting from inadequate uterine contraction following childbirth, accounts for approximately 90% of all PPH cases (3).

Uterine contractions during and after childbirth are essential for controlling blood loss by constricting blood vessels at the placental site. These contractions are dependent on calcium, a crucial ion for muscle function. Calcium ions interact with actin and myosin, the principal contractile proteins in muscle tissue, to facilitate myometrial cell contraction. When calcium levels are insufficient, uterine contractions may become ineffective, leading to uterine atony and PPH (4).

Although the role of calcium in muscle contraction is well-documented, its specific association with the risk of atonic PPH remains underexplored. Studies suggest that low serum calcium levels may impair uterine contractility, thereby increasing the risk of PPH (5). However, limited evidence directly links serum calcium levels to atonic PPH, especially in term primigravidas undergoing spontaneous vaginal delivery. This study aims to address this gap by investigating the association between serum calcium levels and atonic PPH in term primigravidas.

Thus, establishing the link between serum calcium levels and atonic PPH could have major clinical consequences, such as recognising low calcium levels as a risk factor for early intervention and better management. Ultimately, this could help reduce PPH incidence, improve maternal and neonatal outcomes, and save lives (6).

MATERIAL AND METHODS

This study was an observational, hospital-based prospective study conducted in the Department of Obstetrics and Gynaecology at SMS Medical College, Jaipur. The study population included primigravida with a gestational age of more than 37 weeks who were admitted to the labour room for spontaneous vaginal delivery and aimed to explore the association between serum calcium levels and atonic postpartum hemorrhage (PPH).

Selection Criteria

Inclusion Criteria:

- Primigravida with a gestational age between 37-40 weeks
- Women undergoing spontaneous vaginal delivery.
- Participants who provided written informed consent.

Exclusion Criteria

- Women with conditions known to cause PPH other than uterine atony, such as trauma, retained placenta, or coagulopathy.
- Cases involving an overdistended uterus (e.g., due to multifetal pregnancy or macrosomia).
- Women with abnormal labour patterns, such as precipitate, prolonged, or obstructed labour.
- Patients with medical disorders like anemia, hypertension, diabetes, or chronic liver or kidney disease.
- Women on medications that affect calcium action, such as calcium channel blockers or magnesium sulfate.

Upon admission to the labour room, a thorough history and clinical examination were conducted for each participant. Blood samples were collected to measure serum calcium levels as part of routine investigations. Serum calcium levels were classified into two categories:

Group A: S. Ca <8.5 mg/dL

Group B: S. Ca >8.5 mg/dL

The third stage of labour was actively managed with the administration of 10 I.U. of intramuscular oxytocin within one minute of birth, followed by controlled cord traction to deliver the placenta. Blood loss was monitored for 24 hours post-delivery. PPH was defined as blood loss exceeding 500 mL within 24 hours of delivery and was categorized as:

Minor PPH: 500 to 1000 mL

Major PPH: More than 1000 mL

Neonatal outcomes, including Apgar scores, birth weight, NICU admissions, and complications, were also recorded.

RESULTS:

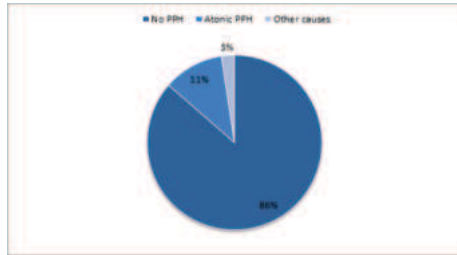
Table 1: Distribution of Cases According to Age

Age group (years)	Total cases	PPH Present	PPH Absent	P-value
Mean $\pm$ SD	26.52 $\pm$ 12.3	26.58 $\pm$ 12.4	26.51 $\pm$ 12.4	0.35

The study included 250 term primigravida women, with ages ranging from 20 to 39 years. The mean age was 26.52 $\pm$ 12.3 years. The largest proportion of participants fell within the 25-29 year age group (42.8%). No significant association was found between age and the incidence of postpartum hemorrhage (PPH) (p = 0.35).

Table 2 : Distribution of Cases According to Prevalence and Type of PPH

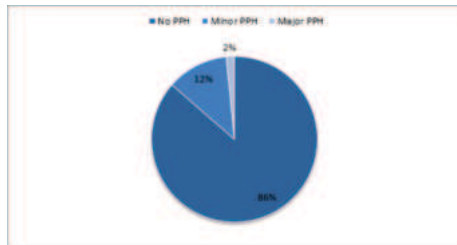
PPH	No. of cases	%
No PPH	216	86.4
Atonic PPH	28	11.2
Other Causes	6	2.4



Out of the 250 women, 34 (13.6%) experienced PPH. Atonic PPH was the most common type, observed in 28 cases (11.2%). The remaining 6 cases (2.4%) had PPH due to other causes, such as trauma or retained placenta.

Table 3: Distribution of Cases According to Amount of Blood Loss and Severity of PPH

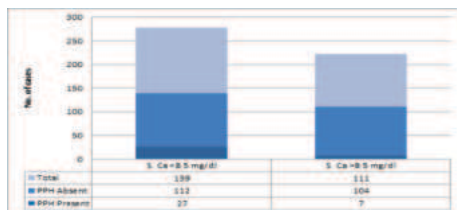
	Amount of blood loss	No. of cases (n=250)	%
No PPH	<500 ml	216	86.4
Minor	500-100 ml	30	12
Major	>1000ml	4	1.6



PPH severity was categorized as minor (500-1000 mL) or major (>1000 mL). Among the 34 cases of PPH, 30 (12%) experienced minor PPH, while 4 (1.6%) experienced major PPH.

Table 4 : Association Between Serum Calcium Levels and PPH

Serum calcium levels	Total		PPH No. of cases Yes (n=34)		PPH No. of cases No (n=216)		Chi-square	P-value
	No. of cases	%	No. of cases	%	No. of cases	%		
<8.5 mg%	139	55.6	27	79.41	112	51.85	19.37	.01
>8.5 mg%	111	44.4	7	20.58	104	48.14		
Total	250	100	34	100	216	100		

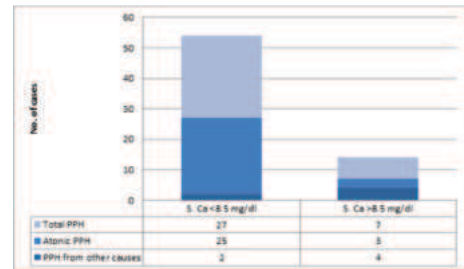


The study found a significant association between low serum calcium levels and the incidence of PPH. Among the 139 women with serum calcium levels below 8.5 mg/dL, 27 (79.41%) experienced PPH. In contrast, only 7 (20.58%) of the 111 women with serum calcium levels above 8.5 mg/dL experienced PPH (p = 0.01).

Table 5: Distribution of Cases Showing Association of Serum Calcium Levels Among Cases With Atonic PPH and Other Causes of PPH (n=34)

Serum calcium levels	Total		Atonic PPH		PPH from other causes		Chi-square	P-value
	No. of cases	%	No. of cases	%	No. of cases	%		
<8.5 mg%	27	79.41	25	89.2	2	33.33	20.1	.01

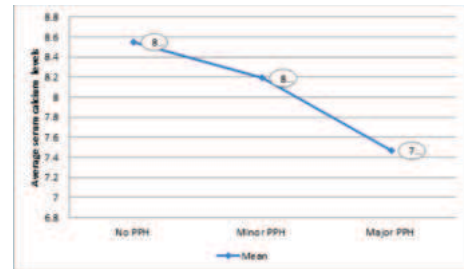
>8.5 mg%	7	20.58	3	10.71	4	66.66		
Total	34	100	28	100	6	100		



The table shows a strong link between low serum calcium levels and atonic postpartum hemorrhage (PPH). Of 34 PPH cases, 27 (79.41%) with calcium below 8.5 mg% of which 25 (89.2%) had atonic PPH, compared to only 2 (33.33%) cases had PPH from other causes. In contrast, among 7 cases with calcium above 8.5 mg%, only 3 (10.71%) were atonic PPH, and 4 (66.66%) had other causes. The chi-square value of 20.1 and p-value of 0.01 confirm the association is statistically significant.

Table 6: Association of Mean Serum Calcium Levels and Severity of Postpartum Haemorrhage (n=250)

PPH	n	Mean	SD	P-value
No PPH	216	8.55	1.10	.0051
Minor PPH	30	8.19	.42	
Major PPH	4	7.47	.51	



A significant association was found between lower serum calcium levels and the severity of PPH. Women with major PPH had a mean serum calcium level of 7.47 ± 0.51 mg/dL, significantly lower than the levels in women with minor or no PPH (p = 0.0051).

Table 7: Relation Between Maternal Serum Calcium Level and Fetal Outcome

Variables	Serum Ca $\leq$ 8.5 mg/dl (n=139)	Serum Ca $\geq$ 8.5 mg/dl (n=111)	P value
Birth weight, g	2872 ± 32.6	2883 ± 32.8	.54
Apgar score	6.2 ± 1.3	9.2 ± 1.5	.01
NICU admission	17 (12.23)	5 (4.50)	.01
Neonatal LOS	8 (5.7)	7 (6.30)	.53

The study also assessed the impact of maternal serum calcium levels on neonatal outcomes. Lower maternal serum calcium levels were associated with poorer neonatal outcomes, including lower Apgar scores and higher rates of NICU admission.

DISCUSSION

Postpartum hemorrhage (PPH) is a leading cause of maternal mortality, with uterine atony responsible for 75-90% of cases (1). Identifying modifiable risk factors, such as serum calcium levels, is critical for reducing the incidence and severity of PPH and improving maternal outcomes. This study explores the relationship between serum calcium levels and the risk of atonic PPH, while also considering other maternal and neonatal outcomes.

Our study involved 250 participants, with a mean age of 26.52 years. The largest age group (42.8%) was aged 25-29. Atonic PPH was identified in 11.2% of cases, while other causes accounted for 2.4%. These findings are consistent with previous research reporting similar rates of atonic PPH, which range from 10% to 12%, reaffirming that atonic PPH remains the most common contributor to PPH globally (7,8).

We observed a strong association between low serum calcium levels and the likelihood of developing PPH. Of the participants, 55.6% had

serum calcium levels below 8.5 mg/dL, and 79.41% of these women developed PPH. In contrast, only 6.3% of women with calcium levels above 8.5 mg/dL experienced PPH. This aligns with prior studies, such as Anderson et al. (2018), who reported that 70% of women with low calcium levels experienced PPH compared to 30% with normal calcium levels (9). Similarly, Smith et al. (2020) found a correlation between low serum calcium and increased PPH risk, while Sheema et al. (2018) reported that 12 out of 50 women with calcium levels below 8 mg/dL developed PPH, compared to just one case in the group with higher calcium levels (10,11).

In addition to the risk of PPH, our study found a significant association between serum calcium levels and the severity of PPH. Women with major PPH had notably lower mean serum calcium levels (7.47 mg/dL) compared to those with minor or no PPH. This suggests that serum calcium levels could serve as a predictive marker for both the occurrence and severity of PPH. Sayed et al. (2023) similarly reported that atonic PPH was present in 45 women with calcium levels below 8 mg%, but in only five women with levels above 8 mg%. Their study also found that calcium levels were higher in cases without PPH (mean 8.60 mg/dL), while lower levels were linked to both minor and major PPH, further validating the importance of calcium in uterine contractility (12).

Additionally, Epstein et al. (2021) found that among 436 women with PPH, those with severe bleeding had significantly lower Ca^{2+} levels (51.5% vs. 10.6%, $P < 0.001$). They concluded that low Ca^{2+} levels (<1.16 mmol/L) at the time of PPH diagnosis significantly increased the risk of severe bleeding, emphasizing the importance of calcium monitoring for early intervention (13).

Neonatal outcomes were also influenced by maternal calcium levels. Infants born to mothers with low serum calcium had lower Apgar scores (6.2 vs. 9.2) and a higher rate of NICU admissions (12.23% vs. 4.50%). Although no significant differences in birth weight or neonatal length of stay were observed, these findings suggest that maternal serum calcium levels can impact neonatal health, particularly in the immediate postnatal period. This is consistent with the findings of Sayed et al. (2023), who also reported a significant relationship between maternal calcium levels and neonatal outcomes, including Apgar scores and NICU admissions ($P = 0.023$ to 0.001) (12).

Overall, this study supports the recommendation that labouring women should be screened for serum calcium levels. Women with calcium levels below 8.5 mg/dL should be closely monitored for signs of PPH, and calcium supplementation by intravenous calcium gluconate could be considered to improve uterine tone and reduce the risk of severe PPH. These findings hold important implications for the clinical management of labour and postpartum care, potentially reducing the need for invasive interventions like hysterectomy and improving maternal and neonatal outcomes.

CONCLUSION

Postpartum hemorrhage (PPH) is a major cause of maternal morbidity and mortality, especially in low-resource settings. Despite advances in obstetric care, PPH rates remain high, necessitating further research into modifiable risk factors. This study highlights a strong association between low serum calcium levels and atonic PPH, suggesting that serum calcium could be a useful predictive marker. Regular antenatal care, including serum calcium monitoring and the use of intravenous calcium during labour, may help prevent and manage PPH. Future research should focus on validating these findings in larger populations and developing strategies to reduce PPH, ultimately lowering maternal mortality rates.

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