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Original Research Article

Serum Calcium Levels in Women with and without Atonic Post-Partum Haemorrhage: A Comparative Study

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Abstract

Background: Postpartum haemorrhage (PPH) is one of the leading causes of maternal mortality and morbidity all over the world, with uterine atony accounting for nearly 70–80% of cases. Calcium plays an important role in myometrial contraction, and hypocalcaemia may impair uterine contractility, thereby increasing the risk of atonic PPH. However, serum calcium levels are not routinely evaluated in women in labour. This study was conducted to assess the association between serum calcium levels and atonic postpartum haemorrhage (PPH).

Aim and Objectives: To estimate serum calcium levels in pregnant women during labour and compare serum calcium levels in women with and without atonic postpartum haemorrhage.

Materials and Methods: This hospital-based comparative observational study was conducted in the Department of Obstetrics and Gynaecology, Assam Medical College and Hospital, Dibrugarh, over a period of one year. A total of 330 pregnant women in labour were included, comprising 110 women with atonic postpartum haemorrhage (Group I) and 220 women without postpartum haemorrhage (Group II). Serum calcium levels were measured at the time of labour. Demographic characteristics, obstetric variables, duration of labour, mode of delivery, haemoglobin levels, and management outcomes were recorded. SPSS software was used for the statistical analysis, and a p-value of less than 0.05 was deemed statistically significant.

Results: Most participants in both groups were aged 18–25 years, with comparable demographic characteristics. Labour duration was significantly longer in women with atonic PPH (64.55% had labour >12 hours) compared to women without PPH (26.82%) ($p < 0.001$). Hypocalcaemia was observed in 68.18% of women with atonic PPH compared to 12.27% in women without PPH ($p < 0.001$). The mean serum calcium level in women with atonic PPH was significantly lower (7.67 ± 0.52 mg/dL) compared to women without PPH (8.91 ± 0.44 mg/dL). Additionally, a higher requirement for blood transfusions and surgical procedures was linked to lower serum calcium levels.

Conclusion: Low serum calcium levels were significantly associated with atonic postpartum haemorrhage. Estimation of serum calcium during labour may help identify women at risk for atonic PPH and allow early correction, thereby improving maternal outcomes and reducing morbidity and mortality.

Keywords: Atonic postpartum haemorrhage, Serum calcium, Hypocalcaemia, Uterine atony, maternal morbidity.

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Introduction

Postpartum hemorrhage (PPH) is the primary cause of maternal death globally and a major obstetric emergency. Postpartum hemorrhage (PPH) is the leading cause of maternal mortality globally, accounting for at least 20% of all maternal deaths. [1] India has made substantial progress in reducing maternal deaths over the past decade. The maternal mortality ratio (MMR) declined from 130 per 100,000 live births in 2014–16 to 97 in 2018–20. [2] In India, PPH contributes to approximately 19.9% of maternal deaths, with an incidence of 6% after caesarean section and 2–4% after vaginal delivery. [3] Among the types of PPH, uterine atony accounts for 75–90% of all cases. [4] Reduced serum calcium levels may predispose to uterine atony and excessive blood loss following delivery. [5] In the myometrium, calcium is the main regulator of excitation-contraction coupling. The contractile machinery of uterine smooth muscle consists of actin and myosin myofilaments,

with calcium ions ([Ca2+]i) serving as the key intracellular messenger. Elevated intracellular calcium activates myosin light chain kinase, leading to cross-bridge formation and uterine contraction. [6] Despite the physiological importance of calcium in myometrial function, serum calcium levels are not routinely assessed in labouring women. Hypocalcaemia and atonic PPH have been linked in a number of studies, [7,8,9,10] yet this remains an underrecognised and potentially modifiable risk factor. The present study was undertaken to estimate serum calcium levels in pregnant women during labour and to compare these levels in women with and without atonic postpartum haemorrhage, with a view to identifying hypocalcaemia as a preventable contributor to PPH.

Materials and Methods

Study Design and Setting: This was a hospital-based analytical observational study conducted in the Department of Obstetrics and Gynaecology, Assam Medical College and Hospital (AMCH), Dibrugarh, Assam, over a period of one year (October 2024 – September 2025). Ethical clearance was obtained from the Institutional Ethics Committee of AMCH (No. AMC/EC/2026/40), and before enrolment, each subject provided written informed consent.

Study Population and Sample Size: Pregnant women in labour admitted to the Department of Obstetrics and Gynaecology, AMCH, were eligible for inclusion. Sample size was calculated using the formula for comparing two means, based on mean serum ionized calcium levels reported by Oguaka et al. (Group I: 1.00 ± 0.35 mmol/L; Group II: 1.11 ± 0.25 mmol/L), [8] with a sample size ratio of 2:1 (Group II : Group I), 95% confidence interval, and 80% power (Open Epi Software v3.01). Accounting for 10% non-response, the final sample comprised 110 women with atonic PPH (Group I) and 220 women without PPH (Group II), totalling 330 participants.

Inclusion Criteria: Pregnant women at term with singleton pregnancies in vertex presentation who provided written informed consent were included.

Exclusion Criteria: Women with multiple gestations, previous caesarean section undergoing VBAC, known metabolic or endocrine disorders affecting calcium levels (e.g., hypoparathyroidism, hyperparathyroidism), severe pre-eclampsia or eclampsia, preterm labour, previous uterine surgery, uterine anomaly, placenta praevia or low-lying placenta, PPROM, malpresentation, muscle disorders, or hypersensitivity to prostaglandins were excluded.

Data Collection: Consecutive sampling was employed. Detailed baseline data including demographic information (age, parity, BMI, gestational age), obstetric history (previous PPH, mode of delivery, use of labour-inducing agents), and duration of labour were recorded. Blood samples were drawn at the time of labour diagnosis, and serum calcium levels were measured in the Biochemistry Laboratory of AMCH. The normal reference range for total serum calcium was taken as 8.5–10.5 mg/dL (Goldstein DA, 1990).[11] Atonic PPH was defined as blood loss >1000 mL or clinical signs of PPH within 24 hours, as per ACOG criteria.[12] Blood loss was assessed by visual inspection, post-delivery haematocrit, and suction volumes combined with swab weight. Management of atonic PPH, including uterotonics, blood transfusion, and surgical intervention, was documented.

Statistical Analysis: Data were analysed using Microsoft Excel 2010 and SPSS for Windows (version 20.0, SPSS Inc., Chicago, IL). Continuous data are expressed as mean ± standard deviation and compared using the Student's t-test. Discrete data are expressed as number (%) and compared using the Chi-square test or Fisher's exact test (for cell counts <5). Pearson's correlation coefficient (r) was used to assess associations between continuous variables. Statistical significance was set at $p < 0.05$.

Results

A total of 330 women were enrolled: 110 with atonic PPH (Group I) and 220 without PPH (Group II).

Demographic Characteristics: Both groups were comparable in age distribution (Table 1). The majority of participants in Group I (62.73%) and Group II (63.64%) were aged 18–25 years ($p = 0.988$). Parity distribution was similar between groups, with parity 1 being most common (56.36% vs 59.09%; $p = 0.920$). BMI distribution was also comparable ($p = 0.994$), with the majority of participants in both groups having a normal BMI (78.18% vs 77.27%). Mean gestational age was 38.66 ± 1.30 weeks in Group I and 38.44 ± 0.94 weeks in Group II ($p = 0.104$). Mode of delivery and use of labour-inducing agents did not differ significantly between groups ($p = 0.315$ and $p = 0.928$, respectively).

Table 1: Age Distribution across Groups

Age Group (years)	Group I n	Group I %	Group II n	Group II %	p value
18–25	69	62.73	140	63.64	
26–30	20	18.18	39	17.73	0.988
31–35	12	10.91	22	10.00	
>35	9	8.18	19	8.64	
Total	110	100.00	220	100.00	

Duration of Labour: Duration of labour differed significantly between the two groups (p <0.001). In Group I, the majority had labour lasting >12 hours (64.55%), while in Group II, the majority had labour lasting 6–12 hours (67.73%) (Table 2).

Table 2: Duration of Labour

Duration (hours)	Group I n	Group I %	Group II n	Group II %	p value
<6	1	0.91	12	5.45	
6–12	38	34.55	149	67.73	<0.001
>12	71	64.55	59	26.82	
Total	110	100.00	220	100.00	

Serum Calcium Level Distribution: Hypocalcaemia (<8.5 mg/dL) was observed in 68.18% of Group I participants and only 12.27% of Group II participants, a difference that was highly statistically significant (p <0.001) (Table 3). The mean serum calcium level was significantly lower in Group I (7.67 ± 0.52 mg/dL) than in Group II (8.91 ± 0.44 mg/dL; p <0.001) (Table 4).

Table 3: Serum Calcium Level Distribution

Category	Group I n (with PPH)	Group I %	Group II n (without PPH)	Group II %	p value
Hypocalcaemia (<8.5 mg/dL)	75	68.18	27	12.27	
Normal (≥8.5 mg/dL)	35	31.82	193	87.73	<0.001
Total	110	100.00	220	100.00	

Table 4: Mean Serum Calcium Level Distribution

Parameter	Group I (with PPH) Mean ± SD	Group II (without PPH) Mean ± SD	p value
Serum Calcium (mg/dL)	7.67 ± 0.52	8.91 ± 0.44	<0.001

Serum Calcium and Management of Atonic PPH: Among Group I patients with serum calcium <8.5 mg/dL (n = 75), blood transfusion was required in 53.33%, uterotonics in 42.67%, and surgical intervention in 4.00%. In contrast, among those with serum calcium ≥8.5 mg/dL (n = 35), the majority were managed with uterotonics alone (85.71%), with blood transfusion required in only 14.29% and no cases requiring surgery (p <0.001) (Table 5).

Table 5: Serum Calcium Level and Management of Atonic PPH (Group I)

Management	Ca <8.5 n	Ca <8.5 %	Ca ≥8.5 n	Ca ≥8.5 %	p value
Uterotonics	32	42.67	30	85.71	
Blood Transfusion	40	53.33	5	14.29	<0.001
Surgical Intervention	3	4.00	0	0.00	
Total	75	100.00	35	100.00	

Discussion

The present study, conducted over one year at a tertiary care centre in Northeast India, demonstrates a statistically significant association between hypocalcaemia and atonic postpartum haemorrhage. The key findings are consistent with published literature and offer important clinical implications. Both groups were comparable with respect to age, parity, BMI, gestational age, mode of delivery, and use of labour-inducing agents, ensuring that the observed differences in serum calcium levels and PPH outcomes were not confounded by these variables. The predominance of women in the 18–25-year age group is consistent with the young reproductive age profile reported by Sayed et al., [7] though Oguaka et al. reported a slightly older distribution (25–34 years). [8]

Duration of labour was significantly prolonged in Group I, with 64.55% having labour lasting >12 hours, compared to 26.82% in Group II (p <0.001). This is consistent with findings by Cai Yi et al., [13] who demonstrated that prolonged labour and

weak uterine contractions were associated with a significantly higher incidence of PPH (relative risk 1.60). Prolonged labour may exacerbate uterine fatigue, contributing to atony. The central finding of this study is the significantly higher prevalence of hypocalcaemia in women with atonic PPH (68.18%) compared to those without PPH (12.27%; p <0.001). The mean serum calcium level was 7.67 ± 0.52 mg/dL in Group I versus 8.91 ± 0.44 mg/dL in Group II. These findings are corroborated by multiple published studies. Premalahta and Krishnegowda10 observed a higher incidence of uterine atony among women with serum calcium <8 mg%, while Sheema and Rafiq [9] found that 12 of 50 women with calcium <8.5 mg/dL developed PPH, compared to only 1 of 50 with normal calcium levels. Similarly, Oguaka et al. [8] reported a significantly lower mean serum ionized calcium in women who developed primary PPH due to uterine atony (1.00 ± 0.35 mmol/L vs 1.11 ± 0.25 mmol/L; p = 0.037).

Sayed et al. [7] demonstrated an inverse relationship between serum calcium and severity of PPH: women without PPH had the highest mean serum calcium (8.60 ± 0.87 mg/dL), those with minor PPH had lower levels (7.77 ± 0.012 mg/dL), and those with major PPH had the lowest (6.66 ± 0.5 mg/dL). The prospective cohort study by Sanaullah et al. [14] (n = 1,584) confirmed that hypocalcaemia is independently associated with atonic PPH (12.1% vs 6.1% in normocalcaemic women) and is associated with greater intervention requirements, higher rates of HDU/ICU admission, and longer hospital stay.

The mechanistic basis for this association is well established. Calcium ions are the primary regulators of excitation-contraction coupling in myometrial smooth muscle.

Hypocalcaemia impairs myosin light chain phosphorylation, reduces actin-myosin cross-bridge formation, and attenuates oxytocin receptor-mediated signalling—all of which compromise uterine contractility. [6] Ansari et al. [15] demonstrated in a pilot randomised controlled trial that intravenous calcium chloride during caesarean delivery safely raised ionized calcium levels and was associated with a lower incidence of uterine atony (20% vs 50% in the placebo group), further supporting the therapeutic potential of calcium supplementation.

Epstein et al. [16] identified ionized calcium as an independent predictor of severe PPH, with each 0.1 mmol/L decrease in ionized calcium nearly doubling the risk (OR 1.97; p = 0.003).

In our study, women with lower serum calcium levels required significantly more aggressive management: blood transfusion (53.33% vs 14.29%) and surgical intervention (4.00% vs 0%) were more frequent among hypocalcaemic women (p <0.001), indicating a more severe clinical course. This is consistent with the findings of Sanaullah et al. [14] and underscores the importance of identifying and correcting hypocalcaemia in labouring women.

The limitations of this study include its single-centre observational design, limiting generalisability; a relatively small sample; no multivariate regression analysis; measurement of total serum calcium rather than ionized calcium, which is the physiologically active fraction; potential uncontrolled confounders such as vitamin D levels, albumin, magnesium, and dietary calcium; and lack of longitudinal follow-up.

Conclusion

This study demonstrates a strong and statistically significant association between low serum calcium levels and atonic postpartum haemorrhage. Hypocalcaemia was markedly more prevalent in women with atonic PPH and was associated with lower mean serum calcium levels, prolonged labour, greater blood loss, and a higher need for blood transfusion and surgical intervention. Routine estimation of serum calcium during labour may serve as a simple, cost-effective strategy to identify women at risk of atonic PPH, enabling timely correction and potentially reducing maternal morbidity and mortality. Larger, multicentre interventional studies are warranted to establish the role of calcium supplementation in the prevention of atonic PPH.

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