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Original Article

Association of Uterine Atonicity and Postpartum Haemorrhage with Serum Calcium Levels – A Prospective Study

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ABSTRACT

Background: Postpartum hemorrhage (PPH) remains a leading cause of maternal mortality worldwide. About 70-80% of PPH cases are due to uterine atony. Calcium plays a pivotal role in uterine contractions, acting as a second messenger in smooth muscle contraction. The novelty of this study lies in its focus on serum calcium levels as a predictor of uterine atony and PPH and to provide insights that could guide interventions, such as calcium supplementation, to reduce the burden of PPH.
Aim: To study the association of uterine atony and PPH with serum calcium level.
Methods: The study was conducted as a prospective case-control study. in the Department of Obstetrics and Gynecology at a tertiary care centre in Secunderabad, Telangana. The study population included 200 women who delivered in the hospital. They were divided in two groups of 100 each, Group A consisted of patients diagnosed with atonic PPH, while Group- B included matched controls without atonic PPH. Blood samples were collected during the first or second stages of labor to assess serum calcium levels. A threshold of 8.5 mg/dl was used to define hypocalcemia.
Results: Multiparas are at significantly higher risk of atonic PPH compared to multiparas (p value<0.001). 74% participants with hypocalcemia had atonic PPH compared to 23.9% eucalcemic participants (p value is <0.0001) indicating significant association between serum calcium levels and atonic PPH. The association between serum calcium levels and the need for uterotonics was also found to be statistically significant.
Conclusion: The results indicate that hypocalcemia is strongly correlated with a higher incidence of PPH, particularly in women with uterine atony and hence the potential importance of maintaining adequate calcium levels during antenatal and peripartum period as a preventive measure against PPH.

Keywords: *Postpartum Haemorrhage (PPH), Uterine Atony, Serum Calcium Levels, Hypocalcemia, Uterotonics.*

INTRODUCTION

Postpartum hemorrhage (PPH) remains a leading cause of maternal mortality worldwide; it is a preventable cause contributing to approximately 25% of all maternal deaths globally (1). About 70-80% of PPH cases are due to uterine atony (the failure of the uterus to contract effectively. The global incidence of PPH is estimated at 6-10% of deliveries,. Calcium plays a pivotal role in uterine contractions, acting as a second messenger in smooth muscle contraction. The release of intracellular calcium triggers the activation of actin- myosin interactions, essential for effective uterine contractility (2).

Identifying modifiable risk factors, such as serum calcium levels, could offer a cost-effective strategy to prevent atony and improve maternal outcomes. The novelty of this study lies in its focus on serum calcium levels as a predictor of uterine atony and PPH and to provide insights that could guide interventions, such as calcium supplementation, to reduce the burden of PPH.

AIMS AND OBJECTIVES

Aim: To study the association of uterine atony and PPH with serum calcium levels.

Objectives:

1. To compare serum calcium levels in patients with and without atonic PPH.
2. To study the correlation between hypocalcemia and uterine atony.

METHODS & MATERIALS

The study was conducted as a prospective case-control study. in the Department of Obstetrics and Gynecology at a tertiary care centre in Secunderabad, Telangana, over a period of 18 months. The study population included 200 women who delivered in the hospital and those who gave an informed consent to participate. Those excluded were patients with placenta previa, retained placenta, traumatic postpartum haemorrhage, antepartum and intrapartum haemorrhage, hypotension, multiple gestation, macrosomia, abruption placenta, uterine anomalies, known bleeding disorders, known chronic renal or liver diseases, anticoagulants intake. A total of 200 postpartum women were selected by purposive sampling technique and were screened for eligibility upon admission to the labor ward or operating room. They were divided in two groups of 100 each. Group A consisted of patients diagnosed with atonic PPH based on visual and clinical assessment, while Group B included matched controls without atonic PPH. Demographic details, obstetric history, delivery outcomes, mode of delivery and clinical findings were recorded for all participants. Blood samples were collected during the first or second stages of labor to assess serum calcium levels. A threshold of 8.5 mg/dl was used to define hypocalcemia.

Statistical Analysis

Data was entered in Microsoft excel (windows 10) and was analyzed using SPSS version 22.0. Continuous variables, such as serum calcium levels and blood loss, were summarized as means and standard deviations, while categorical variables were presented as frequencies and percentages. Comparisons between groups were performed using independent t-tests or Mann-Whitney U tests for continuous variables and chi-square test, Fischers exact test for categorical variables. A p-value of <0.05 was considered statistically significant.

RESULTS

Distribution of participants across different age groups: The largest proportion of participants (43.0%) falls within the 26-30 age range, followed by 32.5% in the 21-25 group. Smaller proportions are seen in the 31-35 group (11.5%), 36-40 group (5.0%), and the youngest group (<20) at 8.0%.

Association between gestational age and PPH:

Among 31 patients at 36 weeks, 14 (45%) had atonic PPH. Among 62 patients at 37 weeks, 24 (39%) had atonic PPH. Among 76 patients at 38 weeks, 45 (59%) had atonic PPH. Among the 17 cases at 39 weeks, 9 (53%) had atonic PPH. Among the 14 patients at 40 weeks, 8(57%) had atonic PPH.

Table 1: Association Between Parity and PPH :

Parity	Group A	Group B	Total	p-value
Multipara	82 (62.5%)	49 (37.5%)	131	
Primipara	18 (26%)	51 (73.9%)	69	<0.001

Multiparas are at significantly higher risk of atonic PPH compared to multiparas (p value<0.001 by Chi Square test).

Table 2: Distribution of Serum Calcium Levels in Women With and Without Atonic PPH (n= 200)

Participants	Serum Calcium < 8.5 mg/dl	Serum Calcium ≥ 8.5 mg/dl	p- value
Group A	77(74%)	23(23%)	
Group B	27(25%)	73(76%)	< 0.001
Total	104(52%)	96 (48%)	

The calculated p value is <0.0001 (Chi Square Test) indicating significant association between serum calcium levels and atonic PPH.

Mode of Delivery: 128 (64.0%) participants had a cesarean section delivery, while 72 (36.0%) had a vaginal delivery.

Table 3: Distribution of Serum Calcium Levels among Women Undergoing LSCS (n=128) Group A vs Group B

Cesarean sections	Serum Calcium <8.5	Serum Calcium ≥8.5	Total LSCS	p-value
Group A	49	17	66 (51.5%)	1
Group B	25	37	62 (48.4%)	
Total	74	54	128	

The p value calculated is 1 indicating no significant association between serum calcium levels and cesarean section.

Table 4: MICU admissions in relation to serum calcium levels among Group A (atonic PPH)

Serum Calcium Level	MICU care	Ward admissions	Total (GROUP A)	p-value
< 8.5 mg/dL	49 (63.6%)	28 (36.3%)	77	0.226
≥ 8.5 mg/dL	11 (47.8%)	12 (52.2%)	23	
Total	60	40	100	

There is **no statistically significant association** between serum calcium levels and MICU admission in Group A patients (**p = 0.226** by Fisher's Exact Test). Although a higher proportion of patients with serum calcium <8.5 mg/dL required MICU care, this difference did not reach statistical significance.

Table 5: Blood products transfusions in atonic PPH (Group A)

Serum Calcium Level	Blood and blood products Transfusion	No Transfusion	TOTAL (GROUP A)	p - value
< 8.5 mg/dL	27	50	77	>0.05
≥ 8.5 mg/Dl	5	18	23	
Total	32	68	100	

Although a higher proportion of transfusions occurred in the hypocalcemic group, the association between serum calcium level and need for transfusion did not reach statistical significance (**p > 0.05**, Fisher's Exact Test).

Table 6: Correlation between serum calcium levels and use of additional uterotonics.

Serum Calcium	Uterotonics Given	Not Given	Total in group A	p-value
< 8.5 mg/dL	69 (89.6%)	8 (10.3%)	77	0.0398
≥ 8.5 mg/dL	16 (69.5%)	7 (30.4%)	23	

The association between serum calcium levels and the need for uterotonics was found to be statistically significant (**p <0.05**, Fisher's Exact Test).

Table 7: Surgical interventions in atonic PPH.

Serum Calcium	Surgical Intervention	No Surgical Intervention	TOTAL IN GROUP A	p-value
<8.5 mg/dL	15	62	77	0.347
≥8.5 mg/dL	2	21	23	

The association between serum calcium levels and the need for surgical intervention was **not statistically significant** (**p = 0.3457**, Fisher's Exact Test)

DISCUSSION

This study explores the relationship between Atonic postpartum hemorrhage (PPH), and serum calcium levels, with the goal of identifying potential links between calcium deficiency and an increased risk of PPH. The findings of this study are consistent with and build upon previous research that has suggested an association between serum calcium levels and uterine atony, a leading cause of PPH. Studies have emphasized the critical role of calcium in uterine muscle contraction, where a decrease in calcium levels can result in impaired uterine contractility, leading to an increased risk of hemorrhage (2). Our findings align with those of Yu and Ling(3), who demonstrated that calcium supplementation prior to cesarean delivery significantly reduced the incidence of PPH . This suggests that similar effects may be observed in cases of uterine atony, regardless of whether the delivery is vaginal or cesarean. The present study, therefore, adds valuable evidence to the existing literature by suggesting that calcium deficiency could contribute to uterine atony and the subsequent development of PPH.

This study shows distribution of participants as 43% is highest in age group of 26-30yrs. Similar to the study by Oguaka et al (4) showing 37% of participants in age group of 25- 29 years.

This study included 131 multiparas and 69 primi para , out of them 62% of multiparas and 26% of primiparas had atonic PPH, indicating Multipara are at significantly higher risk of atonic PPH compared to multiparas (p value<0.001 by Chi Square test). Similar to study by Parvin et al(5), 68% multipara and 35% primipara indicating multiparous to be at higher risk and study by oguaka et al (4) multiparas had 58.6% atonic PPH compared to primiparas. The lack of significant correlation between age, parity, and calcium levels in this study may be due to the homogeneity of the sample, as all participants were postpartum women who delivered either vaginally or by cesarean section at a single tertiary care hospital. Previous studies have suggested that age and parity can affect uterine tone and PPH risk, with younger women and those with higher parity being at increased risk for uterine atony and PPH. However, this study's results suggest that serum calcium levels are an independent factor in uterine tone regulation and hemorrhage prevention, regardless of maternal age or parity.

This study proves association of serum calcium levels with atonic PPH This finding is backed up by multi previous studies like study by Sayed et al (6) showing 25% participants with serum calcium <8.5 mg/dl had PPH while 2% of participants having serum calcium >=8.5 indicating significant association, study by Vinotha et al (7) showing 36% of participants with serum calcium <9 mg/dl while only 7.8% participants with serum calcium >9mg/dl had atonic PPH showing significant association. The association between low serum calcium levels and PPH is further supported by findings from multiple studies, including those by Wattimury et al. (8), who reported a significant relationship between low calcium levels and uterine atony. Our study's observation of a higher prevalence of PPH in patients with serum calcium levels below 8.5 mg/dL further strengthens the hypothesis that calcium plays a critical role in uterine contractility.

Among group A of this study (participants with atonic PPH) 66 of them have been delivered by Cesarean section, 74% of them had serum calcium <8.5 mg/dl and 25.8% had serum calcium level >8.5mg/dl though majority had hypocalcaemia, p value calculated showed no significant association similar to study (6) showing 67% of women who underwent LSCS had calcium levels <8.5mg/dl and 58% had serum calcium>=8.5mg/dl. This study shows among participants with atonic PPH needing MICU care, 63% had hypocalcaemia compared to 47.8% with eucalcaemic levels though association was not significant, majority of hypocalcaemic participants needed MICU care.

Among participants with atonic PPH, 35% hypocalcaemic participants and 21.7% eucalcaemic participants required blood products transfusions without significant association but a significant need for additional uterotonics was observed for atonic PPH, as 89.6% of hypocalcaemic participants and 69.5% of eucalcaemic participants required them. Whereas, surgical interventions like compression sutures and uterine ligation for management of atonic PPH was needed in 19.4% of hypocalcaemic participants and 8% of eucalcaemic participants.

Our study provides new insights into the role of calcium in preventing PPH, particularly in the context of uterine atony, and aligns with previous work by Changhua and Huajiang (9), who also reported that low calcium levels were associated with uterine inertia and PPH. Given the multifactorial nature of PPH, which can result from factors such as uterine tone, trauma, and coagulation issues, it is important to consider calcium's role in conjunction with other risk factors. Research by Sörsjö Stevenazzi et al.in 2024 (10) emphasizes that factors such as vitamin D deficiency and calcium imbalance can exacerbate uterine atony, supporting the idea that calcium management should be prioritized in high-risk obstetric populations. This study underscores the need for further research to examine the impact of calcium supplementation during pregnancy and postpartum, particularly in women with a history of uterine atony or other risk factors for PPH.

CONCLUSION

In conclusion, the findings of this study demonstrate a significant association between uterine atony, postpartum hemorrhage (PPH), and serum calcium levels in postpartum women. The results indicate that lower serum calcium levels (<8.5 mg/dL) are strongly correlated with a higher incidence of PPH, particularly in women with uterine atony. These findings underscore the potential importance of maintaining adequate calcium levels during antenatal and peripartum period as a preventive measure against PPH. The observed relationship between uterine atony and serum calcium levels further suggests that calcium status may play a role in the pathophysiology of uterine atony, which in turn is a major contributor to PPH.

Given the significant association between serum calcium levels and atonic PPH, this study highlights the need for further research to explore the mechanisms underlying this relationship. This study proposes that calcium supplementation in pregnancy could be prophylactic, preventive and therapeutic for atonic PPH and warrants need for future studies to investigate whether calcium supplementation and monitoring during pregnancy and labour may reduce the risk of PPH, especially in high-risk populations. Additionally, the study's findings contribute to the growing body of evidence suggesting that nutritional and biochemical factors, such as calcium levels, could influence obstetric outcomes and may inform clinical practices aimed at improving maternal health and preventing adverse birth outcomes.

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