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The Prevalence And Risk Factors Of Phototherapy-Induced Hypocalcemia In Term Neonates With Neonatal Jaundice.

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ABSTRACT

Neonatal jaundice is a common condition affecting the majority of term neonates, with phototherapy serving as the cornerstone of treatment for unconjugated hyperbilirubinemia. While phototherapy effectively reduces bilirubin levels, emerging evidence suggests a potential risk of iatrogenic hypocalcemia. This study aimed to assess the effect of phototherapy on serum calcium levels in term neonates with jaundice and to identify clinical and treatment-related predictors of post-phototherapy hypocalcemia.To determine the prevalence and severity of hypocalcemia following phototherapy in term neonates with neonatal jaundice in a tertiary care centre in Cuddalore district.A prospective observational study was conducted at Government Cuddalore Medical College and Hospital over a define study period, enrolling 155 term neonates who required phototherapy. Serum calcium levels were measured before and after phototherapy. Data on gestational age, birth weight, type and duration of phototherapy, and clinical symptoms were collected. Statistical analysis included paired t-tests, chi-square tests, ROC curve, and logistic regression.Phototherapy significantly reduced mean bilirubin (14.82 to 10.56 mg/dL) and calcium levels (9.45 to 8.91 mg/dL; $p < 0.001$). Post-phototherapy hypocalcemia was observed in 26.5% of neonates, with 39% of these showing symptoms such as jitteriness and seizures. Risk factors included gestational age 37–38 weeks ($p = 0.044$), phototherapy >48 hours ($p = 0.004$), and double surface phototherapy ($p = 0.007$). A calcium drop ≥0.65 mg/dL predicted hypocalcemia with good accuracy (AUC = 0.802).Phototherapy is associated with a significant risk of hypocalcemia in term neonates. Routine calcium monitoring, especially in high-risk neonates, is recommended. Early identification and intervention may reduce morbidity associated with this complication.

Keywords: Neonatal jaundice, phototherapy, unconjugated bilirubin, hypocalcemia.

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INTRODUCTION

Neonatal jaundice is one of the most common clinical conditions encountered in the first week of life, affecting approximately 60% of term and 80% of preterm neonates. It results from elevated serum bilirubin levels due to increased breakdown of fetal hemoglobin and immature hepatic conjugation mechanisms. While mild jaundice is often physiological and self-limiting, elevated levels of unconjugated bilirubin can cross the blood-brain barrier and lead to acute bilirubin encephalopathy and kernicterus, which are potentially life-threatening. [1]

Phototherapy remains the cornerstone of treatment for unconjugated hyperbilirubinemia in neonates.[2] It converts bilirubin into water-soluble photoisomers that are excreted in bile and urine without the need for conjugation. It is widely used due to its non-invasive nature, ease of administration, and proven efficacy in reducing serum bilirubin levels. Phototherapy has substantially reduced the need for exchange transfusions and the incidence of bilirubin-induced neurologic dysfunction.

Despite its benefits, phototherapy is not without complications. Commonly reported adverse effects include dehydration, skin rashes, loose stools, and transient changes in thermoregulation. In recent years, increasing attention has been given to metabolic effects such as hypocalcemia, which though often overlooked, can have clinical implications in the neonatal period. The potential mechanisms involve phototherapy-induced suppression of melatonin, which in turn affects parathyroid hormone secretion and calcium homeostasis. [3]

Neonatal hypocalcemia is defined as total serum calcium levels <8 mg/dL or ionized calcium below 1.2 mmol/L in term infants. It can manifest with symptoms such as jitteriness, irritability, lethargy, apnea, and in severe cases, seizures. While early neonatal hypocalcemia is often associated with prematurity, birth asphyxia, or maternal diabetes, phototherapy-related hypocalcemia has emerged as an iatrogenic cause that requires clinical attention. Unrecognized hypocalcemia may exacerbate neonatal morbidity, particularly when symptomatic.

Multiple studies have evaluated the relationship between phototherapy and serum calcium levels, with varying results. While some studies have reported a significant incidence of hypocalcemia following phototherapy, others have not found a strong association. The variation may be due to differences in gestational age, birth weight, duration and type of phototherapy, or the intensity of light used. Furthermore, few studies have focused on symptomatology and risk stratification, leading to inconsistencies in clinical recommendations. [1]

Although phototherapy-induced hypocalcemia is increasingly recognized, there is limited data from large prospective studies in Indian settings, particularly among term neonates. Many existing studies have small sample sizes, lack standardization of phototherapy parameters, and do not evaluate predictive markers for hypocalcemia. There is also insufficient evidence on how factors like gestational age within term range, birth weight, and phototherapy duration influence calcium dynamics. This gap necessitates further research to better define risk factors and guide clinical monitoring practices. [4]

Given the widespread use of phototherapy and the potential risk of hypocalcemia, it is essential to investigate the prevalence, severity, and clinical features of this complication in a structured manner. Identifying modifiable risk factors such as the type and duration of phototherapy could help in developing practical clinical guidelines. Moreover, establishing a predictive threshold for calcium decline could enable early identification and timely intervention, thus minimizing complications associated with untreated hypocalcemia. [4]

MATERIALS AND METHODS

Study Design and Setting

This Prospective observational study study was conducted in the Department of Pediatrics at Government Medical College and Hospital, Cuddalore district, Tamil Nadu, India .The study population comprised term neonates with neonatal jaundice who were admitted to the NICU and required phototherapy for the management of hyperbilirubinemia.

Inclusion and Exclusion Criteria

Neonates were included in the study if they met the following criteria:

- Clinically stable, icteric term neonates (≥37 completed weeks of gestation).
- Required phototherapy as part of the management for neonatal jaundice.
- Receiving exclusive breastfeeding or full-strength formula feeding.
- Neonates were excluded if they had:
- Birth asphyxia, congenital malformations, septicemia, or congenital hypothyroidism.
- Infants of diabetic mothers (IDM).
- Required exchange transfusion (ET).
- Neonates with ABO or Rh incompatibility or Hemolytic anemia.

Sample Size and Sampling Technique

The sample size was determined based on previously published data (Aziz et al [5]), which reported a mean serum calcium level of 9.53 ± 0.92 mg/dL before phototherapy and 9.30 ± 1.11 mg/dL after phototherapy. Using these parameters, the **sample size was calculated with NMaster software**, considering a **power of 80%** and a **5% level of significance**. The **required sample size was estimated to be 155** term neonates with neonatal jaundice.

Sample size, $\mathbf{n= (s_1+s_2)^2 \times [(z_1-a/2) + (z_1-b/2)]^2 / [x_1-x_2]^2}$

Mean 1= 9.53 (x_1)
SD1= 0.92 (s_1)
Mean2= 9.30 (x_2)
SD2= 1.11 (s_2)
Sample size, n = 140

Considering 10% non-response rate and rounding off, sample size n = 155

Study Procedure

All neonates admitted to the NICU at Government Medical College and Hospital, Cuddalore district with clinical evidence of neonatal jaundice were screened for eligibility. Term neonates (≥37 weeks of gestation) who fulfilled the inclusion and exclusion criteria were identified by the attending neonatologist or pediatrician. The parents or legal guardians of eligible neonates were approached, and the nature and purpose of the study were explained in their native language. Written informed consent was obtained prior to enrollment in the study.

Following consent, a comprehensive clinical history was obtained, including details of gestational age, mode of delivery, birth weight, feeding pattern (breastfeeding or formula feeding), and presence of any antenatal or perinatal complications. A thorough clinical examination was carried out to ensure that the neonates were hemodynamically stable and did not exhibit any signs suggestive of exclusion criteria such as sepsis, congenital anomalies, or birth asphyxia.

Once enrolled, a baseline blood sample was collected by trained nursing staff or a phlebotomist under aseptic precautions for the estimation of serum calcium levels. The sample was taken prior to the initiation of phototherapy, typically within one hour of admission to the NICU. The blood samples were sent to the central biochemistry laboratory of the hospital and analyzed using an automated chemistry analyzer. Calcium levels were interpreted based on age-appropriate reference ranges.

Subsequently, the neonates were started on phototherapy as per institutional protocols, based on the American Academy of Pediatrics (AAP) guidelines for the management of neonatal hyperbilirubinemia. The type of phototherapy (single or double surface), duration, and device used (LED or fluorescent) were documented. During phototherapy, routine neonatal care and feeding were continued without interruption. After completion of phototherapy, which was determined by achieving bilirubin levels below the treatment threshold, a second blood sample was collected under similar aseptic precautions. This sample was used to reassess serum calcium levels post-therapy. Any clinical signs suggestive of hypocalcemia such as

jitteriness, lethargy, irritability, or seizures were noted and documented during the course of treatment.

Statistical Analysis

Data entry was performed using Microsoft Excel 365, and statistical analysis was Data were entered in Microsoft excel and analysed using SPSS version 26. Descriptive statistics were mentioned as mean, standard deviation and frequencies, percentages. Association between categorical variables were measured using Chi square test. Association between continuous variables were measured using paired t test. ROC was used to predict the cut off value and diagnostic performance. Logistic Regression Analysis was done to elicit the risk Factors for Hypocalcemia. P value of less than 0.05 was considered as statistically significant. Data were represented by tables and charts wherever necessary.

RESULTS

Table 1: Association between Gestational Age and Hypocalcemia Post- Phototherapy (N = 155)

Gestational Age (weeks)	Hypocalcemia Present (n, %)	Hypocalcemia Absent (n, %)	Total (n)
37–38	18 (37.5%)	30 (62.5%)	48
38+1–39+6	18 (23.1%)	60 (76.9%)	78
≥40	5 (17.2%)	24 (82.8%)	29
Total	**41 (26.5%)**	**114 (73.5%)**	**155**
Chi-square			6.24
p-value			**0.044 ***

*-statistically significant

Table 1 presents a stratified analysis examining the association between gestational age and the occurrence of hypocalcemia following phototherapy (N = 155). Hypocalcemia was most prevalent among neonates born between 37 and 38 weeks, with 37.5% (n = 18) affected. This was followed by 23.1% (n = 18) of neonates in the 38+1 to 39+6 weeks category and 17.2% (n = 5) in those born at or beyond 40 weeks of gestation. A chi-square test revealed a statistically significant association between gestational age and hypocalcemia incidence ($\chi^2 = 6.24$, $p = 0.044$), indicating that earlier gestational age may be a risk factor for developing post- phototherapy hypocalcemia.

Table 2: Association Between Duration of Phototherapy and Incidence of Hypocalcemia (N = 155)

Duration of Phototherapy	Hypocalcemia Present (n, %)	Hypocalcemia Absent (n, %)	Total (n)
≤24 hours	6 (12.2%)	43 (87.8%)	49
25–48 hours	20 (28.6%)	50 (71.4%)	70
>48 hours	15 (41.7%)	21 (58.3%)	36
Total	**41 (26.5%)**	**114 (73.5%)**	**155**
Chi-square			10.82
p-value			**0.004 ***

*-statistically significant

Table 2 presents the association between the duration of phototherapy and the incidence of hypocalcemia (N = 155). Hypocalcemia was least common in neonates who received phototherapy for ≤24 hours (12.2%, n = 6), followed by those treated for 25–48 hours (28.6%, n = 20), and most prevalent among those exposed for more than 48 hours (41.7%, n = 15). This association was statistically significant ($\chi^2 = 10.82$, $p = 0.004$), suggesting that longer durations of phototherapy are significantly associated with a higher risk of hypocalcemia in neonates.

Table 3: Association between Type of Phototherapy (SSPT vs DSPT) and Hypocalcemia (N = 155)

Type of Phototherapy	Hypocalcemia Present (n, %)	Hypocalcemia Absent (n, %)	Total (n)
SSPT	22 (20.4%)	86 (79.6%)	108
DSPT	19 (40.4%)	28 (59.6%)	47
Total	**41 (26.5%)**	**114 (73.5%)**	**155**
Chi-square			7.34
p-value			**0.007 ***

*-statistically significant

Table 3 explores the association between the type of phototherapy and the development of hypocalcemia (N = 155). Among neonates who received SSPT, 20.4% (n = 22) developed hypocalcemia, whereas 40.4% (n = 19) of those treated with DSPT were affected. The association was statistically significant ($\chi^2 = 7.34$, p = 0.007), indicating that neonates exposed to double surface phototherapy had a significantly higher risk of developing hypocalcemia compared to those treated with single surface phototherapy. This finding emphasizes the need for closer biochemical monitoring in neonates receiving more intensive phototherapy.

Table 4: Prevalence of Hypocalcemia among Neonates Following Phototherapy (N = 155)

Outcome	Frequency (n)	Percentage (%)
Hypocalcemia Present	41	26.5
Hypocalcemia Absent	114	73.5
Total	**155**	**100.0**

Table 4 presents the prevalence of hypocalcemia among neonates following phototherapy (N = 155). Of the total participants, 26.5% (n = 41) developed hypocalcemia post-treatment, while the remaining 73.5% (n = 114) maintained normal calcium levels. These findings indicate that over one-fourth of neonates experienced a reduction in serum calcium below the normal threshold after undergoing phototherapy.

Table 5: Symptomatic vs Asymptomatic Hypocalcemia Following Phototherapy (n = 41 neonates with hypocalcemia)

Symptom Status	Frequency (n)	Percentage (%)
Symptomatic	16	39.0
Asymptomatic	25	61.0
Total	**41**	**100.0**

Table 5 examines the clinical presentation of neonates with post- phototherapy hypocalcemia (n = 41). Among these, 39.0% (n = 16) were symptomatic, exhibiting clinical signs related to low calcium levels, while 61.0% (n = 25) remained asymptomatic. This indicates that although hypocalcemia was frequently asymptomatic, a significant number of neonates required clinical attention for symptoms related to calcium imbalance.

Table 6: Severity of Hypocalcemia After Phototherapy (Mild, Moderate, Severe) (n = 41)

Severity Category	Serum Calcium Range (mg/dL)	Frequency (n)	Percentage (%)
Mild Hypocalcemia	7.5 – 7.9	24	58.5
Moderate Hypocalcemia	7.0 – 7.49	13	31.7
Severe Hypocalcemia	<7.0	4	9.8
Total		**41**	**100.0**

Table 6 provides a breakdown of the severity of hypocalcemia among the 41 affected neonates. Mild hypocalcemia (serum calcium 7.5–7.9 mg/dL) was the most common, accounting for 58.5% of the cases (n = 24). This was followed by moderate hypocalcemia (7.0–7.49 mg/dL) in 31.7% of the neonates (n = 13), and severe hypocalcemia (serum calcium <7.0 mg/dL) in 9.8% (n = 4). These results suggest that while most cases were mild, a considerable proportion experienced moderate to severe calcium derangement following phototherapy.

Table 7: Clinical Features Among Neonates with Phototherapy-Induced Hypocalcemia (n = 16 symptomatic neonates)

Clinical Feature	Frequency (n)	Percentage (%)
Jitteriness	7	43.8
Irritability/Excitability	5	31.3
Lethargy	3	18.8
Seizures	1	6.3
Total	**16**	**100.0**

Table 7 presents the clinical features observed among neonates who developed symptomatic hypocalcemia following phototherapy (n = 16). The most commonly reported symptom was jitteriness, noted in 43.8% of the affected neonates (n = 7), followed by irritability or excitability in 31.3% (n = 5). Lethargy was observed in 18.8% (n = 3), while seizures were reported in one neonate (6.3%). These findings highlight that although most symptoms were mild to moderate, severe neurological manifestations such as seizures, although rare, can occur and warrant prompt recognition and management.

Table 8: ROC Curve Analysis of Serum Calcium Level Drop Predicting Hypocalcemia (N = 155)

Parameter	Value
Area Under the Curve (AUC)	0.802
95% CI for AUC	0.727 – 0.877
Optimal Cut-off (mg/dL drop)	≥0.65
Sensitivity	82.9%
Specificity	72.8%
Youden's Index	0.556
Positive Likelihood Ratio (LR+)	3.05
Negative Likelihood Ratio (LR–)	0.23
p-value	**< 0.001 ***

*-statistically significant

Table 8 presents the results of the ROC curve analysis assessing the predictive ability of the drop in serum calcium levels for identifying hypocalcemia following phototherapy among neonates (N = 155). The area under the curve (AUC) was 0.802, with a 95% confidence interval ranging from 0.727 to 0.877, indicating good discriminatory power. The optimal cut-off for predicting hypocalcemia was identified as a serum calcium drop of ≥0.65 mg/dL. At this threshold, the sensitivity was 82.9%, and the specificity was 72.8%, yielding a Youden's Index of 0.556. The positive likelihood ratio (LR+) was 3.05, and the negative likelihood ratio (LR–) was 0.23. The association was statistically significant ($p < 0.001$), suggesting that a drop in serum calcium of 0.65 mg/dL or more is a reliable predictor of post-phototherapy hypocalcemia in neonates.

DISCUSSION

The present study demonstrated that the majority of neonates receiving phototherapy were full-term, with 50.3% born between 38+1 and 39+6 weeks of gestation and 31.0% between 37 and 38 weeks. These findings are in line with those of Sohail et al. (2025) [61], who reported a mean gestational age of 38.11 ± 1.49 weeks in their study cohort. . In the current study, although all participants were term neonates, a statistically significant association was observed between lower gestational age within the term range (37–38 weeks) and the incidence of post-phototherapy hypocalcemia ($p = 0.044$). This finding highlights the importance of stratifying term neonates further based on gestational age and suggests that

relatively early-term neonates may be more vulnerable to phototherapy-induced electrolyte disturbances, possibly due to incomplete maturation of parathyroid function or renal calcium reabsorption mechanisms. The current study found that the majority of neonates (56.1%) were initiated on phototherapy between the third and fourth days of life, with 20% started within the first two days and 23.9% on or after day five. While no significant association between age at initiation and hypocalcemia was reported, this temporal distribution is consistent with physiological hyperbilirubinemia peaking around the third day of life. Sohail et al. (2025) reported a mean chronological age of 4.52 ± 1.25 days at initiation, and while hypocalcemia was noted post-phototherapy, it was not significantly associated with age at initiation ($p = 0.134$). Thus, while most studies initiate phototherapy during the early neonatal period, no consistent evidence links age at initiation with the risk of hypocalcemia, suggesting that other factors such as gestational age, duration, and intensity of phototherapy may play more pivotal roles.

Chart 1: Symptomatic vs Asymptomatic Hypocalcemia Following Phototherapy (n = 41 neonates with hypocalcemia)

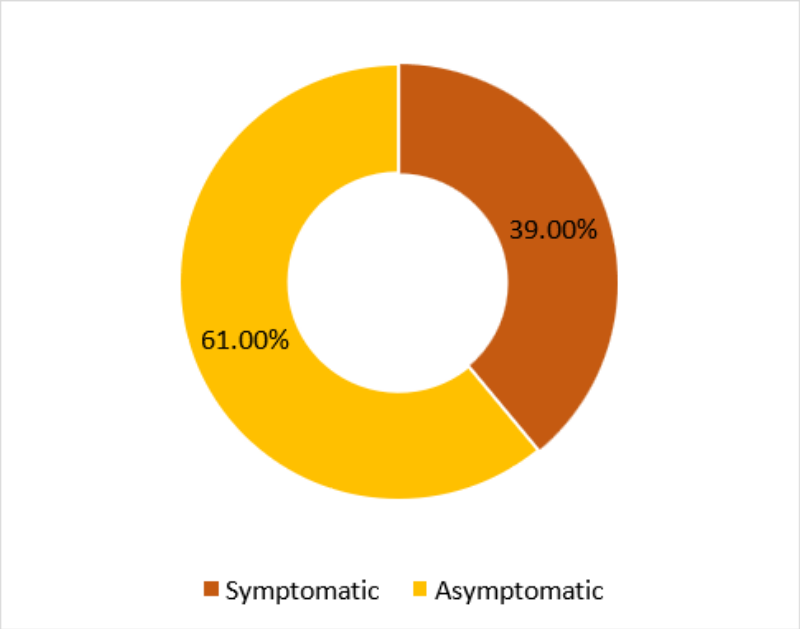

Chart 2: Severity of Hypocalcemia After Phototherapy (Mild, Moderate, Severe) (n = 41)

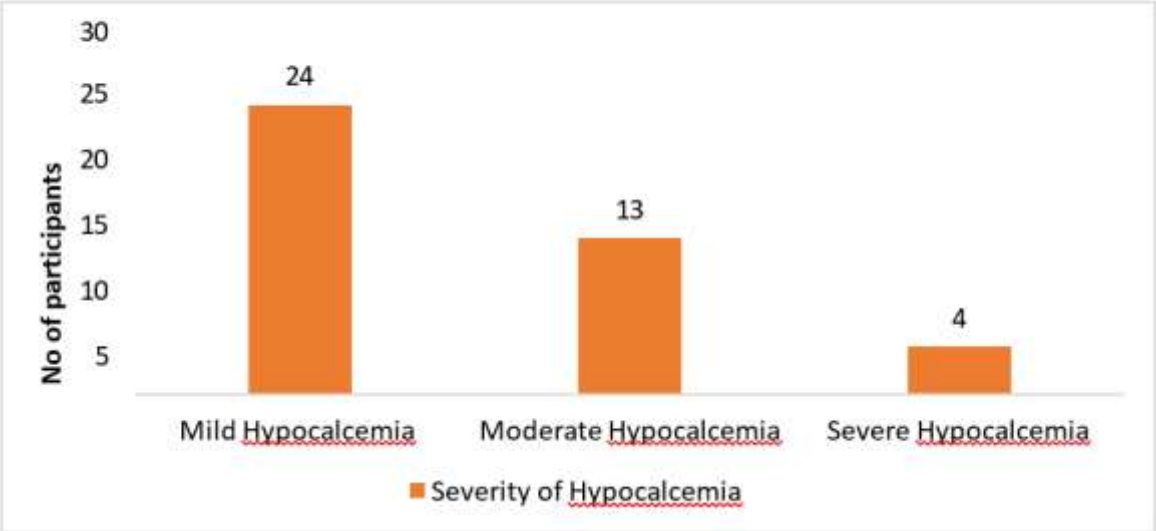

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Chart 3: Clinical Features Among Neonates with Phototherapy-Induced Hypocalcemia (n = 16 symptomatic neonates)

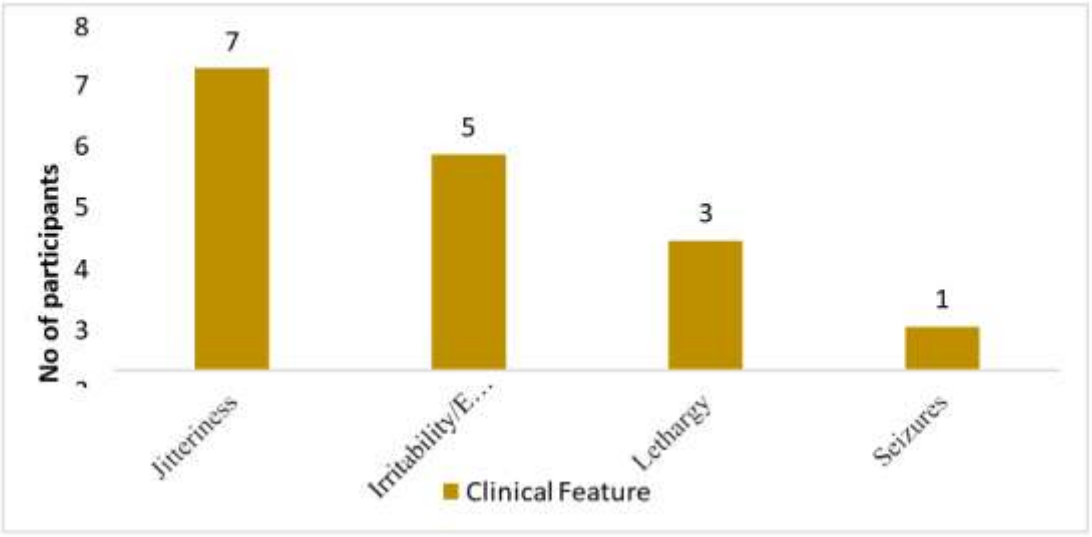
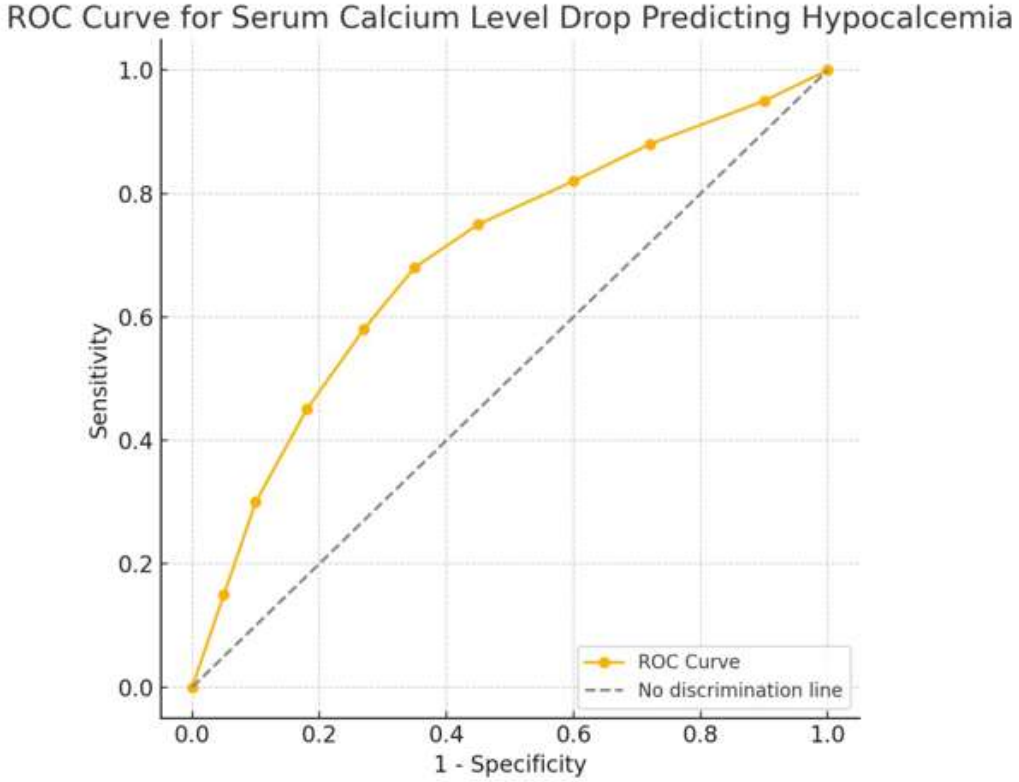


Chart 4: ROC Curve Analysis of Serum Calcium Level Drop Predicting Hypocalcemia (N = 155)



In this study, 26.5% of neonates developed hypocalcemia (serum calcium <8 mg/dL) after phototherapy, compared to only 6.5% before initiation. This prevalence aligns with the findings of Shrestha et al. (2021), who reported hypocalcemia in 22.5% of neonates after phototherapy. Rajesh et al. (2020) found a similar rate of 26% hypocalcemia post-phototherapy in term neonates, corroborating our findings. Javaid et al. (2021) reported a slightly higher prevalence at 41.6%, likely due to differences in inclusion criteria and calcium assay methods. Elshenawi et al. (2021) documented an increase in hypocalcemia prevalence from 24% pre-phototherapy to 38% post-phototherapy (p = 0.039), reinforcing the observation that phototherapy is significantly associated with a shift toward hypocalcemic states. These result

highlight the importance of routinely assessing calcium levels in neonates undergoing phototherapy, especially beyond 24–48 hours of exposure.

In this study, among the 41 neonates who developed post-phototherapy hypocalcemia, 39.0% were symptomatic, while 61.0% remained asymptomatic. The most common symptoms were jitteriness (43.8%) and irritability (31.3%), with lethargy and seizures being less frequent. These findings are in concordance with Rajesh et al. (2020), who found that 56% of hypocalcemic neonates were symptomatic, with jitteriness (38%) and excitability (18%) as predominant features.

Notably, none in that study developed convulsions, mirroring our findings where seizures were observed in only 6.3% of symptomatic neonates. Elshenawi et al. (2021) observed increased incidence of hypocalcemia post-phototherapy but did not detail symptomatology; however, the significant biochemical drop suggests potential for symptomatic manifestations. Durga et al. (2015) reported that 46% of neonates developed hypocalcemia, and clinical features such as lethargy and jitteriness were common among those affected. Similarly, Javaid et al. (2021) observed symptoms including jitteriness and seizures in a subset of neonates post- phototherapy, underscoring the clinical relevance of calcium monitoring. Taken together, these studies confirm that while many cases of phototherapy-induced hypocalcemia remain subclinical, a substantial proportion present with neuromuscular irritability, and occasionally seizures, warranting routine clinical vigilance and prompt correction.

In the present study, of the 41 neonates who developed hypocalcemia following phototherapy, 16 (39.0%) were symptomatic. The most commonly observed clinical manifestation was jitteriness (43.8%), followed by irritability or excitability (31.3%), lethargy (18.8%), and seizures in one neonate (6.3%). These findings align with those of Rajesh et al. (2020), who reported that 56% of hypocalcemic neonates were symptomatic, with jitteriness and excitability as predominant symptoms. Notably, convulsions were not observed in their cohort, similar to the low incidence in the current study. Durga et al. (2015) also highlighted common symptoms among hypocalcemic neonates, including jitteriness, poor feeding, and lethargy, supporting the neuromuscular irritability features observed in our study. Javaid et al. (2021) reported that 41.6% of neonates developed hypocalcemia post-phototherapy, with symptoms including jitteriness, lethargy, and seizures in 3.96% of cases. Similarly, Panneerselvam et al. (2022) observed symptomatic hypocalcemia in neonates exposed to LED phototherapy, primarily manifesting as jitteriness and excitability. These findings collectively underscore the importance of clinical vigilance for subtle signs of hypocalcemia in neonates undergoing phototherapy, especially given that neuromuscular symptoms may precede overt biochemical abnormalities or neurological complications.

The current study demonstrated a statistically significant association between lower gestational age within the term range and post-phototherapy hypocalcemia ($p = 0.044$), with the highest prevalence observed among neonates born between 37 and 38 weeks (37.5%). This suggests that even within term gestation, earlier gestational age may confer greater vulnerability to calcium imbalance following phototherapy. Singh et al. (2017) provided supportive evidence by reporting that 70% of preterm neonates developed hypocalcemia following phototherapy compared to 30% of term neonates, highlighting gestational age as a major risk factor. Similarly, Yadav et al. (2012) observed a significant fall in serum calcium in 80% of preterm and 66.6% of term neonates after 48 hours of phototherapy, with no such change in controls, reinforcing the gestational age-related susceptibility. Elshenawi et al. (2021) reported a pre-phototherapy hypocalcemia prevalence of 24% which rose to 38% post-treatment; though stratification by gestational age was not explicitly provided, the authors inferred increased vulnerability in younger neonates. Shrestha et al. (2021) included neonates with a mean gestational age of 38.55 ± 2.34 weeks, and observed a 22.5% hypocalcemia rate post-phototherapy, again suggesting that gestational maturity may modulate calcium regulation under light therapy. These findings emphasize that neonates at the lower end of term gestation may exhibit a physiological immaturity in parathyroid hormone regulation or renal calcium handling, predisposing them to phototherapy-induced hypocalcemia.

In the present study, the incidence of hypocalcemia increased with longer phototherapy exposure: 12.2% for ≤24 hours, 28.6% for 25–48 hours, and 41.7% for >48 hours. The association was statistically significant ($p = 0.004$), indicating that prolonged phototherapy is an independent risk factor for hypocalcemia in neonates. This observation is consistent with the findings of Arora et al. (2014), who demonstrated that hypocalcemia was more prevalent after 48 hours of continuous phototherapy, with greater risk among neonates receiving double surface therapy. Singh et al. (2017) also noted a higher incidence of hypocalcemia after 48 hours of phototherapy in both term and preterm neonates. Durga et al.

(2015) found that 46% of neonates developed hypocalcemia after 48 hours of phototherapy, with a slightly higher prevalence in preterm infants. Khan et al. (2016) reported a significant reduction in serum calcium after 24 hours of phototherapy, with a mean decrease from 8.73 ± 0.68 mg/dL to 7.47 ± 0.82 mg/dL. While their study focused on shorter phototherapy durations, the magnitude of calcium reduction suggested that even 24 hours of exposure may impact calcium levels, albeit less than longer durations. These findings strongly support the conclusion that phototherapy duration correlates positively with hypocalcemia risk, likely due to cumulative suppression of melatonin and consequent disruption in calcium homeostasis mechanisms, such as parathyroid activity and renal reabsorption.

In the present study, a statistically significant association was observed between the type of phototherapy and the incidence of hypocalcemia ($p = 0.007$). Among neonates who received double surface phototherapy (DSPT), 40.4% developed hypocalcemia, compared to only 20.4% of those treated with single surface phototherapy (SSPT). This suggests that the increased body surface area exposed to light in DSPT may contribute to enhanced suppression of melatonin and altered calcium regulation. These findings are in agreement with those reported by Arora et al. (2014), who found that hypocalcemia was significantly more common under DSPT compared to SSPT in both preterm and term neonates. The study concluded that increased intensity and coverage of phototherapy light were key contributors to the higher incidence observed. Aziz et al. (2014) also used high-intensity phototherapy and found a substantial drop in serum calcium, though they did not stratify by surface type. Yeasmin et al. (2020), focusing exclusively on SSPT, reported a 13.6% prevalence of hypocalcemia, which is notably lower than in studies where DSPT was used. Similarly, Panneerselvam et al. (2022) evaluated LED- based phototherapy (a high-intensity modality comparable to DSPT in light output) and reported hypocalcemia in 12.5% of cases. While the study did not differentiate by surface type, the results indirectly support the association between phototherapy intensity and hypocalcemia. These findings suggest that DSPT may significantly increase the risk of hypocalcemia and warrant closer monitoring compared to SSPT.

Limitations

This study was limited by its single-center design, which may restrict the generalizability of findings to other populations. Additionally, ionized calcium levels were not measured, which may provide a more accurate assessment of physiological hypocalcemia.

CONCLUSION AND RECOMMENDATIONS

This study evaluated the effect of phototherapy on serum calcium levels among term neonates with neonatal jaundice in a tertiary care center. The findings confirmed that while phototherapy is effective in significantly reducing serum bilirubin levels, it is also associated with a modest but statistically significant reduction in serum calcium levels. The prevalence of phototherapy-induced hypocalcemia was found to be 26.5%, with approximately 39% of affected neonates exhibiting clinical symptoms such as jitteriness, irritability, and, in rare cases, seizures. These results underscore the need to consider hypocalcemia as a relevant metabolic complication of phototherapy [5-16].

The study identified several statistically significant associations. Neonates born at 37–38 weeks of gestation had a significantly higher incidence of hypocalcemia compared to those delivered later ($p = 0.044$). Duration of phototherapy beyond 48 hours ($p = 0.004$) and the use of double surface phototherapy ($p = 0.007$) were independently associated with increased risk. ROC curve analysis showed that a serum calcium drop of ≥0.65 mg/dL had good predictive accuracy for hypocalcemia (AUC = 0.802), with high sensitivity and specificity. These findings highlight the importance of monitoring clinical and treatment-related risk factors when managing neonates undergoing phototherapy.

In light of the findings, it is recommended that serum calcium levels be routinely monitored in neonates receiving phototherapy, especially those who are early-term, exposed to phototherapy for more than 48 hours, or treated with double surface phototherapy. Adoption of a calcium drop threshold of ≥0.65 mg/dL as a predictive tool may enhance early detection of at-risk neonates. Clinical vigilance for symptoms of hypocalcemia should be maintained, and consideration may be given to preventive supplementation or early intervention strategies in high-risk cases, subject to further validation through multicenter studies.

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