International Journal of Contemporary Pediatrics
Sravani D et al. Int J Contemp Pediatr. 2025 Jun;12(6):969-974
http://www.ijpediatrics.com
pISSN 2349-3283 | eISSN 2349-3291

DOI: https://dx.doi.org/10.18203/2349-3291.ijcp20251478

Original Research Article

Effect of phototherapy on serum magnesium levels in term newborns with hyperbilirubinemia admitted in tertiary care center

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Received: 10 April 2025
Revised: 08 May 2025
Accepted: 17 May 2025

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ABSTRACT

Background: Neonatal hyperbilirubinemia is a common condition that affects a significant proportion of term neonates. Phototherapy is the treatment of choice for this condition; however, it may influence various biochemical parameters, including serum magnesium levels. This study investigates the effect of phototherapy on serum magnesium levels in term neonates with hyperbilirubinemia.
Methods: A descriptive observational study was conducted at the Department of Pediatrics, Al-Ameen Medical College, Vijayapura, Karnataka, over one year. Fifty term neonates (gestational age 37-42 weeks) diagnosed with hyperbilirubinemia and undergoing phototherapy were included. Serum magnesium and bilirubin levels were measured before and after 48 hours of phototherapy. Paired t-tests and Pearson's correlation coefficient were used for statistical analysis.
Results: The mean gestational age of neonates was 38.76±2.45 weeks. A significant reduction in serum magnesium levels was observed, with a decrease from 2.76±0.28 mg/dl pre-phototherapy to 1.87±0.12 mg/dl post-phototherapy (p=0.001). Serum magnesium levels showed a positive correlation with total bilirubin levels (r=0.76, p=0.001) and a negative correlation with the duration of phototherapy (r=-0.54, p=0.001). There were no significant differences in magnesium levels between the SGA, AGA and LGA groups.
Conclusions: Phototherapy significantly reduces serum magnesium levels in term neonates with hyperbilirubinemia. This decrease in magnesium levels correlates with bilirubin levels and the duration of phototherapy. Clinicians should monitor magnesium levels, particularly in neonates undergoing prolonged phototherapy, to prevent complications associated with hypomagnesemia. Further studies are needed to assess the long-term effects and benefits of magnesium supplementation during phototherapy.

Keywords: Magnesium, Neonatal jaundice, Neonatal hyperbilirubinemia, Phototherapy

INTRODUCTION

Neonatal hyperbilirubinemia or jaundice, is a common condition in newborns, particularly in term infants. It is characterized by elevated bilirubin levels in the blood, which result from an immature liver that is unable to efficiently process and excrete bilirubin. Neonatal jaundice occurs in approximately 60-70% of term infants in India, with some regional studies showing slight variations in incidence.[1] Although jaundice in neonates is typically physiological and resolves within the first week of life, if left untreated, it can lead to severe complications such as kernicterus, a form of brain damage and athetoid cerebral palsy.[2] Phototherapy is the most widely used and effective treatment for neonatal hyperbilirubinemia, as it provides a non-invasive means to reduce serum bilirubin levels.[3] The therapy involves exposing the infant to specific wavelengths of light, which helps to break down the bilirubin in the skin, making it easier for the body to eliminate. While

phototherapy is effective in treating jaundice, it is associated with the wide range of adverse effect, including hyperthermia, skin rashes and gastrointestinal disturbances like diarrhea.[4] Furthermore, studies have shown that phototherapy can also affect several metabolic processes, including electrolyte balance, which can pose potential risks to the neonate's health.[5]

Magnesium is an essential mineral that plays a pivotal role in various biological functions, including neuromuscular transmission, enzyme activation and the regulation of cellular function. Its levels are closely monitored in neonatal care, especially in preterm and sick neonates, as it is crucial for maintaining optimal physiological conditions.[6] Recent studies have suggested that phototherapy may influence magnesium homeostasis, leading to a decrease in serum magnesium levels, which may have clinical implications for neonates undergoing prolonged phototherapy.[7]

The potential decrease in serum magnesium levels during phototherapy raises questions about the mineral's role in neonatal health during treatment. Hypomagnesemia (low magnesium levels) is a condition that can lead to various complications, including muscle weakness, tremors and seizure activity.[8]Therefore, understanding the effect of phototherapy on serum magnesium levels in term neonates with hyperbilirubinemia is important to ensure the safety and efficacy of the treatment. This study aims to investigate the effect of phototherapy on serum magnesium levels in term neonates with hyperbilirubinemia and explore the correlation between these levels and bilirubin levels, as well as the duration of phototherapy.

METHODS

Study type

This study was a descriptive observational.

Study place

The study was conducted at the Department of Pediatrics, Al-Ameen Medical College, Vijayapura, Karnataka, India.

Study duration

The study was conducted over a period of one year, from September 2023 to September 2024.

Sample size

The study included 50 term neonates (gestational age 37-42 weeks) diagnosed with hyperbilirubinemia who were admitted to the neonatal intensive care unit (NICU) and underwent phototherapy.

Ethical approval

The study was approved by Institutional ethical committee Al-Ameen Medical College, Vijayapura, Karnataka, India.

Inclusion criteria

Term neonates of both sexes (gestational age 37-42 weeks) diagnosed with hyperbilirubinemia. Neonates who were initiated on phototherapy within the first 72 hours of life

Exclusion criteria

Preterm neonates (gestational age<37 weeks). Neonates with congenital metabolic disorders or renal insufficiency. Neonates with severe infections or other significant comorbidities. Neonates who were not given phototherapy or those who required exchange transfusion

A detailed clinical history was obtained for each neonate, including gestational age, birth weight and any risk factors for hyperbilirubinemia. Physical examinations were performed to assess jaundice severity, using either the Kramer scale or total serum bilirubin levels. All neonates received standard phototherapy using a blue light-emitting diode (LED) system, with continuous exposure for at least 12 to 24 hours based on clinical indications and bilirubin levels. The neonates were monitored for signs of complications and supportive care was provided, including hydration and adequate feeding. Blood samples were collected via venipuncture to measure serum magnesium levels at two time points: before initiating phototherapy (baseline) and after 48 hours of phototherapy. Hypomagnesemia was defined as a serum magnesium level less than 1.6 mg/dl. Additionally, total serum bilirubin levels were measured before and after phototherapy to assess the treatment's efficacy.

Statistical analysis

Data analysis was performed using descriptive statistics, with paired t tests to compare the pre- and post-phototherapy serum magnesium and bilirubin levels. Correlation analysis was done using Pearson's correlation coefficient to assess the relationship between serum magnesium levels and bilirubin levels before and after phototherapy, as well as between serum magnesium and the duration of phototherapy, with statistical significance set at a p value of <0.05.

RESULTS

The demographics and clinical characteristics of the neonates with jaundice was shown in table 1. This table presents the demographic and clinical characteristics of 50 neonates with hyperbilirubinemia. It includes the distribution of gender, birth weight and gestational age,

with the majority being of average gestational age (38.76 weeks). The mode of delivery shows a higher percentage of vaginal births (62%) compared to cesarean sections (38%). APGAR scores at 1 minute and 5 minutes indicate good neonatal health, with most neonates scoring 9 at both time points. Antenatal complications such as gestational diabetes mellitus (30%) and hypothyroidism (12%) were observed. Additionally, the majority of neonates-initiated breastfeeding within the first hour (86%) and most had no blood group incompatibility (62%). In this study, there were no significant differences in the magnesium level between pre and post therapy for SGA, AGA and LGA neonates. In addition, there was no significant difference in the pre phototherapy (p=0.90) and post phototherapy magnesium levels when compared between the SGA, AGA and LGA babies. The results were shown in Table 2. There was a significant decrease in the total bilirubin level (9.45±1.76 vs 14.76±3.24, p=0.001) and direct bilirubin level (0.12±0.01 vs 0.25±0.03, p=0.001) in post phototherapy when compared to the pre phototherapy. The results were shown in Table 3. In the present study, there was a significant decrease in the total magnesium level (1.87±0.12 vs 2.76±0.12, p=0.001) in post phototherapy when compared to the pre phototherapy. The results were shown in Table 4. In the present study, there was a significant positive correlation between the total magnesium and total bilirubin level with a r value of 0.76 and it was significant (p=0.001). The results were shown in Table 5. In this study, there was a significant negative correlation between the total magnesium and duration of phototherapy level with a r value of -0.54 and it was significant (p=0.001). So, when the duration of phototherapy increases there was a significant decline in the magnesium level. The results were shown in Table 6.

Table 1: Demographics and clinical characteristics of the neonates with jaundice.

Variables	Values
Gender, N (%)	
Male	29 (58%)
Female	21 (42%)
Birth weight (mean±SD)	3.2±0.4
Birth weight categories, N (%)	
SGA	3 (6%)
AGA	42 (84%)
LGA	5 (10%)
Gestational age in weeks (mean±SD)	38.76±2.45
Gestational age categories, N (%)	
37 weeks	9 (18%)
38 weeks	18 (36%)
39 weeks	14 (28%)
40 weeks	7 (14%)
42 weeks	2 (4%)
Mode of delivery, N (%)	
Vaginal	31 (62%)
Caesarean	19 (38%)
APGAR score (1 min), N (%)	
Score 8	5 (10%)
Score 9	45 (90%)
APGAR score (5 min), N (%)	
Score 8	0
Score 9	50 (100%)
Antenatal complications, N (%)	
GDM	15 (30%)
PIH	4 (8%)
Hypothyroidism	6 (12%)
APH	1 (2%)
Time of initiation of first feed, N (%)	
Within 1 hour	43 (86%)
After 1 hour	7 (14%)
Feed type, N (%)	
Direct breast feeding	41 (82%)
Others	9 (18%)

Continued.

Variables	Values
Anthropometry	
Length in cm (mean±SD)	49.8±0.9
Head circumference in cm (mean±SD)	33.8 (0.7)
Type of incompatibility, N (%)	
None	31 (62%)
ABO	14 (28%)

Table 2: Comparison of pre and post phototherapy magnesium level among the birth weight categories.

Birth weight categories	Pre phototherapy (mg/dl)	Post phototherapy (mg/dl)	P value
SGA	2.14±0.12	1.98±0.06	0.54 [aNS]
AGA	2.26±0.14	2.15±0.08	0.32 [aNS]
LGA	2.28±0.12	2.21±0.06	0.21b[aNS]
P value	0.90 [bNS]	0.94 [bNS]	

a-paired student's t test, b-One way ANOVA, NS-Non-Significant.

Table 3: Comparison of pre and post phototherapy bilirubin levels in neonates with jaundice.

Bilirubin levels	Pre phototherapy (mg/dl)	Post phototherapy (mg/dl)	P value
Total Bilirubin (mg/dl)	14.76±3.24	1.98±0.06	0.001*
Direct Bilirubin (mg/dl)	0.25±0.03	0.12±0.01	0.001*

Paired student's t test; * denotes significant (p<0.05).

Table 4: Comparison of pre and post phototherapy magnesium levels in neonates with jaundice.

Parameter	Pre-phototherapy	Post phototherapy	P value
Total Magnesium (mg/dl)	2.76±0.28	1.87±0.12	0.001*

Paired student's t test; *significant (p<0.05).

Table 5: Correlation between total magnesium and bilirubin level after 48 hours of phototherapy in neonates with jaundice.

Parameter	Pearson's Correlation coefficient (r)	P value
Total magnesium vs total bilirubin after 48 hours of phototherapy	0.76	0.001*

Pearson's Correlation coefficient; * denotes significant (p<0.05).

Table 6: Correlation between total magnesium and duration of phototherapy in in neonates with jaundice.

Parameter	Pearson's Correlation coefficient (r)	P value
Total magnesium vs duration of phototherapy	-0.54	0.001*

*Significant (p<0.05).

DISCUSSION

Neonatal hyperbilirubinemia, commonly known as jaundice, is a widespread condition among newborns, particularly term infants. Although it often resolves spontaneously, untreated hyperbilirubinemia can result in significant neurodevelopmental sequelae, such as kernicterus and cerebral palsy.[9]Phototherapy remains the cornerstone of treatment for neonatal jaundice due to its effectiveness in reducing serum bilirubin levels.[10] However, this non-invasive treatment is not without its potential complications, including effects on electrolytes like magnesium.

In the present study, we observed that there was a significant decrease in the serum magnesium levels following phototherapy. Specifically, the total magnesium level dropped from 2.76±0.28 mg/dl before phototherapy to 1.87±0.12 mg/dl after 48 hours of phototherapy, with a p-value of 0.001, indicating a statistically significant reduction. This result is consistent with previous studies that reported a decrease in magnesium levels during phototherapy. Likewise, in a study done by Subhashini et al, there was significant decrease in the magnesium level post phototherapy when compared to pre phototherapy (2.11±0.24 vs 2.49±0.243, p<0.001).[8] A potential explanation for this decrease could be related to phototherapy's effect on renal magnesium

excretion or changes in the neonate's acid-base balance due to the phototherapy process.[11]

The mechanism behind the reduction in magnesium levels during phototherapy remains complex and multifactorial. One potential mechanism is the alteration in calcium metabolism. Phototherapy has been known to cause hypocalcemia, which may indirectly affect magnesium levels because calcium and magnesium often have reciprocal effects on one another in the body. Moreover, phototherapy may affect vitamin D metabolism, which plays a crucial role in regulating both calcium and magnesium homeostasis. Vitamin D, through its effects on the intestines, facilitates magnesium absorption and phototherapy may disrupt this delicate balance.[12]

A key finding of our study was the significant positive correlation between serum magnesium and total bilirubin levels. The Pearson's correlation coefficient of 0.76 (p=0.001) suggests that as bilirubin levels decrease during phototherapy, magnesium levels tend to decrease as well. This finding aligns with the hypothesis that the reduction in bilirubin levels during phototherapy might alter the distribution of magnesium or affect its binding capacity in the blood.

The lowering of bilirubin levels could result in changes in the neonate's physiological condition, potentially leading to a shift in magnesium dynamics.[13] Pravalika et al, observed that phototherapy results in a reduction of serum magnesium levels concomitant with a decrease in serum bilirubin levels.[14] This indicates a positive correlation between serum bilirubin and serum magnesium levels. The elevation of magnesium during hyperbilirubinemia may represent a physiological compensatory response.

Interestingly, the positive correlation suggests that magnesium levels might serve as a compensatory mechanism against the toxic effects of elevated bilirubin. Some studies have suggested that magnesium may help counteract the toxic effects of bilirubin in the brain, particularly in cases of high bilirubin concentrations in the neonate. The decrease in magnesium following phototherapy may reflect the reduction in bilirubin levels as part of the overall treatment response.[15]

Another significant finding in our study was the negative correlation between the duration of phototherapy and serum magnesium levels. The Pearson's correlation coefficient of -0.54 (p=0.001) indicates that as the duration of phototherapy increases, serum magnesium levels tend to decrease. This is an important observation, as it highlights the potential cumulative effect of prolonged phototherapy on magnesium depletion.

Neonates who undergo extended periods of phototherapy may be at greater risk for hypomagnesemia, which could have clinical implications for their neurological and muscular function. This finding is particularly important for clinicians, as it underscores the need to monitor magnesium levels in neonates receiving long-term phototherapy. Likewise, in a study done by Khatab et al, there was a significant negative correlation between duration of phototherapy and magnesium levels in neonates ($r=-0.419$; $p<0.001$).[16]

The negative correlation between phototherapy duration and magnesium levels could also be related to the continuous exposure to light, which may exacerbate the renal excretion of magnesium. Prolonged exposure to phototherapy may lead to sustained changes in the neonate's electrolyte balance, requiring careful monitoring of magnesium and other electrolytes to prevent adverse effects.[17] Given the findings of our study, it is evident that while phototherapy is effective in treating hyperbilirubinemia, it can have significant effects on serum magnesium levels. This highlights the need for clinicians to carefully monitor serum magnesium levels in neonates undergoing phototherapy, especially those receiving prolonged treatment. Hypomagnesemia could potentially lead to clinical complications, such as tremors, seizures and impaired neuromuscular function. Therefore, magnesium supplementation may be considered in neonates who exhibit signs of magnesium deficiency, particularly those receiving extended phototherapy.

Furthermore, our study supports the idea that magnesium supplementation should be individualized based on the neonate's clinical condition, serum magnesium levels and duration of phototherapy. Neonates with prolonged phototherapy exposure may require more frequent monitoring and possible magnesium supplementation to ensure optimal electrolyte balance and prevent complications.

While this study provides valuable insights into the relationship between phototherapy and magnesium levels, it has certain limitations. First, the sample size of 50 neonates may not be large enough to fully generalize the findings. Additionally, the study only measured serum magnesium levels at two time points: before phototherapy and after 48 hours. Future studies should include more frequent sampling to better understand the dynamics of magnesium fluctuations during the entire course of phototherapy.

Another limitation is the lack of long-term follow-up to assess the potential long-term effects of magnesium depletion on the neurodevelopment of neonates who received phototherapy. Future research should also explore whether magnesium supplementation during phototherapy has any effect on the long-term developmental outcomes in neonates treated for hyperbilirubinemia.

CONCLUSION

In conclusion, our study demonstrated a significant decrease in serum magnesium levels following phototherapy for neonatal hyperbilirubinemia. The findings also highlighted a positive correlation between serum magnesium and bilirubin levels, as well as a negative correlation between the duration of phototherapy and serum magnesium levels. These results suggest that prolonged phototherapy can lead to hypomagnesemia, which may have clinical implications. Given these findings, it is crucial to monitor magnesium levels in neonates receiving phototherapy and consider appropriate interventions to maintain optimal electrolyte balance and prevent complications. Further studies with larger sample sizes and longer follow-up periods are needed to better understand the long-term effects of phototherapy on magnesium homeostasis and neonatal health.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Sravani D, Ukkali SB, Thobbi AN. Effect of phototherapy on serum magnesium levels in term newborns with hyperbilirubinemia admitted in tertiary care center. Int J Contemp Pediatr 2025;12:969-74.