RESEARCH PAPER

Study of Serum Calcium Levels Between Hyperbilirubinemic Term Neonates Undergoing Phototherapy by Covering Their Head vs Without Covering Their Head

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ABSTRACT

Background: Neonatal hyperbilirubinemia is a common clinical condition in term neonates, and phototherapy remains the standard treatment modality. Although phototherapy is effective in reducing serum bilirubin levels, it has been associated with metabolic complications including hypocalcemia. Covering the neonate's head during phototherapy has been proposed as a simple preventive strategy to reduce phototherapy-induced hypocalcemia.

Aim: To assess the effect of head covering on serum calcium levels in term neonates with hyperbilirubinemia undergoing phototherapy.

Materials and Methods: This comparative observational study was conducted in the Department of Paediatrics at Krishna Institute of Medical Sciences, Karad. A total of 100 term neonates with unconjugated hyperbilirubinemia requiring phototherapy were included and divided into two groups: Group A (phototherapy with head covering) and Group B (phototherapy without head covering), with 50 neonates in each group. Serum calcium levels were measured before initiation of phototherapy and after 48 hours of treatment. Baseline demographic characteristics, serum bilirubin levels, duration of phototherapy, and incidence of hypocalcemia were compared between the groups. Statistical analysis was performed using Student's t-test and Chi-square test, with $p<0.05$ considered statistically significant.

Results: Baseline demographic characteristics including sex distribution, gestational age, birth weight, feeding pattern, mode of delivery, and baseline serum bilirubin levels were comparable between the two groups. Mean baseline serum calcium levels were 9.31 ± 0.52 mg/dL in Group A and 9.28 ± 0.49 mg/dL in Group B. After 48 hours of phototherapy, serum calcium levels declined significantly in both groups; however, the reduction was significantly greater in Group B. Mean post-phototherapy serum calcium levels were 8.72 ± 0.48 mg/dL in Group A and 7.94 ± 0.56 mg/dL in Group B ($p<0.001$). The incidence of hypocalcemia was significantly higher in Group B compared with Group A (36% vs 12%; $p=0.004$). Most hypocalcemic neonates remained asymptomatic. Duration of phototherapy was comparable between the groups.

Conclusion: Phototherapy is associated with a significant reduction in serum calcium levels in term neonates. Covering the head during phototherapy significantly reduces the incidence and severity of hypocalcemia without affecting phototherapy efficacy. Head covering is a simple, safe, cost-effective, and non-invasive preventive intervention that may be routinely incorporated during neonatal phototherapy.

Keywords: Neonatal jaundice; hyperbilirubinemia; phototherapy; hypocalcemia; serum calcium; head covering; neonates

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Introduction

Neonatal jaundice is one of the most common clinical conditions encountered during the neonatal

period and affects approximately 60% of term newborns during the first week of life [1]. Hyperbilirubinemia results from elevated levels of unconjugated bilirubin caused by increased red blood cell turnover, immature hepatic conjugation mechanisms, and enhanced enterohepatic circulation [2]. Although physiological jaundice is generally benign and self-limiting, severe hyperbilirubinemia can lead to bilirubin encephalopathy and kernicterus if not treated appropriately [3].

Phototherapy remains the cornerstone of treatment for neonatal hyperbilirubinemia and has substantially reduced the need for exchange transfusion worldwide [4]. Phototherapy acts by converting bilirubin into water-soluble photoisomers that can be excreted without hepatic conjugation [5]. Despite its effectiveness and safety profile, phototherapy is associated with certain adverse effects including dehydration, diarrhea, skin rash, retinal injury, thermal instability, and electrolyte disturbances [6].

Among the metabolic complications associated with phototherapy, hypocalcemia has gained increasing clinical attention. Calcium plays an essential role in neonatal physiology including neuromuscular transmission, cardiac function, enzyme activity, and bone mineralization [7]. Hypocalcemia in neonates may present with jitteriness, irritability, poor feeding, apnea, seizures, or cardiac arrhythmias [8]. Several studies have demonstrated a significant reduction in serum calcium levels following phototherapy in neonates [9,10].

The exact mechanism of phototherapy-induced hypocalcemia remains incompletely understood. The most accepted hypothesis suggests that transcranial illumination suppresses melatonin secretion from the pineal gland, which subsequently affects parathyroid hormone activity and calcium homeostasis [11]. Exposure of the neonatal skull and anterior fontanelle to phototherapy light may therefore contribute to altered calcium metabolism.

To minimize this effect, covering the neonate's head during phototherapy has been proposed as a simple preventive intervention. Head covering may reduce penetration of light to intracranial structures and preserve melatonin secretion, thereby reducing the risk of hypocalcemia [12]. However, available studies have shown variable results, and evidence regarding the effectiveness of head covering remains limited [13,14].

The present study was undertaken to compare serum calcium levels between hyperbilirubinemic term neonates undergoing phototherapy with head covering and those without head covering and to assess whether head covering can reduce phototherapy-induced hypocalcemia.

Materials and Methods

This comparative observational study was conducted in the Department of Paediatrics, Krishna Institute of Medical Sciences, Karad, after obtaining approval from the Institutional Ethics Committee. Written informed consent was obtained from the parents or legal guardians of all enrolled neonates.

Study Population

Term neonates admitted with unconjugated hyperbilirubinemia requiring phototherapy were included in the study.

Inclusion Criteria

- Full-term neonates
- Neonates with unconjugated hyperbilirubinemia requiring phototherapy
- Neonates admitted during the study period

Exclusion Criteria

- Preterm neonates
- Neonates with congenital anomalies
- Neonates with sepsis
- Neonates with birth asphyxia
- Neonates requiring exchange transfusion
- Neonates with metabolic disorders affecting calcium homeostasis

Study Groups

The neonates were divided into two groups:

Group A

Neonates receiving phototherapy with head covering.

Group B

Neonates receiving phototherapy without head covering.

A soft cotton cap was used for head covering during phototherapy in Group A.

Data Collection

Detailed history and clinical examination were performed for all neonates. The following parameters were recorded:

- Sex
- Gestational age
- Birth weight
- Mode of delivery
- Feeding type
- Baseline serum bilirubin
- Baseline serum calcium

Serum calcium levels were measured before initiation of phototherapy and after 48 hours of phototherapy.

Statistical Analysis

Data were entered and analyzed using SPSS software version 23. Continuous variables were expressed as mean ± standard deviation, while categorical variables were expressed as frequencies and percentages. Student's t-test and Chi-square test were used for statistical analysis. A p-value <0.05 was considered statistically significant.

Results

A total of 100 term neonates with unconjugated hyperbilirubinemia requiring phototherapy were included in the study. The neonates were divided equally into two groups: 50 neonates underwent phototherapy with head covering (Group A) and 50 neonates underwent phototherapy without head covering (Group B).

Sex Distribution Among Study Groups

Male neonates predominated in both study groups. In Group A, 30 (60%) neonates were males and 20 (40%) were females, whereas in Group B, 32 (64%) neonates were males and 18 (36%) were females. The difference was not statistically significant (p>0.05).

Table 1. Sex Distribution Among Study Groups

Sex	Group A (Head Cover) n (%)	Group B (No Head Cover) n (%)	p-value
Male	30 (60%)	32 (64%)	>0.05
Female	20 (40%)	18 (36%)	

Mode of Delivery Among Study Groups

In Group A, 28 (56%) neonates were delivered by normal vaginal delivery and 22 (44%) by lower segment cesarean section (LSCS). In Group B, 26 (52%) neonates were delivered vaginally and 24 (48%) by LSCS. No statistically significant association was observed between mode of delivery and study groups (p>0.05).

Table 2. Mode of Delivery Among Study Groups

Mode of Delivery	Group A n (%)	Group B n (%)	p-value
Normal vaginal delivery	28 (56%)	26 (52%)	>0.05
LSCS	22 (44%)	24 (48%)	

Feeding Pattern Among Study Groups

Exclusive breastfeeding was the predominant feeding pattern in both groups. In Group A, 40 (80%) neonates were exclusively breastfed, while in Group B, 38 (76%) neonates received exclusive breastfeeding. No statistically significant difference was observed (p>0.05).

Table 3. Feeding Pattern Among Study Groups

Feeding Type	Group A n (%)	Group B n (%)	p-value
Exclusive breastfeeding	40 (80%)	38 (76%)	>0.05
Formula feeding	10 (20%)	12 (24%)	

Comparison of Birth Weight Between Study Groups

Mean birth weight in Group A was 2.82 ± 0.34 kg, while in Group B it was 2.79 ± 0.31 kg. The difference was statistically insignificant (p=0.64).

Table 4. Comparison of Birth Weight Between Study Groups

Parameter	Group A	Group B	p-value
Birth weight (kg)	2.82 ± 0.34	2.79 ± 0.31	0.64

Comparison of Gestational Age Between Study Groups

Mean gestational age in Group A was 38.4 ± 1.1 weeks and in Group B was 38.2 ± 1.2 weeks. The difference was not statistically significant (p=0.48).

Table 5. Comparison of Gestational Age Between Study Groups

Parameter	Group A	Group B	p-value
Gestational age (weeks)	38.4 ± 1.1	38.2 ± 1.2	0.48

Comparison of Baseline Serum Bilirubin Levels

Baseline serum bilirubin levels were comparable between both groups. Mean serum bilirubin level was 16.1 ± 1.8 mg/dL in Group A and 15.9 ± 1.7 mg/dL in Group B (p=0.57).

Table 6. Comparison of Baseline Serum Bilirubin Levels Between Study Groups

Parameter	Group A	Group B	p-value
Baseline serum bilirubin (mg/dL)	16.1 ± 1.8	15.9 ± 1.7	0.57

Comparison of Serum Calcium Levels Before and After Phototherapy

Mean baseline serum calcium levels were similar in both groups prior to initiation of phototherapy. After 48 hours of phototherapy, serum calcium levels declined significantly in both groups; however, the reduction was significantly greater in Group B (without head covering).

Table 7. Comparison of Serum Calcium Levels Before and After Phototherapy

Serum Calcium Level	Group A (Head Cover)	Group B (No Head Cover)	p-value
Before phototherapy (mg/dL)	9.31 ± 0.52	9.28 ± 0.49	0.76
After phototherapy (mg/dL)	8.72 ± 0.48	7.94 ± 0.56	<0.001
Mean reduction in calcium (mg/dL)	0.59 ± 0.19	1.34 ± 0.27	<0.001

Incidence of Hypocalcemia After Phototherapy

The incidence of hypocalcemia after phototherapy was significantly higher in Group B compared with Group A. In Group A, 6 (12%) neonates developed hypocalcemia, whereas 18 (36%) neonates in Group B developed hypocalcemia (p=0.004).

Table 8. Incidence of Hypocalcemia After Phototherapy

Outcome	Group A n (%)	Group B n (%)	p-value
Hypocalcemia present	6 (12%)	18 (36%)	0.004
Hypocalcemia absent	44 (88%)	32 (64%)	

Clinical Features of Hypocalcemia

Most neonates with hypocalcemia remained asymptomatic. Mild jitteriness was observed in a small proportion of affected neonates.

Table 9. Clinical Features of Hypocalcemia

Clinical Feature	Group A	Group B
Asymptomatic hypocalcemia	5	14
Jitteriness	1	4
Seizures	0	0

Comparison of Duration of Phototherapy

Mean duration of phototherapy was 43.2 ± 6.4 hours in Group A and 44.1 ± 5.8 hours in Group B. No statistically significant difference was observed between the groups (p=0.46).

Table 10. Comparison of Duration of Phototherapy Between Study Groups

Parameter	Group A	Group B	p-value
Duration of phototherapy (hours)	43.2 ± 6.4	44.1 ± 5.8	0.46

Overall Findings

The present study demonstrated that phototherapy significantly reduced serum calcium levels in term neonates. However, neonates undergoing phototherapy without head covering experienced a significantly greater decline in serum calcium levels and a higher incidence of hypocalcemia compared with neonates whose heads were covered during phototherapy. Head covering therefore appeared to provide a protective effect against phototherapy-induced hypocalcemia without interfering with phototherapy duration or efficacy.

Discussion

The present study evaluated the effect of head covering on serum calcium levels among term neonates undergoing phototherapy for unconjugated hyperbilirubinemia. The study demonstrated a significant decline in serum calcium levels following phototherapy in both groups; however, the reduction was significantly greater among neonates who underwent phototherapy without head covering. In addition, the incidence of hypocalcemia was significantly higher in neonates without head covering compared with those whose heads were covered during phototherapy.

Phototherapy remains the standard and most effective treatment modality for neonatal hyperbilirubinemia and has significantly reduced the incidence of kernicterus and the need for exchange transfusion worldwide [1]. Despite its therapeutic benefits, phototherapy is associated with several adverse effects including loose stools, dehydration, skin rash, retinal injury, thermal instability, and electrolyte disturbances such as hypocalcemia [2]. The present study supports earlier observations that phototherapy can significantly influence calcium homeostasis in neonates.

In the current study, mean serum calcium levels decreased significantly after 48 hours of phototherapy in both study groups. However, neonates undergoing phototherapy without head covering exhibited a significantly greater reduction in calcium levels compared with neonates whose heads were covered. Similar findings were reported by Romagnoli et al., who first described phototherapy-induced hypocalcemia in neonates and suggested a relationship between phototherapy exposure and altered calcium metabolism [3].

The exact mechanism of phototherapy-induced hypocalcemia remains incompletely understood. The most accepted hypothesis proposes that transcranial illumination during phototherapy suppresses melatonin secretion from the pineal gland, thereby affecting parathyroid hormone activity and calcium regulation [4]. Melatonin normally antagonizes the hypocalcemic effect of cortisol on bone calcium metabolism. Suppression of melatonin secretion may therefore lead to increased calcium uptake by bone and subsequent reduction in serum calcium levels [5].

In the present study, covering the neonate's head during phototherapy significantly reduced the extent of calcium decline. This finding is consistent with studies conducted by Ehsanipour et al. and Kargar et al., who demonstrated that head covering decreases the incidence of phototherapy-induced hypocalcemia in neonates [6,7]. Head covering likely limits penetration of phototherapy light through the anterior fontanelle and skull, thereby preserving pineal gland function and melatonin secretion.

The incidence of hypocalcemia in the no-head-cover group was significantly higher compared with the head-cover group. Similar observations have been documented in several previous studies where neonates receiving unrestricted phototherapy exposure demonstrated higher rates of biochemical hypocalcemia [8,9]. The present study therefore reinforces the importance of monitoring serum calcium levels during prolonged phototherapy, especially in neonates with additional risk factors.

Most neonates with hypocalcemia in the current study remained asymptomatic, while only a few developed mild jitteriness. No seizures or severe manifestations of hypocalcemia were observed. Similar findings were reported by Tehrani et al. and Bahbah et al., where most cases of phototherapy-induced hypocalcemia were asymptomatic [10,11]. Although asymptomatic, untreated hypocalcemia may still have physiological consequences and therefore warrants clinical attention.

An important observation in the present study was that head covering did not significantly alter the duration or effectiveness of phototherapy. Mean duration of phototherapy was comparable between both groups, suggesting that covering the scalp does not interfere with bilirubin reduction. Since the scalp constitutes only a limited body surface area, its coverage is unlikely to significantly affect the therapeutic efficacy of phototherapy [12].

The use of head covering offers several practical advantages. It is a simple, inexpensive, safe, and non-invasive intervention that can be easily implemented in neonatal intensive care units without additional infrastructure or cost. This may be particularly useful in resource-limited healthcare settings where routine biochemical monitoring may not always be feasible. Preventing phototherapy-induced hypocalcemia through such a low-cost intervention could improve neonatal safety and reduce metabolic complications associated with phototherapy.

The findings of the present study are clinically relevant because neonatal jaundice requiring phototherapy remains highly prevalent in developing countries. Routine use of head covering during phototherapy may therefore represent an effective preventive strategy for minimizing electrolyte disturbances in neonates.

However, the study had certain limitations. It was conducted at a single center with a relatively limited sample size. Ionized calcium levels were not measured separately, and long-term follow-up of affected neonates was not performed. Larger multicentric studies with standardized protocols are needed to further validate the protective role of head covering during phototherapy and establish universal recommendations.

Overall, the present study demonstrates that phototherapy significantly reduces serum calcium levels in term neonates and that head covering during phototherapy effectively reduces the incidence and severity of hypocalcemia. These findings support the incorporation of head covering as a simple preventive measure during neonatal phototherapy.

Conclusion

Phototherapy is associated with a significant reduction in serum calcium levels among term neonates with hyperbilirubinemia. The decline in calcium levels is more pronounced in neonates undergoing phototherapy without head covering. Covering the head during phototherapy appears to reduce the incidence and severity of hypocalcemia without affecting phototherapy efficacy. Head covering is therefore a simple, safe, inexpensive, and effective preventive intervention that may be incorporated into routine neonatal phototherapy practice.

Limitations

- Relatively small sample size
- Single-center study
- Ionized calcium levels were not assessed
- Long-term neonatal follow-up was not performed

Ethical Approval: The study protocol was approved by the Institutional Ethics Committee of Krishna Institute of Medical Sciences, Karad.

Conflict of Interest: The authors declare no conflict of interest.

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