ejpmr, 2025, 12(6), 278-283

SJIF Impact Factor 7.065

EUROPEAN JOURNAL OF PHARMACEUTICAL AND MEDICAL RESEARCH

www.ejpmr.com

Research Article

ISSN 2394-3211

EJPMR

TO STUDY THE IMPACT OF HEAD COVERING ON THE INCIDENCE OF PHOTOTHERAPY-INDUCED HYPOCALCAEMIA IN TERM NEONATES WITH HYPERBILIRUBINEMIA

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Article Received on 03/04/2025 **Article Revised on 23/04/2025** **Article Accepted on 13/05/2025**

ABSTRACT

Introduction: The use of head covering during phototherapy has been suggested as a way to prevent heat loss and increase the effectiveness of treatment, but its impact on the incidence of phototherapy-induced hypocalcaemia remains unclear. Therefore, this study aims to investigate the effect of head covering on the incidence of phototherapy-induced hypocalcaemia in term neonates with hyperbilirubinemia. **Materials and Methods:** The neonates were randomly assigned into two groups. Study Group: Neonates receiving phototherapy while wearing a cap to cover their heads. Control Group: Neonates receiving phototherapy without any head covering. Serum calcium levels were measured for all neonates at two time points, Before the initiation of phototherapy and Post-Therapy: After 48 hours of phototherapy. The duration of phototherapy was standardized for both groups, ensuring uniform exposure. The randomization of cases minimized selection bias, and the findings aimed to provide evidence on the efficacy of head covering as a preventive measure for phototherapy-induced hypocalcemia. **Results:** The study analysed 160 term neonates with hyperbilirubinemia undergoing phototherapy, divided into two groups: with head covering (study group) and without head covering (control group). The baseline characteristics, including gender, gestational age, birth weight, maternal thyroid status, baby blood group and mode of delivery, were comparable between the groups. However, the baseline serum calcium levels were significantly higher in the study group compared to the control group. After 48 hours of phototherapy, both groups experienced a significant reduction in serum calcium levels, but the reduction was less pronounced in the study group (8.80 ± 1.01 mg/dL) than in the control group (8.13 ± 1.09 mg/dL), with a statistically significant difference ($p < 0.001$). While serum bilirubin levels significantly decreased in both groups, there was no significant difference in the extent of bilirubin reduction between the groups. These results suggest that head covering during phototherapy may help reduce the risk of phototherapy-induced hypocalcemia without affecting bilirubin clearance. **Conclusion:** This study highlights the protective effect of head covering in reducing phototherapy-induced hypocalcemia in term neonates with hyperbilirubinemia. While phototherapy effectively reduces serum bilirubin levels, it poses a risk of hypocalcemia due to melatonin suppression. The findings demonstrate that neonates with head covering experienced significantly smaller reductions in serum calcium levels compared to those without head covering, indicating a potential role in maintaining calcium homeostasis.

KEYWORD:- Calcium, Head covering, Hypocalcaemia, Neonate, Newborn, Phototherapy.

INTRODUCTION

Neonatal hyperbilirubinemia is a common and significant clinical condition observed during the first week of life. It manifests as jaundice due to the accumulation of unconjugated bilirubin, which results from the immature hepatic system's inability to conjugate and eliminate bilirubin efficiently. Nearly 60% of term neonates and 80% of preterm neonates develop clinical jaundice26, with 6.1% of term neonates experiencing serum bilirubin levels exceeding 12.9 mg%. In 3% of normal term neonates, serum bilirubin levels may surpass 15 mg%, often requiring medical intervention.

While physiological jaundice is benign and self-limiting, severe hyperbilirubinemia can lead to complications like bilirubin-induced neurological dysfunction (BIND) and kernicterus, causing long- term neurodevelopmental deficits such as cerebral palsy, hearing loss, and intellectual disabilities. Early detection and management are critical to mitigate these risks.[1]

While phototherapy has dramatically reduced the incidence of kernicterus and the need for invasive procedures like exchange transfusion, it is not without side effects. Common complications include dehydration, diarrhea, temperature instability, and phototherapy- induced hypocalcemia. Hypocalcaemia, defined as a total serum calcium level below 7 mg/dL, is an under- recognized complication of phototherapy. It can present as jitteriness, poor feeding, irritability, seizures, or cardiac arrhythmias, with severe cases potentially leading to life-threatening complications.

The pathophysiology of phototherapy-induced hypocalcemia is linked to the suppression of melatonin secretion by phototherapy light. Melatonin regulates parathyroid hormone (PTH), which is crucial for calcium homeostasis.[2]

Hypocalcaemia management often involves calcium supplementation. However, preventive measures are preferable, especially in low-resource settings. Head covering during phototherapy has emerged as a potential non-invasive intervention. By shielding the pineal gland from direct light exposure, head coverings may preserve melatonin secretion and thus maintain calcium balance. Head coverings represent a simple, cost-effective solution to a clinically significant problem. Preliminary studies suggest that neonates receiving phototherapy with head coverings exhibit higher serum calcium levels than those without. This intervention is particularly valuable in low-resource settings, where advanced monitoring and pharmacological treatments may not be feasible.[3]

The use of head coverings during phototherapy offers a scalable and cost-effective intervention to improve neonatal outcomes globally.

The aim of this prospective study is to investigate the relationship between head covering and the incidence e of phototherapy-induced hypocalcemia in term neonates with hyperbilirubinemia.

MATERIALS AND METHODS

It’s a Open label randomized controlled study, conducted at Radhakrishnan government medical college for 1 year duration. Term neonate (≥ 37weeks gestations age) with hyperbilirubinemia requiring phototherapy were included for the study.

Neonates with congenital anomalies or chromosomal abnormalities, calcium metabolism disorders, receiving medications that affect calcium homeostasis Congenital hypothyroidism, Respiratory distress syndrome or hyaline membrane disease, Clinical sepsis, Hypoxic ischemic encephalopathy, Serum bilirubin in exchange range were excluded from this study were excluded from the study.

The babies were allocated randomly into two groups: one group received phototherapy with head covering, and the other group received phototherapy without head covering. The allocation was done using a computer-generated randomization (block randomization method) sequence, which was kept by an independent researcher who was not involved in the recruitment or treatment of the babies. The babies were assigned to the groups according to the order of their enrolment into the study. Thus, it was a single-blinded randomized controlled study.

The study team explained the randomization process to the parents and obtained their consent before enrolling their babies into the study. The parents were informed that their babies had an equal chance of being assigned to either group and that the head covering was a simple and safe intervention that could potentially reduce the risk of hypocalcemia. The phototherapy devices used for both groups were identical. The nurses administering the phototherapy were not blinded as they needed to put the head covering in place for the intervention group. However, they were not involved in the assessment of hypocalcemia or data analysis.

Information about neonatal characteristics (e.g., gestational age, birth weight, gender), phototherapy protocol (e.g., duration, irradiance, distance from neonate), and calcium levels would be collected prospectively using a standardized data collection form. Additional information about maternal and neonatal factors that may influence the incidence of hypocalcemia (e.g., maternal diabetes, sepsis, respiratory distress) it was recorded.

The phototherapy protocol for this study was standardized and followed the American Academy of Pediatrics (AAP) guidelines for the management of hyperbilirubinemia. In this study, neonates in the intervention group wore a head covering made of cotton fabric that completely covered the head, except for the face, during phototherapy sessions.

The serum calcium levels were measured before starting phototherapy and 48 hours after the start of phototherapy for all neonates enrolled in the study, regardless of group allocation. The serum calcium levels were measured using a standard laboratory assay with a reference range of 7.0-11.0 mg/dL. Neonates with serum calcium levels below the reference range were considered hypocalcemic and were managed according to the protocol.

Statistical analysis

Hypocalcemia incidence and potential risk factors would be compared between the two groups using appropriate statistical tests (e.g., chi-square test, t-test, logistic regression). Subgroup analyses based on gestational age, bilirubin level, and other factors would also be performed

RESULTS

In this study total of 160 babies were enrolled out of which 79(49.4%) were in the study group and 81(50.6%) in control group. There were 89(55.6%) male and

71(44.4%) were female. The gender distribution between the study group (with head cover) and control group (without head cover) was statistically comparable, with 53.1% males and 46.9% females in the study group, and 58.2% males and 41.8% females in the control group.

Both groups had similar gestational ages, with mean values of 38.5 ± 1.07 weeks in the study group and 38.4 ± 1.07 weeks in the control group.

The analysis of birth weight in the overall population demonstrated that male neonates had a higher mean birth weight (3.12 ± 0.3 kg) compared to female neonates (2.58 ± 0.19 kg), with a statistically significant difference indicated by a p-value of 0.029, a comparison between the study groups showed that neonates in the study group (with head cover) had a mean birth weight of 2.92 ± 0.367 kg, while those in the control group (without head cover) had a mean birth weight of 2.82 ± 0.333 kg.

The mean age of onset of hyperbilirubinemia was 43 ± 12.8 weeks in the study group and 44.3± 13.6 weeks in the control group.

In the overall population, the analysis of maternal thyroid status revealed that the majority of mothers were euthyroid, accounting for 95.62% (153 mothers), while 4.38% (7 mothers) were diagnosed with hypothyroidism. Maternal thyroid status was similar across the groups, with 95.1% euthyroid mothers in the study group and 96.2% in the control group.

In the overall population, the majority of deliveries were conducted through Normal Vaginal Delivery (NVD), accounting for 70.62% (113 deliveries), while Lower Segment Caesarean Section (LSCS) was the mode of delivery in 29.38% (47 deliveries). The mode of delivery was comparable between the study groups, with NVD accounting for 66.7% in the study group and 74.7% in the control group, while LSCS accounted for 33.3% and 25.3%, respectively.

In this study, the mean bilirubin levels were analysed based on baby blood groups, both before and after phototherapy. The results revealed that neonates with blood group A had the highest mean bilirubin levels before phototherapy, followed closely by those with blood group AB. After phototherapy, a significant reduction in bilirubin levels was observed across all blood groups, indicating the effectiveness of the treatment.

The mean serum bilirubin before phototherapy was 13.4 ± 1.75 mg/dL in the study group and 13.3 ± 1.41 mg/dL in the control group. After 48 hours of phototherapy, the levels were 11.1± 1.56 mg/dL and 11.2 ± 1.30 mg/dL, respectively. The differences between groups were not statistically significant (p = 0.735 and p = 0.799) And significant within the group (p=<.001). Showed in Table 1 and Figure1.

Table 1: Distribution of study subjects according to the serum bilirubin levels before and after the therapy.

S. Bilirubin Levels	Study group (with head cover)	Control group (without head cover)	p value between
Mean S. Bilirubin Before phototherapy	13.4 ± 1.75	13.3 ± 1.41	0.735
Mean S. Bilirubin After 48 hrs of phototherapy	11.1 ± 1.56	11.2 ± 1.30	0.799
Mean Difference	2.28 ± 1.79	2.14 ± 1.51	0.532
P value within	<.001	<.001	0.63

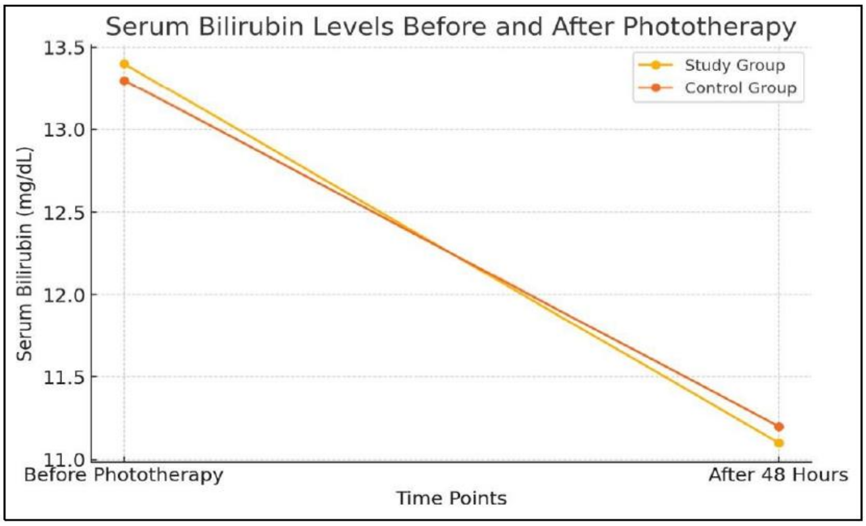

Figure 1: Serum Bilirubin levels Before and After phototherapy.

The mean serum calcium level before phototherapy was 9.17 ± 0.626 mg/dL in the study group and 8.85 ± 0.667 mg/dL in the control group (p < 0.001). After 48 hours of phototherapy, the levels were 8.80 ± 1.01 mg/dL and 8.13 ± 1.09 mg/dL, respectively (p < 0.001). The mean difference in serum calcium levels between groups was statistically significant (p = 0.050). Showed in table 2 and Fig 2.

Table 2: Distribution of study subjects according to the serum calcium levels Before and After the therapy.

S. calcium Levels	Study group (with head cover)	Control group (without head cover)	p value between
Mean S. calcium Before phototherapy	9.17 ± 0.626	8.85 ± 0.667	<.001
Mean S. calcium After 48 hrs of phototherapy	8.80 ± 1.01	8.13 ± 1.09	<.001
Mean Difference	0.372 ± 0.928	0.720 ± 1.10	0.050
P value within	<.001	<.001	0.63

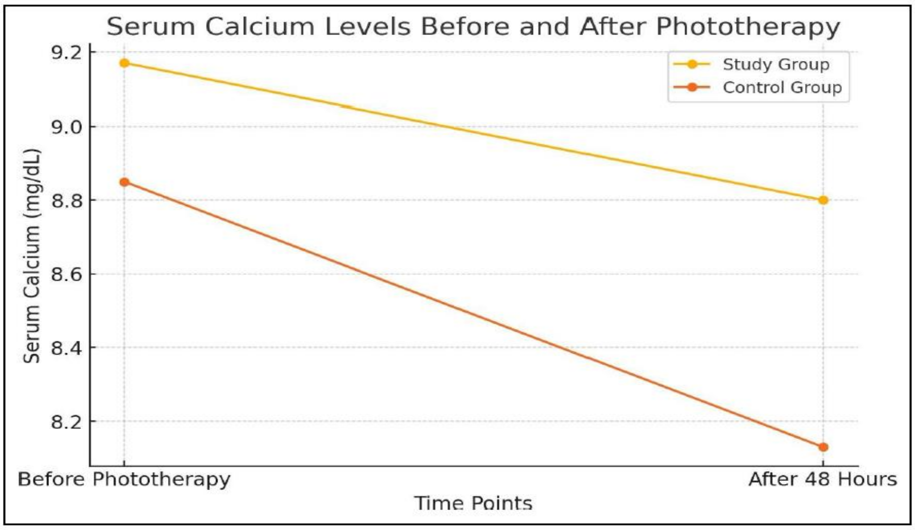

Figure 2: Serum calcium level Before and After phototherapy.

DISCUSSION

In this study, the gender distribution between the study group (53.1% males, 46.9% females) and the control group (58.2% males, 41.8% females) was statistically comparable (p = 0.5128), eliminating gender-related bias. Similar findings were reported by Zahraa Ezzeldin et al. (2015), where gender distribution was 51% males and 49% females in the study group and 50% males and 50% females in the control group, with no significant impact on hypocalcemia outcomes (p = 0.640).[4] Ayesha Bibi et al. (2020) also observed balanced gender distribution (study group: 52.5% males, 47.5% females; control group: 54% males, 46% females; p = 0.589), reinforcing that gender does not act as a confounding factor in evaluating the effects of phototherapy-induced hypocalcemia.[5] These results collectively suggest that gender does not influence the outcomes of interventions like head covering during phototherapy.

The mean gestational age in the study group (38.5 ± 1.07 weeks) and the control group (38.4± 1.07 weeks) in this study showed no significant difference (p = 0.385), ensuring uniform neonatal maturity levels. Zahraa Ezzeldin et al. (2015) reported a similar result, with mean gestational ages of 38.3 ± 1.2 weeks in the study group and 38.4 ± 1.1 weeks in the control group (p = 0.400).[4] Karamifar et al. (2002) further validated this uniformity with a mean gestational age of 38.6 ± 1.1 weeks in the study group and 38.5 ± 1.2 weeks in the control group (p = 0.390).[6] These comparable results across studies confirm that differences in maturity levels do not influence the effectiveness of head coverings in reducing phototherapy- induced hypocalcemia.

In this study, serum bilirubin levels before and after phototherapy were comparable between the study group (13.4 ± 1.75 mg/dL and 11.1 ± 1.56 mg/dL, respectively) and the control group (13.3 ± 1.41 mg/dL and 11.2 ± 1.30 mg/dL, respectively), confirming no significant impact of head coverings on bilirubin clearance. These findings align with Sharma et al. (2018), who observed pre- and post-phototherapy bilirubin levels of 13.5 ± 1.8 mg/dL and11.0 ± 1.7 mg/dL in the study group and 13.4 ± 1.7 mg/dL and 11.1 ± 1.6 mg/dL in the control group[7], respectively. Similarly, Karamifar et al. (2002) reported consistent bilirubin reductions (study group: 13.6 ± 1.9 mg/dL to 11.2 ± 1.5 mg/dL; control group: 13.5 ± 1.8 mg/dL to 11.3 ± 1.4 mg/dL),[6] reinforcing that head coverings do not interfere with the efficacy of phototherapy.

Table 9: Serum Bilirubin Levels comparison with others studies.

Study	Year	Before Phototherapy (Study)	After Phototherapy (Study)	Before Phototherapy (Control)	After Phototherapy (Control)	Significance
Current Study	2025	13.4 ± 1.75	11.1 ± 1.56	13.3 ± 1.41	11.2 ± 1.30	Confirms head covering Does not affect Bilirubin clearance.
Sharma et Al.[7]	2018	13.5 ± 1.8	11.0 ± 1.7	13.4 ± 1.7	11.1 ± 1.6	Phototherapy Is effective Regardless of head covering.
Karamifar et al.[6]	2002	13.6 ± 1.9	11.2 ± 1.5	13.5 ± 1.8	11.3 ± 1.4	Validates efficacy in Bilirubin reduction.

This study highlighted the significant protective role of head coverings during phototherapy in reducing the incidence of phototherapy-induced hypocalcemia. Before phototherapy, serum calcium levels in the study group (9.17 ± 0.626 mg/dL) were significantly higher than in the control group (8.85 ± 0.667 mg/dL, $p < 0.001$). After phototherapy, the reduction in calcium levels was markedly lower in the study group (0.372 ± 0.928 mg/dL) compared to the control group (0.720 ± 1.10 mg/dL, $p = 0.050$). These findings suggest that head coverings effectively mitigate hypocalcemia, potentially by preserving melatonin levels, which are known to play a role in calcium homeostasis. This aligns with the results of Karamifar et al. (2002)[6], who reported a significantly smaller mean reduction in serum calcium levels in neonates with head coverings (0.23 ± 0.19 mg/dL) compared to those without (0.73 ± 0.33 mg/dL, $p < 0.05$), further validating the effectiveness of this intervention.

Similarly, Zahraa Ezzeldin et al. (2015)[4] observed a significant reduction in the incidence of hypocalcemia in neonates with head coverings, with post-phototherapy serum calcium levels of 8.6 ± 0.4 mg/dL in the study group compared to 8.3 ± 0.5 mg/dL in the control group ($p = 0.043$). This reinforces the evidence that head coverings can minimize calcium loss during phototherapy. Ayesha Bibi et al. (2020)[5] also demonstrated a trend supporting the protective effect of head coverings, with a smaller reduction in calcium levels in the study group (9.1 ± 0.7 mg/dL to 8.7 ± 0.6 mg/dL) compared to the control group (9.0 ± 0.6 mg/dL to 8.2 ± 0.5 mg/dL), though the statistical significance was marginal ($p = 0.052$).

The findings from this study, along with the results of these prior studies, collectively emphasize the value of head coverings as a low-cost, simple, and effective intervention to reduce phototherapy- induced hypocalcemia without compromising the efficacy of phototherapy in bilirubin clearance. These studies also underscore the consistent protective effect across different study populations, further validating the role of head coverings in neonatal care settings. By mitigating the metabolic disturbances associated with phototherapy, head coverings offer a practical solution to improving the safety and outcomes of this common treatment for neonatal hyperbilirubinemia.

Table 12: serum calcium level Before and After phototherapy comparison with other studies.

Study	Year	Before Phototherapy (Study)	After Phototherapy (Study)	Before Phototherapy (Control)	After Phototherapy (Control)	p- value	Significance
Current Study	2025	9.17 ± 0.626	8.80 ± 1.01	8.85 ± 0.667	8.13 ± 1.09	< 0.001	Head covering mitigates hypocalcemia.
Zahraa Ezzeldin et al.[4]	2015	9.2 ± 0.5	8.6 ± 0.4	9.1 ± 0.6	8.3 ± 0.5	0.043	Confirms head covering reduces calcium loss.
Ayesha Bibi et al.[5]	2020	9.1 ± 0.7	8.7 ± 0.6	9.0 ± 0.6	8.2 ± 0.5	0.052	Trend supports reduced hypocalcemia incidence.
Karamifar et al.[6]	2002	9.53 ± 0.92	9.30 ± 1.11	9.45 ± 0.95	8.90 ± 1.10	< 0.05	Validates protective role of head covering.

Limitations

The baseline serum calcium levels were higher in the study group compared to the control group, which may have influenced the results. This could introduce a potential bias in comparing post-phototherapy calcium reduction. The study was conducted exclusively on term neonates, limiting the applicability of findings to preterm neonates who may have different responses to phototherapy.

CONCLUSION

This study demonstrates the significant impact of head covering on reducing the incidence of phototherapy-induced hypocalcemia in term neonates with hyperbilirubinemia. Phototherapy, while effective in reducing serum bilirubin levels, is associated with a well-documented risk of hypocalcemia due to the suppression of melatonin secretion. By shielding the neonates' pineal gland from light exposure, head covering mitigates this effect, preserving calcium homeostasis. The findings showed that neonates in the study group (with head covering) experienced significantly smaller reductions in serum calcium levels compared to the control group (without head covering). This protective effect highlights the potential of head covering as an easy-to- implement, non-invasive intervention to enhance the safety of phototherapy in neonates, particularly in reducing the risk of metabolic disturbances such as hypocalcemia.

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