EFFECTS OF PHOTOTHERAPY ON SERUM CALCIUM LEVEL IN NEONATES WITH HYPERBILIRUBINEMIA

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ABSTRACT

Background: Jaundice, a yellowing of the skin caused by high bilirubin levels, is very common in newborns. It is the most frequent issue doctors find in babies, affecting more than two out of three within their first week. In most newborns, hyperbilirubinemia is a normal, though sometimes exaggerated, physiological process [1]. Neonatal jaundice is a significant contributor to morbidity and the primary cause for hospitalization within the initial week of life

Objective: To determine the effect of phototherapy on serum calcium level in neonates with hyperbilirubinemia.

Methods: It is descriptive study and was conducted at department of pediatrics, PAF Mushaf hospital from 14 March 2025 to 14 September 2025. Ninety-six neonates who met the selection criteria were enrolled upon providing informed consent; their demographic details were then recorded. Baseline serum calcium levels were measured prior to initiating phototherapy, which was administered for 48 hours. During treatment, all neonates received oral feeding supplemented with 20% intravenous fluids to compensate for phototherapy-related losses. A post-phototherapy assessment of serum calcium levels was conducted at the 48-hour mark, and all resultant data were captured using a pre-designed proforma.

Results: Of the 96 neonates, 61.5% (n=59) were male and 38.5% (n=37) were female. Mean serum calcium declined significantly from a pre-treatment level of 9.25 ± 0.29 mg/dl to 7.32 ± 0.22 mg/dl after 48 hours (mean decrease: 1.93 ± 0.36 mg/dl, $p<0.001$).

Conclusion: The study found phototherapy to be significantly associated with reduced serum calcium levels in hyperbilirubinemic neonates, noting a significant decline from baseline specifically after the 48-hour.

Keywords: Hyperbilirubinemia, Phototherapy, Serum Calcium Level

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INTRODUCTION

Jaundice, a yellowing of the skin caused by high bilirubin levels, is very common in newborns. It is the most frequent issue doctors find in babies, affecting more than two out of three within their first week. In most newborns, hyperbilirubinemia is a normal, though sometimes exaggerated, physiological process [1]. Neonatal jaundice is a significant contributor to morbidity and the primary cause for hospitalization within the initial week of life [2].

The global occurrence of severe neonatal jaundice changes region to region in which 3.34% in Africa to 2.58% in South-East Asian regions [3]. The incidence of

jaundice within the 1st week of life is estimated at 60% in term neonates and rises to 80% in those born preterm [4]. In the majority of cases, it is a benign, physiological state that resolves spontaneously without intervention [5, 6]. Even though it is a transient condition, it accounts for up to three-quarters of all hospital admissions during the first postnatal week. Among these cases, phototherapy is mandatory for the 5-10% with clinically significant hyperbilirubinemia [6, 7].

If left untreated, unconjugated hyperbilirubinemia can lead to neurotoxicity [8]. Phototherapy is the first-line and most frequently used for hyperbilirubinemia [9]. Phototherapy disrupts key components of the neonatal oxidant/antioxidant defense system, potentially inducing severe oxidative stress [10]. Phototherapy is a safe, effective, and easy-to-use treatment that uses a special blue light to break down the bilirubin that causes jaundice [6].

Despite its overall safety the adverse effects like dehydration, hyperthermia, skin rashes, diarrhea, retinal damage, bronze baby syndrome, hypocalcemia, and genital toxicity can be occurred due to phototherapy [8]. Several proposed mechanisms explain the phototherapy effects on calcium metabolism, including the reduction of melatonin levels and inhibition of corticosterone secretion [11]. In our population, current clinical practice often omits the routine measurement of serum calcium following phototherapy for neonatal indirect hyperbilirubinemia, creating a notable deficiency in patient data. To address this, we conducted the present study to determine the effect of phototherapy on calcium homeostasis. The study's outcomes underscore the significance of early hypocalcemia diagnosis and intervention to mitigate the risk of subsequent complications. So, the objective of this study was "to determine the effect of phototherapy on serum calcium level in neonates with hyperbilirubinemia".

METHODS

This was descriptive study which was carried out at pediatric department, PAF Hospital Mushaf, Sargodha from 14 March to 14 September 2025 In our study, hyperbilirubinemia was defined as a bilirubin concentration exceeding 5 mg/dl in the circulating blood. In this study the infants having gestational age >36 weeks were labeled as term infants. Serum calcium levels (mg/dl) were measured in infants before at baseline and 48 hours after the phototherapy. Mean change was determined by the following formula.

Mean Change in serum Ca^{+} levels =

$$SCL_{\text{before phototherapy}} - SCL_{\text{after phototherapy}}$$

The calculated sample size was 96 with 95% CI and 5% margin of error while taking expected mean serum Ca^{+} level in the infants to be 9.85 ± 0.64 mg/dl[12] at baseline and 48 hours after phototherapy to be 9.51 ± 0.54 mg/dl[12] in infants with hyperbilirubinemia. The term infants of both gender from birth to twenty eight days of life and infants having weight >2500 g having indication of phototherapy and had hospitalized status due to hyperbilirubinemia were fall in inclusion criteria. Infants with respiratory rate >60/minutes, Coombs test positivity and those who had received exchange transfusion (as per clinical record), infants who left against medical advice or expired during data collection procedure and Infants of mothers with DM, neonates undergoing phenobarbital therapy, as well as those born to mothers who were administered magnesium sulfate or oxytocin prior to delivery, were excluded from the study. All the patients were enrolled in this study by applying non-probability consecutive sampling technique. After taking approval from the hospital's ethical committee, 96 term infants who were in NICU included in the study. Before phototherapy began, calcium levels were checked. The infants received 48 hours of light treatment. During this time, they were fed orally and also given extra IV fluids (20% more than usual) to prevent dehydration from the therapy. Following 48 hours of phototherapy, serum calcium levels were re-assessed. The samples were analyzed by the hospital laboratory, and the results were interpreted by a pathologist. Data were collected using a structured proforma and statistically analyzed. To minimize bias, all phototherapy sessions were administered by a single resident under supervision, and all serum calcium levels were assayed at a single laboratory (the hospital's patient care lab). The collected data were entered and analyzed in SPSS V23. Quantitative variables, such as gestational age, weight, and serum calcium levels (both baseline and 48-hour), are reported as mean ± SD. Descriptive statistics for categorical variables are presented as frequencies and percentages. To analyze the difference in mean changes between independent groups t-test was applied. *P*-value≤0.05 was taken as significant .

RESULTS

This study enrolled 96 neonates from the NICU with a mean gestational age of 39.09 ± 1.39 weeks. The study population of 96 neonates (59 male, 37 female) had a mean birth weight of 3.09 kg. According to this study the mean serum bilirubin level of the patients was 7.79±1.12 mg/dl. A pronounced decrease in serum calcium was observed post-phototherapy, falling from 9.25 ± 0.29 mg/dl before treatment to 7.32 ± 0.22 mg/dl after 48 hours. The mean decrease in serum calcium levels from baseline to post-phototherapy was 1.93 ± 0.36 mg/dl. **Table 1**

Table 1: Descriptive statistics of gender, gestational age, neonatal weight and serum calcium level before and after phototherapy of the patients

	Frequency	Percent
Gender		
Male	59	61.5
Female	37	38.5
Gestational age (weeks)	39.09±1.39	
Weight (kg)	3.09±0.31	
Serum Bilirubin level (mg/dl)	7.79±1.12	
Serum Calcium level before phototherapy (mg/dl)	9.25±0.29	
Serum Calcium level after phototherapy (mg/dl)	7.32±0.22	
Change in serum calcium level (mg/dl)	1.93±0.36	

The mean serum Ca^{+} level demonstrated a statistically significant reduction of 1.93 mg/dl after 48 hours of phototherapy, falling from 9.25 ± 0.29 mg/dl to 7.32 ± 0.22 mg/dl ($p < 0.0001$). **Table 2**

Among neonates with a gestational age of 37–39 weeks, the mean change in serum Ca^{+} level was 1.92 ± 0.32 mg/dl, while in those with a gestational age >39 weeks it was 1.95 ± 0.40 mg/dl ($p = 0.629$). In male neonates, the mean change was 1.94 ± 0.37 mg/dl compared to 1.93 ± 0.34 mg/dl in females ($p = 0.897$). Similarly, in neonates weighing ≤3 kg, the mean change was 1.89 ± 0.32 mg/dl, whereas in those weighing >3 kg it was 1.96 ± 0.38 mg/dl ($p = 0.296$). **Table 3**

Table 2: Comparison of serum calcium level before and after phototherapy of the patients

Calcium Level	n	Mean	Std. Deviation	Paired t-test	p-value
Before Phototherapy (mg/dl)	96	9.25	0.29	53.04	<0.001
After Phototherapy (mg/dl)	96	7.32	0.22		

Table 3: Comparison of change in serum calcium level before and after phototherapy between gestational age, gender and weight of the patients

	Change in Ca+ level	n	Mean	Std. Deviation	t-test	p-value
Gestational Age	37-39	54	1.92	0.32	-0.485	0.629
	>39	42	1.95	0.40		
Gender	Male	59	1.94	0.37	0.130	0.897
	Female	37	1.93	0.34		
Weight (Kg)	≤3	44	1.89	0.32	-1.05	0.296
	>3	52	1.96	0.38		

DISCUSSION

Despite its therapeutic benefits, phototherapy is associated with several potential adverse effects, notably hypocalcemia, hypomagnesemia, ocular injury, rashes, dehydration, and elevated body temperature [12]. The use of phototherapy for neonatal hyperbilirubinemia can influence serum calcium levels [13].

The results demonstrate a significant reduction in serum calcium levels post-phototherapy. The mean pre-treatment level was 9.25 ± 0.29 mg/dl, which declined to 7.32 ± 0.22 mg/dl after 48 hours, representing a statistically significant mean decrease of 1.93 ± 0.36 mg/dl ($p<0.001$). This outcome is consistent with a number of existing studies, though it conflicts with findings from others.

In one study on pre-treatment of phototherapy the mean serum Ca^{+} level of neonates was 9.11±0.50 mg/dl and post-phototherapy (after 48 hours) the mean serum calcium level of the neonates was 8.39±0.54 mg/dl (p-value=<0.001) [14]. Another study resulted that at hospitalization time the mean serum calcium level of the infants was 9.85 ± 0.64 and at 48 hours after phototherapy the mean calcium level of infants was 9.51 ± 0.54 (p-value=<0.0001). Similarly total bilirubin level of infants was [at time of hospitalization= 15.19± 2.29 versus after 48 hours= 8.53± 1.6] (p-value<0.05)[12]. A local study found a statistically significant decrease in mean serum calcium levels following phototherapy, from 9.28 ± 0.23 mg/dl to 8.54 ± 0.68 mg/dl. Consequently, the incidence of hypocalcemia in neonates reached 40% after treatment of 24 hours [11].

A study by Ghanwa Pervaiz et al concluded that the incidence of hypocalcemia was observed in 31 term neonates (23.1%) undergoing phototherapy for indirect hyperbilirubinemia. While phototherapy is effective in lowering levels of serum bilirubin, it is also linked with a reduction in serum Ca^{+} level in neonates[13]. Hina Sohail et al. also investigated the effect of phototherapy, reporting a significant decrease in serum calcium levels following treatment. The mean serum Ca^{+} level fell from 9.59 ± 0.52 mg/dl pre-therapy to 9.07 ± 0.44 mg/dl

post-therapy (p=0.0001) after a mean phototherapy duration of 3.17 ± 0.55 hours. A reduction in calcium levels was observed; however, it was insufficient to cause hypocalcemia in any neonate. Furthermore, the post-therapy calcium levels showed no significant correlation with the infants' gestational age (p=0.174), gender (p=0.269), or chronological age (p=0.134) [15].

According to Salman Javaid et al., phototherapy is significantly associated with hypocalcemia in newborns. Their study showed that 41.58% of neonates developed hypocalcemia after treatment, with significant drop in level of calcium (p<0.005). Since seizures were observed in 3.96% of the cases, the researchers advise checking serum calcium levels in babies undergoing phototherapy [16].

A decline in Ca^{+} levels after phototherapy was common finding by the studies both Reddy et al. and Elky et al [17, 18]. The study by Lidia et al. documented a statistically significant reduction in blood calcium levels, yet no instances of hypocalcemia occurred [19]. Conversely, a second study found clinically significant electrolyte imbalances, notably low calcium levels [20]. Pereira and colleagues identified a reduction in total serum calcium levels among a considerable number of neonates. Nonetheless, the incidence of hypocalcemia was comparatively lower than prior studies, indicating it is not a prevalent outcome in their population [21].

As our study findings differ from some previously published research, it is recommended that future studies be conducted with larger sample sizes and data collected from multicenter settings to reduce potential bias. One limitation of the present study was its small sample size, primarily due to time and financial constraints, which restricts the result generalizability to the population.

CONCLUSION

The study found phototherapy to be significantly associated with reduced serum calcium levels in hyper-bilirubin-emic neonates, noting a significant decline from baseline specifically after the 48-hour.

ETHICAL APPROVAL

Ethical approval of article was granted by the Hospital Ethical Committee of the PAF Hospital, Mushaf, Sargodha vide reference No MSF(H)/308/3/1/Trg, dated December, 2024.

CONFLICT OF INTEREST

Authors declare no conflict of interest.

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AUTHOR'S CONTRIBUTIONS

MBI, HBS: Conceived idea, study design, manuscript writing, data analysis
BB: Data analysis, proof reading, critical review
MWI: Manuscript writing, proof reading
MRG: Manuscript writing, critical review
MH: Data collection, data interpretation
All Authors: Approval of the final version of the manuscript to be published

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