An observational study: Correlation of serum calcium levels in relation to phototherapy in term newborns

Lovish Gupta[1], Sanjay Mandot[2], Dileep Goyal[3]

From [1]Resident, [2]Professor, [3]Assistant Professor, Department of Pediatrics, Geetanjali Medical College and Hospital, Udaipur, Rajasthan, India

Correspondence to: Dr. Sanjay Mandot, A 13, Saheli Nagar, Udaipur - 313 001, Rajasthan, India. E-mail: drmandot@yahoo.com

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ABSTRACT

Background: Hyperbilirubinemia is one of the most prevalent problems in neonates. Jaundice is observed during the 1st week of life in approximately 60% of term neonates and 80% of preterm neonates. Phototherapy is one of the routine methods for the management of hyperbilirubinemia. **Objective:** The objective of this study was to assess the effect of phototherapy on serum calcium levels in term newborns with neonatal hyperbilirubinemia. **Materials and Methods:** Full-term newborns admitted in the postnatal ward with hyperbilirubinemia were included in the study population. Serum calcium estimation was done before phototherapy and all newborns were subjected to double surface phototherapy. After 24–48 h of phototherapy, serum calcium was estimated again and compared with the earlier value. **Results:** A total of 50 newborns were included in the study. After phototherapy, serum calcium levels were 7.31–7.60 mg/dl in 20 newborns, 7.61–7.90 mg/dl in 19 newborns, 7.0–7.30 mg/dl in 7 newborns, and 7.91–8.20 mg/dl in 4 newborns. This reduction in calcium level was found to be statistically significant ($p<0.05$). None of them were symptomatic. **Conclusion:** This implies that decrease in calcium levels is one of the major complications of phototherapy. It was also identified in the study that the babies given phototherapy for longer duration showed higher chances of hypocalcemia.

Key words: *Phototherapy, Serum calcium, Term newborns*

Neonatal jaundice refers to the yellow discoloration of the skin and the sclera of newborn babies that result from the accumulation of bilirubin in the skin and mucous membranes. This is associated with a raised level of bilirubin in the circulation, known as hyperbilirubinemia. Jaundice is one of the most common conditions requiring medical attention in newborn babies. Approximately 60% of term and 80% of preterm babies develop jaundice in the 1st week of life, and about 10% of breastfed babies are still jaundiced at 1 month of age. In most of the babies, there is no underlying disease, and this early jaundice (termed as physiological jaundice) is generally harmless. However, pathological jaundice may coexist with physiological jaundice. Around 50–60% of all newborns are reported to be jaundiced in the 1st week of life. The total serum bilirubin peaks at 3–5 days and the mean peak total serum bilirubin is 6 mg/dl [1]. When severe jaundice goes untreated for too long, it can lead to kernicterus, where a deposition of bilirubin in basal ganglia leads to athetoid cerebral palsy and hearing loss [2].

Phototherapy is a safe and non-invasive technique which caters a key role in the treatment and prevention of hyperbilirubinemia in neonates [3]. There are variable types of phototherapy methods, namely, single, double, light-emitting diode, and blanket. The common side effects reported are overheating, tanning, low calcium, damage to DNA, loose stools, rashes, retinal injury, bronze baby syndrome, etc. [4]. Neonatal hypocalcemia, seen in newborns undergoing phototherapy, is defined as total serum calcium concentration of <8 mg/dl or ionized calcium concentration of <4.4 mg/dl (<1.10 mmol/l) [5]. Hypocalcemia increases cellular permeability to sodium ions, increases cell membrane excitability, and can cause complications such as convulsions, apnea, stridor, irritability, and jitteriness.

Hypocalcemia in phototherapy is due to the inhibition of pineal gland through transcranial illumination, resulting in a decline in melatonin secretion that further inhibits the effect of cortisol on bone calcium. Cortisol has direct hypercalcemic effect by decreasing the bone uptake of calcium [6]. This study was undertaken to evaluate the incidence and factors responsible for hypocalcemia in newborns on treatment with phototherapy.

MATERIALS AND METHODS

This was an observational study on 50 term newborns. The study was carried out at a tertiary care center in Rajasthan, India, for 1 year (January 1–December 31) after obtaining permission from the Institutional Ethical Committee. All full-term newborns in the postnatal ward with hyperbilirubinemia undergoing double surface phototherapy for the duration of at least 24–48 h were included in the study. Infants with sepsis, with jaundice lasting more than 14 days, with serum calcium <7 mg/dl, small for gestational age and preterm babies, with direct hyperbilirubinemia, and

Table 1: Serum calcium level in relation to the duration of phototherapy

Duration of phototherapy	Serum calcium levels after phototherapy (mg/dl)					p value
	7.0–7.30	7.31–7.60	7.61–7.90	7.91–8.20	Total	
<24 h	0	2	5	3	10	<0.05
24–48 h	2	18	14	1	35	
>48 h	5	0	0	0	5	
Total	7	20	19	4	50	

newborns of diabetic mothers or of mothers having a history of taking anticonvulsants were excluded from the study.

All babies fulfilling the inclusion criteria were enrolled in the study. Informed consent was taken from the parents/guardians. A complete history was recorded and physical examination was done. Birth weight and age in hours at the time of diagnosis of hyperbilirubinemia were noted. While taking blood for routine investigations, serum calcium estimation was done before phototherapy. All newborns were subjected to double surface phototherapy using blue light 420–470 nm (Phoenix Medical Systems). The babies were monitored for any symptoms of hypocalcemia during phototherapy. After phototherapy, along with serum bilirubin, serum calcium was also estimated and compared with the earlier value to find out any significant difference.

Sample size:

$$n = \frac{(Z_{\alpha})^2 * P(1-P)}{E^2} = 50$$

The sample size of 50 patients was considered, confidence level of 95%, allowable error of 10%, and non-responsive state of 15%. Data were analyzed using computer software, Statistical Package for the Social Sciences. Data were expressed in frequency and percentage as well as mean and standard deviation (SD). To elucidate the associations and comparisons between different parameters, the Chi-square test was used. Paired Student's t-test was used to compare mean values. $p<0.05$ was considered statistically significant. Continuous variable age, serum bilirubin level, and serum calcium level were expressed as mean±SD. A categorical variable was expressed in percentage.

RESULTS

In our study, the number of males was more than females and the mean birth weight was 2.738±0.22 kg. The main cause of jaundice in the patients under study was exaggerated physiological (n=39) followed by ABO incompatibility (n=8) with p=0.409. The mean total serum bilirubin before phototherapy was 17.27±1.21 mg/dl and after phototherapy was 9.24±0.94 mg/dl ($p<0.05$). The mean serum calcium before phototherapy was 8.80±0.61 mg/dl and after phototherapy was 7.59±0.25 mg/dl ($p<0.05$). The maximum patients had serum calcium level in the range of 7.31–7.60 mg/ dl (Table 1). Calcium level declined more in babies receiving phototherapy for >48 h.

DISCUSSION

Neonatal jaundice is a frequent cause of morbidity in newborns worldwide and the most frequent cause of hospitalization and readmission in the initial week of life [7]. Recent global surveys curtail that every year, roughly 1.1 million babies develop severe neonatal jaundice and the vast majority resides in South Asia [8]. Phototherapy is an appropriate and safe measure to reduce jaundice in a newborn. Romagnoli *et al*. were the first to suggest the association of hypocalcemia in newborns following phototherapy [9].

In the present study, the number of males was more than females. It is in accordance with the studies by Ezzeldin *et al*. and Bahbah *et al*. [10,11]. The mean birth weight in our study was 2.738±0.22 kg. However, Ezzeldin *et al.* observed the mean birth weight of 3.188±0.336 kg in his study which was more than the present study [10]. In India, the average birth weight of newborn babies is 2.8–3 kg, which explains the lower mean weight observed in our study [12]. As per the present study, the maximum number of babies presented at 3rd day of life with jaundice. Singh *et al.* also observed similar results in 2017 [13]. This could be contributed to the excessive breakdown of red blood cells and limited capacity of the liver to conjugate excess of bilirubin.

In our study, the mean serum bilirubin before phototherapy was 17.28±1.21 mg/dl, which was more than that observed by Bahbah *et al.* and the level after phototherapy was 9.24±0.94 mg/dl which was less than that reported by Bahbah *et al.* [11]. However, both the studies showed a decrease in the mean serum bilirubin after phototherapy.

As per the present study, the mean serum calcium before phototherapy was 8.87±0.61 mg/dl, which was comparable with the studies of Singh *et al.* and Karamifar *et al*. [13,14]. However, the level after phototherapy was 7.59±0.25 mg/dl, which was lower than that observed by Karamifar *et al.* [14]. Thus, this study also showed a decrease in the mean serum calcium level after phototherapy. None of the babies suffered from tetany or seizures. The study had a few limitations. The sample size was small and it was not a case–control study.

CONCLUSION

The level of mean serum calcium showed a significant decline after phototherapy ($p<0.05$). This implies that hypocalcemia is one of the major complications of phototherapy. The frequency of hypocalcemia increased with increased duration of phototherapy. Further, trials with a larger sample size are required.

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