

Original Research Article

Electrolyte changes in the neonates receiving phototherapy

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Received: 04 June 2020

Accepted: 30 June 2020

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ABSTRACT

Background: Neonatal jaundice is the most commonly observed clinical condition of early neonatal period. It remains a common cause of readmission and important cause of concern for the parents and clinicians. Therefore, appropriate management of neonatal hyperbilirubinemia is of paramount importance. Phototherapy plays a significant role in its management but this modality is not devoid of complications. Authors studied electrolyte changes in the neonates, who received phototherapy.

Methods: This perspective hospital based observational study conducted over the period of one year on 90 eligible admitted neonates who received phototherapy as per AAP guideline. Serum bilirubin, sodium, potassium and calcium were determined before and after termination of phototherapy. The first samples were considered as controls and compared with the samples collected after termination of phototherapy.

Results: The incidence of LBW babies in this study was 21.9%, while mean birth weight and gestational age was 2.76 ± 0.38 kg and 38.34 ± 0.88 weeks respectively. Mean duration of phototherapy was 38.48 ± 0.934 hours. The mean sodium, potassium and calcium level before therapy were 146.6 ± 6.2 mg/dl, 4.7 ± 0.47 mg/dl and 9.4 ± 0.73 mg/dl respectively. Authors found statistically significant changes in the electrolyte's levels (Na^+ 141.3 ± 6.1 , K^+ 4.2 ± 0.51 and Ca^{+2} 8.4 ± 0.68 respectively), after phototherapy however none of any neonate shown any clinical signs of dyselectrolytemia.

Conclusions: Neonates undergoing phototherapy are at greater risk of dyselectrolytemia especially in preterm babies therefore close clinical and biochemical monitoring is required for the prompt management of any significant electrolyte imbalance.

Keywords: Neonatal hyperbilirubinemia, Phototherapy, Potassium, Sodium and calcium

INTRODUCTION

Neonatal hyperbilirubinemia is a common clinical problem encountered during the neonatal period. High serum bilirubin levels can be toxic for central nervous system development and may cause behavioral and neurological impairment (Kernicterus) even in term newborns.¹ Pathological jaundice may also lead to deafness, cerebral palsy and/or mental retardation.² Several risk factors have been identified for the occurrence of exaggerated or severe unconjugated hyperbilirubinemia out of which low birth weight and

preterm birth are the major risk factors for exaggerated jaundice warranting intervention.³

The treatment options for jaundice include phototherapy further subdivided to conventional, intensive and exchange transfusion, and pharmacological treatment subdivided to phenobarbitone, intravenous immunoglobulins (IVIG), metallo-porphyrins and follow-up remedies.⁴ Phototherapy is one of the most effective way available in preventing the neurotoxic complications of indirect hyperbilirubinemia.⁵ It leads to changes in the structure of bilirubin, and the resulting isomers,

lumirubin which is radially excreted in bile and urine.⁶ Phototherapy is safe, but is only used when needed (usually for two to three days after which the baby's liver takes over). The commonly known side effects of phototherapy are loose stools, hyperthermia, dehydration fluid loss, skin burn, photo retinitis, low platelet count, increased red cell osmotic fragility, bronze baby syndrome, riboflavin deficiency and DNA damage. A lesser known side effect, but potential complication of phototherapy is electrolyte imbalance specially hypocalcaemia.⁷ Therefore authors intended to study the what electrolyte changes occurs due to phototherapy, and to find out whether there is any significant change occurs in neonate's serum sodium, potassium and calcium level after receiving phototherapy. Authors also will study the prevalence of hypocalcemia in neonates receiving phototherapy admitted in tertiary centre of western Rajasthan, India.

METHODS

This is a prospective hospital based observational study conducted in the department of paediatrics, attached to Dr. S. N. Medical College, Jodhpur, with due permission from the institutional ethical committee and after taking written informed consent from neonates' parents. The sample size of 90 was determined by power analysis. The study period was from January 2019 to December 2019.

Inclusion criteria

- All the neonates delivered intramurally or extramurally delivered and referred here with hyperbilirubinemia not associated with any co morbidity which received phototherapy for at least 24 hours were included in the study. The age, sex, gender, the gestational age, the day and hours of life presentation of hyperbilirubinemia were also included in the study.

Exclusion criteria

- History suggestive of birth asphyxia
- Neonatal septicemia
- Respiratory distress syndrome
- Major or life-threatening congenital malformations
- Icterus in the range requiring exchange transfusion
- Mother taken phenobarbitone during antenatal period
- History of hyperthyroidism in mother
- Diabetic mother, and
- Prolonged difficult labour.

All enrolled neonates were subjected for the test of serum level of sodium potassium and calcium at the time of admission along with serum bilirubin levels at the start of phototherapy and at the intervals of 24 hours, 48 hours or at the discontinuation of phototherapy whichever earlier.

Informed and written consent were obtained from the parents of all enrolled neonates blood samples of neonate

withdraw for regular biochemical examination were used for analysis of electrolytes before phototherapy

Venous blood samples were collected from the neonates during the course of phototherapy and sent for total bilirubin, direct bilirubin, electrolytes, and blood group. Total direct bilirubin is measured by Diazo method: electrolytes (Na, K,) by auto analyser Erba EM 200 machine and calcium by Arsenazo method. Blood group of new-borns was analysed by antisera method.

Electrolytes were checked at 0 hour (first sample) at the start of phototherapy and at after 24 hours, 48 hours and at the discontinuation of phototherapy (second sample). The first sample were considered as control. Comparative study was made between these two samples groups to determine the changes in electrolytes.

RESULTS

The mean sodium, potassium and calcium level before therapy were 146.6 ± 6.2 , 4.7 ± 0.47 , and 9.4 ± 0.73 respectively. After phototherapy the mean sodium, potassium and calcium level were 141.3 ± 6.1 , 4.2 ± 0.51 and 8.4 ± 0.68 respectively. There was significant difference in sodium level before and after phototherapy with p -value= 0.003. But, in level of Potassium there was no significant difference ($p=0.21$) due to phototherapy before and after. Before phototherapy none of baby had hyponatremia while after phototherapy 6.7% cases had hyponatremia. Similarly, hypocalcaemic was present in 2.2% cases before phototherapy and after phototherapy 23.3% cases had hypocalcaemic which was found significant statistically. However, serum potassium was almost normal before and after phototherapy. Sodium and calcium were found statistically significant with p -value=0.03 and <0.0001 respectively.

There was a significant difference in mean bilirubin, sodium and calcium after therapy as compared to before therapy (p -value=0.001, 0.03, and 0.02 respectively). But the difference was statistically non-significant in potassium, urea and creatinine after and before therapy (p -value=0.101, 0.092 and 0.120) (Table 1).

Hypocalcemia was found more in cases (10.4%) below 3 days old as compared above 3 days old cases (9.4%). The difference was not statistically significant. In low birth weight group before phototherapy (11.7%) patients had hypocalcaemic and in normal birth weight (9.5%) patients had hypocalcaemic before therapy. But after phototherapy (52.9%) patients in low birth weight group and (60.3%) in normal weight group had hypocalcaemic respectively. Thus, hypocalcaemic in cases increases after phototherapy with statistically significant difference (p -value <0.05) (Table 2).

Incidence of hypocalcaemic increases after phototherapy in low weight babies as compared to normal weight

babies. The difference was statistically significant (p-value=0.001) (Figure 1).

Similarly, there is a hyponatremia in low birth weight babies after phototherapy as compared to patients before

phototherapy. The difference was statistically significant (p-value=0.03). And in low birth weight baby's incidence of hypocalcemia increases as compared to normal weight babies after therapy but difference was not statistically (p-value=0.473) (Table 3).

Table 1: Mean serum parameters before and after phototherapy.

	Before phototherapy		After phototherapy		p-value
	Mean	SD	Mean	SD	
Bilirubin (mg/dl)	17.7	3.0	12.1	2.6	0.001
Urea (mg/dl)	35.4	12.2	31.92	0.7	0.092
Creatinine (mg/dl)	0.8	0.2	0.72	0.1	0.120
Sodium (mEq/L)	146.6	6.2	141.3	6.2	0.03
Potassium (mEq/L)	4.7	0.5	4.3	0.5	0.101
Calcium (mg/dl)	8.9	0.7	8.0	0.7	0.02

Table 2: Prevalence of hypocalcaemia among neonates according their age group.

Calcium level	≤3 days old (n=58)	>3 days old (n=32)	Total (n=90)	p value
<8.0 (mg/dl)	6 (10.4%)	3 (9.4%)	9 (10%)	0.833
≥8.0 (mg/dl)	52 (89.6%)	29 (90.6%)	81 (90%)	

Table 3: Correlation of post phototherapy serum electrolytes with the duration of phototherapy.

	Electrolytes	At admission	At 24 hours	p value
Sodium	<135 (mEq/L)	0 (0%)	6 (6.7%)	0.03
	>135 (mEq/L)	35 (38.8%)	29 (32.2%)	
Potassium	3.5-5.5 (mEq/L)	33 (36.7%)	35 (38.8%)	0.473
	>5.5 (mEq/L)	2 (2.2%)	0 (0%)	
Calcium	<8.0 (mg/dl)	2 (2.2%)	21 (23.3%)	<0.0001
	≥8.0 (mg/dl)	33 (36.7%)	14 (15.6%)	

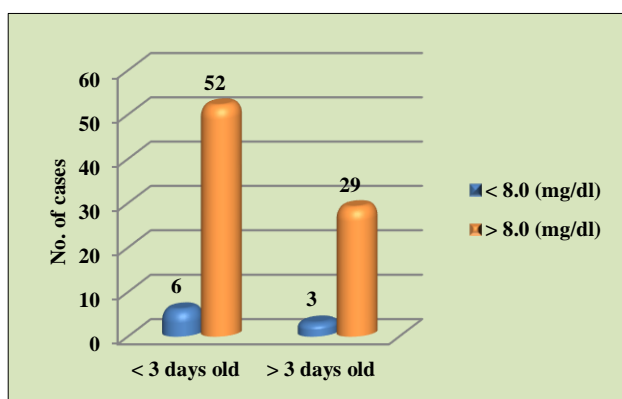


Figure 1: Prevalence of hypocalcaemia among neonates according their age group.

DISCUSSION

Neonatal jaundice is one of the leading causes of NICU admission, and phototherapy is one of the best and safe methods as a treatment option in neonatal jaundice as

described by Cremer et al.⁸ Every safe method has its own side effects and so also with the phototherapy. One of the known side effects of phototherapy is the disturbance in serum electrolytes specially the changes in serum calcium level. Romagnoli was the first to observe the association of hypocalcemia as an effect of phototherapy among the preterm neonates.⁹ Hakinson and Hunter have hypothesized that phototherapy inhibits the pineal secretion of melatonin, which blocks the effect of cortisol on bone calcium.^{10,11} So, cortisol increases the bone uptake of calcium and induces hypocalcemia.

In the present study, majority of cases were of 3-4 days (55%) followed by 1-2 days (27.8%), 15% cases were of 5-6 days and 1.1% cases were more than 6 days. 46.6% cases were males and 53.3% were female.

In this study there was significant decrease in total and direct bilirubin at the time of admission and after 24-hour phototherapy. Here, means total bilirubin at the time admission was 17.67 ± 3.05 and after phototherapy there were significant decrease in bilirubin 12.08 ± 2.59 .

Similarly, mean direct bilirubin at the time admission was 1.82 ± 5.13 and after phototherapy there were significant decrease in bilirubin 0.84 ± 0.355 .

Mean urea at the time admission was 35.41 ± 12.19 and after phototherapy there were significant decrease in urea 31.92 ± 10.48 . And, mean creatinine at the time admission was 0.83 ± 0.20 and after phototherapy there were significant decrease in creatinine 0.72 ± 0.16 .

In a study by Suneja et al, observed that there were marked alterations were observed in levels of bilirubin profile markers, in patients of Neonatal hyperbilirubinemia after receiving phototherapy.¹² There occurred significant decrease in Serum creatinine levels following phototherapy whereas decrease in urea levels were insignificant.

In this study the mean sodium, potassium and calcium level before therapy was 146.6 ± 6.2 , 4.7 ± 0.47 , and 9.4 ± 0.73 respectively. After phototherapy the mean sodium, potassium and calcium level was 141.3 ± 6.1 , 4.2 ± 0.51 and 8.4 ± 0.68 respectively. There was significant difference in calcium and sodium level before and after phototherapy with p-value= 0.011 and 0.003 respectively. But, in level of potassium there was no significant difference due to phototherapy.¹² The p-value is 0.21. Study by Reddy et al found similar results.¹³ They found that the frequency of potassium and chloride imbalances was found to be non- significant (p value of potassium vs chloride was 0.967 versus 0.085 respectively) with duration of phototherapy. Overall, there was significant decline in serum calcium and sodium along with total bilirubin following phototherapy.

Bezboruah and Majumder found following phototherapy the mean values of all the electrolytes were significantly decreased.¹⁴ Rangaswamy et al, found that there was significant decline in serum sodium and potassium along with total bilirubin following 48 hours of phototherapy.¹⁵

Rozario et al, found that after phototherapy about 67% babies had a decrease in serum calcium level from the initial value.¹⁶ Out of these 32% babies had a 5-9% reduction and 20% babies had >10% reduction in serum calcium value. This reduction in serum calcium level was found to be statistically significant (p value - <0.001). Even though 67% babies had a reduction in calcium value only 3% babies developed hypocalcemia after phototherapy. These results are comparable with an Iranian study done by Tahari et al, reported that out of 147 term babies about 56% babies had a reduction in serum calcium level after phototherapy and 7% newborns developed hypocalcemia after 48 hours of phototherapy.¹⁷

In this study there were hyponatremia and hypocalcemia after phototherapy. Here, before phototherapy no hyponatremia was present but after phototherapy 6 cases had hyponatremia. Similarly, hypocalcemia was present in 2 cases before phototherapy and after phototherapy 21

cases had hypocalcemia. Level of Potassium was almost normal before and after phototherapy. In this study authors found hypocalcemia in cases below 3 days old as compared above 3 days old patients. It is found that Phototherapy has emerged as the most widely used form of treatment and is the current therapy of choice to reduce severity of neonatal unconjugated hyperbilirubinemia. In study by Reddy et al, also found that the frequency of hypocalcemia following phototherapy was more in preterm neonates (41.2%) than in term neonates (6.2%).¹³

In this study hypocalcemia in cases increases after phototherapy with 9 hypocalcemia cases before phototherapy which increases to 53 cases after phototherapy. In study by Bezboruah and Majumder found similar results with 41.3% cases had hypocalcemia after phototherapy.¹⁴ They found that the incidences of hypocalcemia are also more in LBW (26.25%, 10% respectively) than in normal neonates (7.94%, 4.76%). Based on this study it is suggested that, even though the prevalence of hypocalcemia is less there is significant reduction in serum calcium level in term newborns undergoing phototherapy, so it is better to monitor S. calcium level in newborns treated with phototherapy for 48 hours or more. Authors recommend further and larger studies needed for estimation of prevalence of hypocalcemia in phototherapy.

CONCLUSION

Neonatal hyperbilirubinemia can easily pickup on clinical examination however require quick and on the spot treatment. If not treated properly, it leads to many complications. Currently the best treatment option for jaundice is photo therapy. Phototherapy is the therapy of choice for neonates with neonatal jaundice, as it decreases the levels of indirect bilirubin and prevents kernicterus.

The use of neonatal phototherapy must be judicious and aimed only at neonates who really need it, following the recommended guidelines and always weighing the risks and benefits of the treatment for neonates. Phototherapy is not a treatment free of side effects and further studies need to be conducted to elucidate its harmful effects on neonates.

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: Purohit A, Verma SK. Electrolyte changes in the neonates receiving phototherapy. *Int J Contemp Pediatr* 2020;7:1753-7.