Original Research Article

Electrolyte changes in neonates ≥ 35 weeks gestation receiving phototherapy for neonatal jaundice

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Abstract

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 behavioural and neurological impairment (Kernicterus) even in term newborns. Phototherapy is one of the most effective ways available in preventing the neurotoxic complications of indirect hyperbilirubinemia. **Methodology:** It is a prospective interventional study. Ethical clearance was obtained from institutional ethical committee. Neonates who were born or admitted to a tertiary care centre from September 2020 to August 2021, receiving Light Emitting Diode(LED) phototherapy for unconjugated hyperbilirubinemia after 24 hrs of life without any co-morbidities were involved in the study. **Results:** A total of 100 neonates were involved of which 55 were males and 45 were females (Figure 1). The mean sodium, potassium and calcium level before therapy were 147.6±5.2, 4.9±0.3, and 9.6±0.6 respectively. After phototherapy the mean sodium, potassium and calcium level were 142.3±5.6, 4.1±0.5 and 8.5±0.7 respectively. There was significant difference in sodium level before and after phototherapy with p-value= 0.02. But, in level of Potassium there But, in level of Potassium there was no significant difference (p=0.31) due to phototherapy before and after. Before phototherapy none of baby had hyponatremia while after phototherapy 8.7% cases had hyponatremia. Similarly, hypocalcaemic was present in 4.2% cases before phototherapy and after phototherapy 28.3% cases had hypocalcaemic which was found significant statistically. **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.

Key Words: Electrolyte Changes, Phototherapy , Neonatal Jaundice

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]. Neonatal hyperbilirubinemia nearly affects 60% of term and 80% of preterm neonates during first week of life[4].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[5]. Phototherapy is one of the most effective way available in preventing the neurotoxic complications of indirect hyperbilirubinemia[6]. It leads to changes in the structure of bilirubin, and the resulting isomers, lumirubin which is radially excreted in bile and urine[7].

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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[8].

Objectives

1. To assess the effect of Phototherapy on Electrolyte levels among neonates≥ 35 weeks gestation receiving phototherapy for neonatal jaundice.

Methodology

It is a prospective interventional study. Ethical clearance was obtained from institutional ethical committee. Neonates who were born or admitted to a tertiary care centre from September 2020 to August 2021, receiving Light Emitting Diode(LED) phototherapy for unconjugated hyperbilirubinemia after 24 hrs of life without any co-morbidities were involved in the study.

Inclusion Criteria

Neonates receiving phototherapy for unconjugated hyperbilirubinemia after 24 hrs of life without any co-morbidities were included in the study.

Exclusion Criteria

1. Neonates with evidence of Hemolysis.
2. Onset of jaundice < 24 hrs. & received exchange transfusion.
3. Neonates with Conjugated Hyperbilirubinemia.
4. Neonates who receive I.V. fluid and intensive care.

5. Neonates with formula feeding
6. Neonates with co-morbidities like birth asphyxia, septicaemia, acute renal failure and others.
7. Abnormal electrolyte status detected Pre phototherapy.
8. Mother taken phenobarbitone during antenatal period
9. History of hyperthyroidism or diabetes in the mother, and
10. 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 was considered as control. Comparative study was made between these two sample groups to determine the changes in electrolytes.

Data was entered in Microsoft Excel sheet and analysed using SPSS v20 for frequencies, mean, standard deviation, Chi square test and Paired T test.

Results

A total of 100 neonates were involved of which 55 were males and 45 were females (Figure 1). The mean sodium, potassium and calcium level before therapy were 147.6±5.2, 4.9±0.3, and 9.6±0.6 respectively. After phototherapy the mean sodium, potassium and calcium level were 142.3±5.6, 4.1±0.5 and 8.5±0.7 respectively. There was significant difference in sodium level before and after phototherapy with p-value= 0.02. But, in level of Potassium there But, in level of Potassium there was no significant difference (p=0.31) due to phototherapy before and after. Before phototherapy none of baby had hyponatremia while after phototherapy 8.7% cases had hyponatremia. Similarly, hypocalcaemic was present in 4.2% cases before phototherapy and after phototherapy 28.3% 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=0.02 and 0.01 respectively.

There was a significant difference in mean bilirubin, sodium and calcium after therapy as compared to before therapy (p-value=0.001, 0.02, and 0.01 respectively). But the difference was statistically non-significant in potassium, urea and creatinine after and before therapy (p-value=0.31, 0.087 and 0.13) (Table 1).

Hypocalcemia was found more in cases (9.6%) below 3 days old as compared above 3 days old cases (8.1%) as shown in Table 2. 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 (10.1%) patients in low birth weight group and (6.4%) in normal weight group had hypocalcaemic respectively.Incidence of hypocalcaemic increases after phototherapy in low weight babies as compared to normal weight. 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). (Table 3)

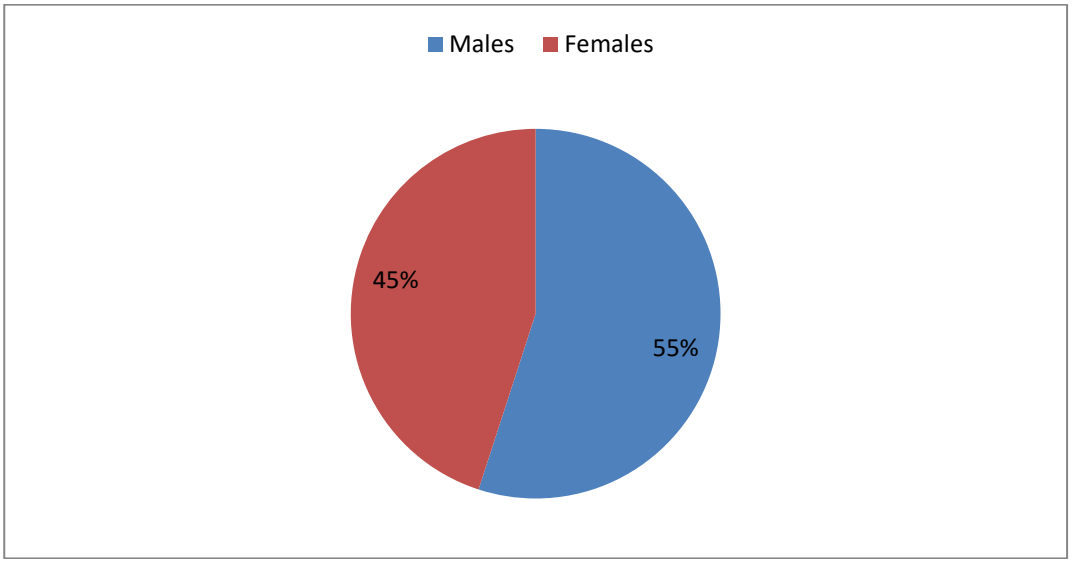

Fig 1: Gender distribution of study participants

Table 1: Mean serum parameters before and after phototherapy

Variables	Before phototherapy		After phototherapy		P value
	Mean	SD	Mean	SD	
Bilirubin (mg/dl)	17.4	3.4	12.4	2.7	0.001
Urea (mg/dl)	36.3	11.2	30.6	7.2	0.087
Creatinine (mg/dl)	0.9	0.2	0.6	0.1	0.13
Sodium (mEq/L)	147.6	5.2	142.3	5.6	0.02
Potassium (mEq/L)	4.9	0.3	4.1	0.5	0.31
Calcium (mEq/L)	9.6	0.6	8.5	0.7	0.01

Table 2: Prevalence of Hypocalcemia according to their age

Calcium level	≤3 days old	>3 days old	Total	P value
<8.0 mg/dl	6 (9.6%)	3 (8.1%)	9 (10%)	0.85
≥8.0 mg/dl	56 (90.4%)	34 (91.9%)	91 (90%)	

Table 3: Association of post phototherapy serum electrolytes with birth weight

	Electrolytes	Low birth weight	Normal birth weight	Total	P value
Sodium	<135 mEq/L	33 (70.2%)	23 (43.4%)	56	0.03
	>135 mEq/L	14 (29.8%)	30 (56.6%)	44	
Potassium	3.5-5.5 (mEq/L)	35 (63.6%)	40 (88.8%)	75	0.421
	>5.5 (mEq/L)	20 (36.4%)	5 (11.2%)	25	
Calcium	<8.0 (mg/dl)	7 (10.1%)	2 (6.4%)	9	0.654
	≥8.0 mg/dl	62 (89.9%)	29 (93.6%)	91	

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[9]. Every safe method has its own side effects. 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[11,12]. So, cortisol increases the bone uptake of calcium and induces hypocalcemia. In the present study, majority of cases were of 3-4 days (65%) followed by 1-2 days (27%). 55% were males and 45% were female.

In this study there was significant decrease in total and direct bilirubin at the time of admission and after 24-hour phototherapy. Mean bilirubin at the time admission was 17.4±3.4 and after phototherapy there were significant decrease in bilirubin 12.4±2.7.Mean urea at the time admission was 36.3±11.2 and after phototherapy there were significant decrease in urea 30.6±7.2, and, mean creatinine at the time admission was 0.9±0.20 and after phototherapy there were significant decrease in creatinine 0.6±0.1, which are similar to study done by Purohit A et al[13].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[14]. 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 147.6±5.2, 4.9±0.3, and 9.6±0.6 respectively. After phototherapy the mean sodium, potassium and calcium level was 142.3±5.6, 4.1±0.5 and 8.5±0.7 respectively. There was significant difference in calcium and sodium level before and after phototherapy with p-value= 0.01 and 0.03 respectively. But, in level of potassium there was no significant difference due to phototherapy[12]. The p-value is 0.31. Study by Reddy et al found similar results[15]. 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[16]. Rangaswamy et al, found that there was significant decline in serum sodium and potassium along with total bilirubin following 48 hours of phototherapy[17].Rozario et al, found that after phototherapy about 67% babies had a decrease in serum calcium level from the initial value[18]. 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[19].In the present study there were hyponatremia and hypocalcemia after phototherapy. Here, before phototherapy no hyponatremia was present but after phototherapy 8.7% cases had hyponatremia. Similarly, hypocalcemia was present in 4.2% cases before phototherapy and after phototherapy 28.3% 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%)[15].

In study by Bezboruah and Majumder found similar results with 41.3% cases had hypocalcemia after phototherapy[16]. 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. 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. It has proved to cause electrolyte imbalance especially hyponatremia and hypocalcemia. Phototherapy is not a treatment free of side effects and further studies need to be conducted to elucidate its harmful effects on neonates.

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