Section: Pediatrics

Original Research Article

ELECTROLYTE CHANGES IN TERM NEONATES FOLLOWING LIGHT EMITTING DIODE PHOTOTHERAPY FOR NEONATAL HYPERBILIRUBINEMIA

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ABSTRACT

Background: Neonatal jaundice is the most common abnormal clinical finding during the early neonatal period. Neonatal hyperbilirubinemia occurs as a result of unconjugated bilirubin accumulation. Neonatal hyperbilirubinemia is managed by phototherapy in which the baby is exposed to blue-green light (wavelength 460-490nm), by which bilirubin molecule gets converted to a soluble, nontoxic substance that is eliminated by kidneys via urine and gastrointestinal tract via feces. Although phototherapy is effective in treating hyperbilirubinemia, it adversely affects the newborn's electrolyte balance. The change in the electrolyte levels has a range of clinical consequences, from mild symptoms to potentially fatal situations. Newborn outcomes can be improved and issues linked to electrolyte imbalances can be avoided with early detection and intervention. **Objective:** To compare the serum calcium, sodium, potassium, and magnesium levels, before and after phototherapy of term neonates admitted to the newborn intensive care unit, Government Medical College, Kottayam.

Materials and Methods: In this analytical study, 264 newborns admitted for neonatal jaundice and receiving phototherapy were included after applying inclusion and exclusion criteria. Serum sodium, calcium, potassium, and magnesium levels were measured by collecting venous blood before and 24 hours after phototherapy. Serum electrolytes were measured using standard laboratory techniques. Each electrolyte (Sodium, Calcium, Potassium, and Magnesium) was expressed as a mean with standard deviation. A paired t-test was used to compare pre and post-phototherapy electrolyte levels. The P-value of <0.05 is considered statistically significant.

Results: In our study, there was a statistically significant decline in the levels of sodium, calcium, potassium, and magnesium following phototherapy. The percentage of study subjects who underwent a decline in the levels of sodium, calcium, potassium, and magnesium following phototherapy were 69.7%, 72%, 62.1%, and 61.4%, respectively. The prevalence of hyponatremia, hypocalcemia, hypokalemia, and hypomagnesemia following phototherapy was found to be 4.2%, 5.3%, 0.4%, and 21.6%respectively. The prevalence of hypocalcemia was only statistically significant. None of the babies had clinical manifestations of electrolyte imbalance.

Conclusion: A statistically significant decline was noted in the levels of sodium, calcium, potassium, and magnesium, but none of the babies exhibited any clinical manifestations.

Keywords: Neonatal hyperbilirubinemia, Phototherapy, Electrolyte.

INTRODUCTION

Neonatal jaundice,[1] is the most common abnormal clinical finding during early neonatal period. Neonatal hyperbilirubinemia is managed by phototherapy in which the baby is exposed to blue-green light (wavelength 460-490nm), by which bilirubin molecule gets converted to a soluble, nontoxic substance that is eliminated by kidneys via urine and gastrointestinal tract via feces. Phototherapy has reduced the need for double-volume exchange transfusion in neonates.[2]

Although phototherapy is effective in treating hyperbilirubinemia, its possible effects on the newborn's electrolyte balance have drawn attention.[3] Alteration in newborn's electrolyte balance could have a significant clinical impact due to their sensitive physiology.[5] Early investigations regarding electrolyte alterations in neonates receiving phototherapy have produced conflicting outcomes. Some studies have revealed abnormalities in sodium, potassium, calcium, and other vital electrolytes following phototherapy.[6] The change in the electrolyte levels has a range of clinical consequences, from mild symptoms to potentially fatal situations. In light of this discrepancy, a study on the changes in the electrolytes following phototherapy is needed.[6]

It is important to understand the nature and severity of electrolyte alterations in term newborns after phototherapy for many reasons. First of all, it can help medical professionals monitor patients and possibly modify their treatment plans to guarantee that jaundiced newborns receive the safest and best care possible. Second, newborn outcomes can be improved and issues linked to electrolyte imbalances can be avoided with early detection and intervention. Finally, this information may encourage additional studies to improve and optimize the present therapeutic approaches for newborn hyperbilirubinemia.

MATERIALS AND METHODS

It was a Analytical study design conducted at Neonatology unit, Department of Pediatrics, Government Medical College, Kottayam for a period **of** 1 year after obtaining IRB approval

Sample size: As per the study, 'A comparative study of electrolyte changes in newborns delivered after 35 weeks of gestation before and after receiving phototherapy in a tertiary care hospital' done by Subhajit Karan et al[7]. At Bankura Sammilani Medical College and Hospital, West Bengal, the prevalence of hypocalcemia following light emitting diode phototherapy was found to be 20%. Based on this prevalence, the sample size was estimated using the formula

$N = 4pq/d^2$

{p = prevalence q = 100- prevalence d = relative precision taken as 5%}. A sample size of 264 was obtained.

All neonates who were admitted with neonatal hyperbilirubinemia for phototherapy in the neonatology unit during the period of study were included in the study after applying the inclusion and exclusion criteria. They were included in the order of getting admitted to the neonatology unit until the required sample size was met.

Inclusion Criteria

1. Term (37-42 weeks of gestational age) neonates.
2. Indirect hyperbilirubinemia, with total serum bilirubin in the phototherapy range, based on the Clinical Practice Guidelines by the American Academy of Pediatrics.[115]

Exclusion Criteria

1. Neonatal asphyxia.
2. Infants of diabetic mothers.
3. Infants undergoing exchange transfusion.
4. Hemolytic anemia
5. Sepsis.
6. Congenital malformations.
7. Phototherapy duration less than 24 hours
8. Acute Kidney Injury
9. Cardiac failure

Under all aseptic precautions, the first venous sample of 2-3 ml was taken before the commencement of phototherapy, and the second sample was taken 24 hours after phototherapy. Total and direct bilirubin is determined by the Diazo Method by Mindray BS-390 autoanalyser. Serum Sodium and Serum Potassium were estimated by the Acculyte 3P electrolyte analyser. Calcium estimation done using Arsenazo method by Mindray BS-390 autoanalyser. Serum Magnesium was measured by Xylidyl blue method using Mindray BS-390 autoanalyser.

Data management and statistical analysis

Levels of serum electrolytes before and after phototherapy with the baseline data of all study subjects were recorded in a predesigned proforma and master chart prepared in a Microsoft Excel sheet. For the analysis of the data, SPSS (Statistical Package for Social Sciences) software was used. Each electrolyte (Sodium, Calcium, Potassium, and Magnesium) was expressed as a mean with standard deviation. Paired t-test was used to compare pre and post-phototherapy serum electrolyte levels. A P-value of <0.05 was considered statistically significant.

RESULTS

Table 1: Total Serum Bilirubin at the Time of Initiation of Phototherapy

	Frequency	Percent
<15mg/dl	11	4.2
15-19mg/dl	142	53.8
20- 24mg/dl	106	40.2
>25mg/dl	5	1.5
Total	264	100.0

The mean total serum bilirubin at the time of initiation of phototherapy was 19.2 ±2.3 mg/dl. Among the study population, 4.2% (n =11) had total serum bilirubin level less than 15mg/dl, 53.8% (n=142) had total serum bilirubin in the range of 15-19 mg/dl, 40.2% (n=106) had total serum bilirubin between 20 -24mg/dl and 1.5%(n=5) had total serum bilirubin value more than 25mg/dl. The mean duration of phototherapy was 24.64 ± 3.8 hours.

Table 2: Association of Hyponatremia and Phototherapy

Pre-Phototherapy Sodium		Post Phototherapy Sodium		Total	χ^2	P value
		<135	>135			
<135	Count	2	21	23	1.02	.311
	%	8.7%	91.3%	100.0%		
>135	Count	9	232	241		
	%	3.7%	96.3%	100.0%		
Total	Count	11	253	264		
	%	4.2%	95.8%	100.0%		

Changes in serum sodium among 264 babies were analysed. 69.7% (n=184) showed a decrease in serum sodium following phototherapy. 25% (n=66) had increase in serum sodium level, while 5.3% (n=14) had no change. Eleven babies (4%) had hyponatremia following phototherapy, but it was not statistically significant. None of the babies had any symptoms.

Table 3: Association of Hypocalcemia and Phototherapy

Pre Phototherapy Calcium		Post Phototherapy Calcium		Total	χ^2	P Value
		Calcium < 8	Calcium >8			
<8mg/dl	Count	8	1	9	37.43	<0.01
	%	88.8%	11.2%	100.0%		
>8mg/dl	Count	6	249	255		
	%	2.35%	97.6%	100.0%		
Total	Count	14	250	264		
	%	5.3%	94.6%	100.0%		

Changes in serum calcium among 264 babies were analysed. It was seen that 72% (n= 190) had a decrease in serum calcium levels, while 26.5% (n= 70) had an increase in serum calcium levels following phototherapy. 4 babies (1.5%) had no change in serum calcium levels. 14 babies (5.3%) developed hypocalcemia following phototherapy which was statistically significant with p-value of <0.01. None of them had any clinical manifestations of hypocalcemia.

Table 4: Association of Hypokalemia and Phototherapy

Pre-Phototherapy Potassium		Post-Phototherapy Potassium		Total	χ^2	P-value
		<3.5	>3.5			
<3.5	Count	0	1	1	.008	.931
	%	0.0%	100.0%	100.0%		
>3.5	Count	1	262	263		
	%	0.4%	99.6%	100.0%		
Total	Count	1	263	264		
	%	0.4%	99.6%	100.0%		

Among 264 babies, it was seen that 62.1% (n =164) had a decrease in serum potassium following phototherapy, while 34.5% (n = 91) had an increase in serum potassium levels following phototherapy. Nine babies (3.4%) had no change in potassium levels. Only one baby (0.4%) developed hypokalemia following phototherapy, but it was not statistically significant with a p-value of 0.32. The baby with hypokalemia was asymptomatic.

Table 5: Association of Hypomagnesemia and Phototherapy

Pre-Phototherapy Magnesium		Post-Phototherapy Magnesium		Total	χ^2	P value
		<1.7	>1.7			
<1.7	Count	6	12	18	1.42	.232
	%	33.3%	66.7%	100.0%		
>1.7	Count	51	195	246		
	%	20.7%	79.3%	100.0%		
Total	Count	57	207	264		
	%	21.6%	78.4%	100.0%		

Changes in serum magnesium among 264 babies were analysed. It was seen that 61.4% (n= 162) had a decrease in serum magnesium levels, while 31.1% (n= 82) had an increase in serum magnesium levels following phototherapy. Twenty babies (7.6%) had no change in serum magnesium levels. In our study, 58 babies (21.9%) developed hypomagnesemia, but it was not statistically significant with the p-value of 0.232. None of them had any clinical manifestations.

DISCUSSION

In our study, post-phototherapy sodium, calcium, potassium, and magnesium were measured 24 hours after phototherapy. The mean pre-phototherapy serum sodium and mean post-phototherapy serum sodium were 142.95± 5.37 meq/L and 139.56 ±11.7meq/L, respectively. The decline in mean serum sodium level was found to be significant when statistically tested with paired t test (t value -4.63), with a p-value <0.01. In the study by Subhajit Karan et al,[7] he mean pre-phototherapy serum sodium and the mean post- phototherapy serum sodium were 140.24±2.50meq/l and 137.17±3.83meq/l, respectively. In another study by Gayatri Bezboruah et al8 the mean pre- phototherapy seum sodium and the mean post-phototherapy serum sodium were 141.52±2.408meq/l and139.26±4.170meq/l, while a study by Shardha Sharma et al,[9] mean pre-phototherapy serum sodium and the mean post-phototherapy serum sodium were 141.3 ± 2.69meq/l and 140.5 ± 2.70meq/l.

Among 264 babies, 69.7% had a decrease in serum sodium level.[11] babies (4%) had hyponatremia following phototherapy, but it was not statistically significant. No babies had any clinical findings of hyponatremia. In contrast to our findings, the study done by Subhajit Karan et al,[7] showed 18.75% of term newborns and 76.14% of preterm newborns had post-phototherapy hyponatremia. Gayatri Bezboruah et al8 in their study found 11.02% of term and 18.31% of preterm newborns had hyponatremia after phototherapy.

The study done by Kumar et al,[3] had findings similar to our study, where 3.1% of term and 17.5% of preterm newborns developed hyponatremia following phototherapy. The association of post-phototherapy serum sodium with birth weight was found to be statistically insignificant. This is in contrast to the study by Subhajit Karan et al,[7] and Gayatri Bezboruah et al,[8] where a significant association was found between birth weight and hyponatremia, and hyponatremia was more prevalent among low birth weight according to these studies. In our study population, the mean pre-phototherapy serum calcium and the mean post-phototherapy serum calcium were 9.27 ± 0.73mg/dl and 9.01 ± 0.62mg/dl, respectively. The decline in mean serum calcium level was found to be significant when statistically tested with the paired t-test (t value -6.59) with a p-value <0.01. In the study by Subhajit Karan et al,[7] the mean pre-phototherapy serum calcium and the mean post-phototherapy serum calcium were 8.98±0.52mg/dl and 8.26±0.99 mg/dl, respectively.

In our study population, it was seen that 72% (n=190) had a decrease in serum calcium levels following phototherapy, while 14 babies (5.3%) had hypocalcemia following phototherapy. This is comparable with the study done by Subhajit Karan et al,[7] in which 3.5% of term neonates developed hypocalcemia. According to our study, there was no significant relation between birth weight and hypocalcemia in term babies. The occurrence of hypocalcemia in low birth weight neonates after phototherapy in research by Subhajit Karan et al,[7] and the one by Reddy et al,[11] are similar and statistically significant. However, neither study could obtain such a correlation in term babies. Our study included only term babies, so these findings are consistent with our study. The mean pre-phototherapy serum potassium value was 5.08 ± 0.58mm/L and the mean post-phototherapy serum potassium was 4.8±0.53 mm/L. The decline in mean serum potassium level was found to be significant when statistically tested with paired t-test (t value -4.86), with a p-value <0.01. In the study by Subhajit Karan et al,[7] the mean pre-phototherapy serum potassium and the mean post- phototherapy serum potassium were 4.24±0.48Mm/L and 3.95±0.31mm/L, respectively.

Among the study population, 62.1% (n=164) had a decrease in serum potassium following phototherapy. This is consistent with the Gayatri Bezboruah et al8 study, in which 64.08% had a decline in serum potassium following phototherapy.

The only baby that developed hypokalemia was an early-term baby, and the association between gestational age and hypokalemia was found to be statistically insignificant with a p-value of 0.31. The association between post-phototherapy potassium and birth weight was insignificant with a p-value of 0.988. A similar finding was also noted in the study done by Subhajit Karan et al,[7] with no significant correlation between post- phototherapy serum potassium change and birth weight with a p-value of 0.8150.[10]

The mean pre-phototherapy serum magnesium value was 2.07± 0.23mg/dl and the mean post-phototherapy serum magnesium was 1.96 ± 0.26mg/dl. The decline in mean serum magnesium level was statistically tested with paired t-test. It was statistically significant with a t-value of 4.8 and a p-value <o.o1. In the study by Gayatri Bezboruah et al8, the mean pre-phototherapy serum magnesium and the mean post-phototherapy serum magnesium were 2.25±0.267mg/dl and 2.07±0.335mg/dl, respectively.

In our study, 57 babies (21.6%) developed hypomagnesemia following phototherapy, and it was statistically insignificant with a p-value of 0.232. The study by Gayatri Bezboruah et al,[8] also had statistically insignificant hypomagnesemia following phototherapy. Our study population did not have statistically significant association between post-phototherapy serum magnesium with birth weight as well as gestational age, with a p-value of 0.216 and 0.087 respectively. The Gayatri Bezboruah et al study also had similar findings with no statistically significant correlation between post-phototherapy serum magnesium with birth weight as well as gestational with a p-value of 0.82 and 0.45 respectively.[8,10,11]

CONCLUSION

Thus in our study, the percentage of study subjects who underwent a decline in the levels of sodium, calcium, potassium and magnesium following phototherapy were 69.7%, 72%, 62.1%, and 61.4%, respectively. The prevalence of hyponatremia, hypocalcemia, hypokalemia, and hypomagnesemia following phototherapy was found to be 4.2%, 5.3%, 0.4%, and 21.6% respectively. The prevalence of hypocalcemia was only statistically significant. None of the babies had clinical manifestations of electrolyte imbalance.

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