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Original Research Article

Adverse effects of phototherapy on calcium, magnesium and electrolytes levels in neonatal jaundice

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ABSTRACT

Introduction: The current study was planned to study the change in calcium, magnesium and electrolytes levels after phototherapy in neonatal jaundice.

Materials and Methods: The study was carried out on 50 neonates requiring photo therapy for neonatal jaundice. Ethical clearance and written informed consent was obtained from parents of the neonates prior to the conduct of the study. Details regarding gestational age, mode of delivery, birth weight were collected. 3ml of blood sample was collected before initializing phototherapy and 48 hrs after initializing phototherapy from the neonates. The dose and duration of phototherapy was noted. Total and direct bilirubin, serum calcium, magnesium and electrolytes were estimated.

Results: The study included 50 new-born babies of which 48% were girl child and 52% were boy child. The mean gestational age of the mothers were 36.72 ± 1.8 weeks and the age of the study subjects was 3.54 ± 1.6 days. The phototherapy was given for a mean duration of 1.7±0.46 days. The average birth weight of the neonates was 2.73 ± 0.49 kg. There was decrease in the level of serum calcium (0.58 ± 0.02 mg/dL), magnesium (0.38 ± 0.03 mg/ dL), sodium (1.28 ± 0.01 mmol/L) after phototherapy. 13 neonates(26%) developed hypocalcemia following phototherapy. The incidence of hyponatremia in the study was 18%.

Conclusion: The present study clinches that the photo therapy leads to decrease in the levels of serum calcium, magnesium, sodium. The decrease in calcium levels were more in low birth weight and preterm babies.

1. Introduction

Hyperbilirubinemia in neonates is a common problem seen in first week after delivery. There is increased bilirubin production due to ineffective erythropoiesis. This leads to jaundice because of physiological immaturity of new- born child to handle enhanced production of bilirubin. Preterm neonates are more prone for hyperbilirubinemia(80%) than term neonates(60%).[1] Managing this is of vital importance as it is toxic to the brain leading to kernicterus. The treatment options available for hyperbilirubinemia are phototherapy, exchange transfusion, and pharmacological treatment.[2]

Phototherapy is the safest and commonly used treatment option for neonatal jaundice. It converts indirect bilirubin to water-soluble stereoisomers by a process called photo-isomerization. As there is loss of fluids and hyperthermia, phototherapy leads to some adverse complications but the potential complications of phototherapy are hypocalcemia and hypomagnesemia.[3,4]

Inhibition of pineal gland due to trans-cranial illumination due to phototherapy decreases melatonin levels. One of the functions of melatonin is to inhibit the action of corticosterone. Corticosterone increases calcium absorption by bone. Hence the increase in the level corticosterone leads to hypocalcemia and hypomagnesemia. Urinary excretion of calcium is also increased following phototherapy.[5]

Magnesium is involved in calcium regulation. Magnesium levels are also decreased by phototherapy.[6,7] There

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were few studies exploring the effects of phototherapy on magnesium and electrolytes level.[8,9] The present study was indented to study the changes in the levels of calcium, magnesium and electrolytes in newborns exposed to phototherapy for 48 hrs or more.

2. Materials and Methods

This study was conducted by department of Biochemistry in collaboration with the department of Pediatrics, Mahatma Gandhi Medical College and Research Institute, SBV, Puducherry, India. The study was approved by the Institute research committee and Institute Ethics Committee. A written informed consent was obtained from both the parents of the neonates prior to the conduct of the study. 50 Stable icteric infants who require management with phototherapy for exaggerated physiological jaundice were recruited in the study over a period of 2 months (June and July 2018). Neonates suffering from pathological jaundice (jaundice <1 day and > 2 weeks), birth asphyxia, congenital malformation, septicemia, hypocalcemia, hypomagnesemia and electrolyte abnormalities before starting phototherapy, any newborn needing exchange transfusion, ABO or Rh incompatibility and an infant born to diabetic, hypothyroid mother and mothers taking anti-convulsant drugs were excluded. Hypocalcemia is diagnosed if the serum total calcium level is less than 8 mg/ dL for term neonates and less than 7 mg/ dL for preterm neonates.

Details regarding gestational age, mode of delivery, birth weight were collected. After taking all aseptic precautions, approximately 3 ml of blood sample was collected from the neonates before initializing phototherapy and 48 hrs after initializing phototherapy or stoppage of phototherapy whichever was earlier. The dose and duration of phototherapy were noted. Total and direct bilirubin, serum calcium and magnesium were estimated using IFCC recommended method in the fully automated auto analyzer of central laboratory. Electrolytes were estimated using electrolyte analyzer. Samples were processed after doing quality checks for all the above parameters

2.1. Statistical analysis

Descriptive statistical analysis was carried out in the present study. Results on continuous measurements were presented as Mean +/- SD, and results on categorical measurements were represented in Number (%). Quantitative data were analyzed by the Student t-test and paired t-test. Qualitative data were analyzed by the chi-square –test. The test is considered significant when the P value is less than 0.05.

We have included 50 new born babies, 24 girls (48%) and 26 boys (52%). The mean gestational age of the study population was 36.72 ± 1.8 weeks with a mean age of 3.54 ± 1.6 days.

The mean birth weight of the neonates was 2.73 ± 0.49 kg. The phototherapy was given for a mean duration of 1.7 ± 0.46 days. The proportion of neonates delivered by normal vaginal delivery was 66% (33) and by cesarean section was 34% (17). This is shown in Table 1.

Response to phototherapy was seen in the reduction of serum total and indirect bilirubin. There was statistically significant difference in the level of serum calcium, magnesium, and sodium after phototherapy. There was no difference in the levels of potassium and chloride after phototherapy (Table 2)

13 neonates (26%) developed hypocalcemia following phototherapy. Stratified analysis was performed and we found that there was no significant difference in hypocalcemia among gestational age, mode of delivery, birth weight, age of neonates, gender, and the duration of phototherapy. Low birth weight developed hypocalcemia more when compared to normal birth weight babies. The incidence of hypocalcemia increased with increase in duration of phototherapy, but the difference was not statistically significant (Table 3)

The incidence of hyponatremia in the study was 18% (9). There was no significant difference in the incidence of hyponatremia with respect to birth weight and gestational age.

3. Discussion

The frequent cause for hospitalization and morbidity in newborn worldwide is neonatal jaundice. It is also the main reason for readmission of neonates.[10] The incidence of jaundice is more in preterm infants than in term infants. Treatment of hyperbilirubinemia is of vital importance as hyperbilirubinemia leads to kernicterus. Pharmacological treatment, phototherapy, and exchange transfusion are the available treatment options for neonatal jaundice. Phototherapy is an effective therapy which lowers bilirubin levels by converting bilirubin to isomers which can be excreted in urine without undergoing conjugation in liver.[11] The development of hypocalcemia after phototherapy in the newborn was first noticed by Romagnoli et al in 1979[12].

The incidence of hypocalcemia after 48 hrs of phototherapy in our study was 26%. The incidence was more in preterm neonates 28.6% than term neonates (24.1%) and when the duration of phototherapy was more than 48 hrs. This report is in agreement with previous studies. A study by Karamifar et al showed 23% of pr eterm neonates and 8.7% of full-term neonates developed hypocalcemia following phototherapy.[5] Another study by Sethi et al concluded that neonates had significantly lower levels of both total and ionized calcium after phototherapy and they recommended calcium supplementation to prevent hypocalcemia due to phototherapy.[12]

The reason for hypocalcemia may be explained by the decrease in melatonin secretion. Melatonin is found to

Table 1: Demographic data of the study population

Variable	N(%)
Gestation age in weeks (mean ± SD)	36.72 ± 1.8
Age in days (mean ± SD)	3.54 ± 1.6
Birth weight in kg (mean ± SD)	2.73 ± 0.49
Sex	
Male	26(52%)
Female	24 (48%)
Mode of delivery	
Normal vaginal delivery	33 (66%)
Cesarean section	17 (34%)

Table 2: Comparison of study parameters before and after phototherapy

S.No	Parameter	Before phototherapy	After Phototherapy	P value
1	Total Bilirubin (mg/dL)	17.11 ± 3.12	12.30 ± 2.85	< 0.01
2	Direct Bilirubin (mg/dL)	0.35 ± 0.13	0.35 ± 0.12	0.971
3	Indirect Bilirubin (mg/dL)	16.77 ± 3.07	11.95 ± 2.80	< 0.001
4	Calcium(mg/dL)	8.84 ± 0.46	8.26 ± 0.45	< 0.001
5	Magnesium (md/dL)	2.49 ± 0.243	2.11 ± 0.24	< 0.001
6	Sodium (mmol/L)	135.38 ± 3.54	134.12 ± 3.54	<0.001
7	Potassium (mmol/L)	3.83 ± 0.36	3.78 ± 0.32	0.069
8	Chloride (mmol/L)	96.56 ± 3.72	96.04 ± 3.37	0.121

Table 3: Frequency of hypocalcemia with respect to gestational age, mode of delivery, birth weight, neonatal age, gender and duration of phototherapy

S.No	Variables	Hypocalcemia			
		Yes N(%)	No N(%)	Total	p value
1	Gestational age in weeks				
	< 37	6(28.6%)	15(71.4%)	21	0.72
	≥ 37	7(24.1%)	22(75.9%)	29	
2	Mode of delivery				
	Normal vaginal delivery	8(24.2%)	25(75.8%)	33	0.69
	LSCS	5(29.4%)	12(70.6%)	17	
3	Birth weight in kg				
	< 3	11(28.2%)	28(71.8%)	39	0.5
	≥ 3	2(18.2%)	9(81.8%)	11	
4	Age in days				
	< 5 days	11(24.4%)	34(75.6)	45	0.45
	≥ 5days	2(40%)	3(60%)	5	
5	Gender				
	Male	9(34.6%)	17(65.4%)	26	0.15
	Female	4(16.7)	20(83.3%)	24	
6	Duration of phototherapy in days				
	≤ 2	3(20.0%)	12(80.0%)	15	0.78
	2	10(28.6%)	25(71.4%)	35	

inhibit the secretion of corticosterone. Corticosterone increases the absorption of calcium by bones. Phototherapy by transcranial illumination decreases the level by melatonin by inhibiting the pineal gland thereby increasing corticosterone levels. Cortisol has also got a direct hypocalcemic effect.[2] By its antivitamin D action, it decreases the absorption of calcium and phosphorous from the gastrointestinal tract. It also increases the uptake of calcium by bones and excretion of calcium by renal tubules. Phototherapy also increases renal excretion of calcium.[13] A study by Karamifar et al recommends calcium supplementation and special hats covering the head and occipital area of newborns during phototherapy which can prevent phototherapy induced hypocalcemia.[5]

Serum magnesium levels before initialization of phototherapy in newborns are increased in our study. There was a significant decrease in the level of magnesium after phototherapy bu t none reached hypomagnesemia. This

may be explained by the neuroprotective role of magnesium against the toxic effects of hyperbilirubinemia.[14] This is in agreement with the previous study by Mohsen et al. They concluded that because of generalized cellular injury which includes neurons, magnesium is released extracellularly. It acts as neuro-protector against bilirubin toxicity.[15] Bhat et al recommended that the treatment of magnesium sulfate will protect the brain from the toxic effects of bilirubin.[16]

The incidence of hyponatremia was 18% in our study. There was no significant difference in the levels of potassium and chloride in our study. In a study done by PK Sunil et al, the incidence of hyponatremia was 6%. They stated that during phototherapy there is impairment in the absorption of electrolytes and the baby can develop hyponatremia due to inadequate fluid replacements.[17] Phototherapy caused increased insensible water loss due to alteration in the temperature of the newborn and its environment. Phototherapy also increased gastric mobility leading to increased fluid loses and hence increasing the daily fluid intake is known to prevent the side effects of phototherapy.[18]

It is apparent from the present study that phototherapy leads to hypocalcemia, hyponatremia, and decreases in the level of magnesium. The incidence of hypocalcemia was more in low birth weight and preterm babies but the exact cause has to be evaluated by future studies. Further studies are needed to study the effect of calcium and fluid supplementation to neonates receiving phototherapy.

4. Conclusion

The present study concludes that the phototherapy leads to a decrease in the levels of serum calcium, magnesium, and sodium. The incidence of hypocalcemia is more in low birth weight and preterm babies. They should be monitored for electrolyte imbalance to prevent complications.

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None.

7. Conflict of interest

The authors stated that they have no conflicts of interest regarding the publication of this article.

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