Original Article

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Serum Electrolytes and Calcium Levels in Neonates Receiving Phototherapy for Neonatal Jaundice

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ABSTRACT

Background: *Neonatal Jaundice (NJ) is one of the most common causes of neonatal admission. Phototherapy is an important treatment modality for NJ. However, this treatment modality may itself result in changes of different biochemical parameters. The study aimed to evaluate the changes in serum electrolytes (Sodium, potassium and chloride) and calcium in neonates receiving phototherapy for NJ.*

Materials and methods: *One hundred and two term neonates admitted to the Special Care Newborn Unit, Chattogram Medical College Hospital for the management of NJ by phototherapy were enrolled in this prospective observational study. Serum bilirubin, sodium, potassium, chloride and calcium were measured before and after 48 hours of phototherapy and compared.*

Results: *The mean gestational age and mean age of admission of the neonates were 38.6±0.6 weeks and 6.42 ± .67 day respectively. The mean sodium, potassium and calcium level before therapy was respectively, 138.4±1.8 mmol/L, 4.1±0.3 mmol/L and 8.8±0.3 mg/dl. There was significant decrease in the level of mean sodium (136.4±1.6 mmol/L), potassium (3.8 ± 0.3 mmol/L) and calcium (8.4±0.4 mg/dL) after phototherapy. All neonates had normal level of serum calcium, sodium, potassium and chloride before phototherapy. After 48 hours of phototherapy, 46 (45.1%) of them had abnormal values with the incidence hypocalcaemia, hyponatraemia and hypokalemia respectively in 21.6%, 25.5% and 10.8% of the neonates.*

Conclusion: *Neonates undergoing phototherapy are at risk of developing hyponatraemia, hypokalaemia and hypocalcaemia. Closed monitoring is essential to observe the changes in sodium, potassium and calcium and should be managed accordingly.*

Key words: Electrolytes; Neonatal jaundice; Phototherapy.

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Introduction

Over 60% of all newborns develop NJ, a physiologic condition characterized by yellowish discolouration of the skin and conjunctiva due to increased serum bilirubin levels during the first week of life.[1] The burden is unacceptably high in low-income and middle-income countries and has prompted calls for intense scrutiny and attention.[2]

Phototherapy is the most common and effective treatment for NJ, which lowers the serum bilirubin level by transforming bilirubin into water-soluble isomers that can be eliminated without conjugation in the liver.[3] It's both well-tolerated and safe. Also, it decreases the need for exchange transfusion or drugs as phototherapy transforms bilirubin into isomers that are water soluble and thus can be easily eliminated through gastrointestinal tract or kidneys in urine, without the need for conjugation in the liver.[4] Nevertheless, a few side effects of phototherapy were documented, such as hyperthermia, dehydration, loose stool feed, intolerance, skin rash and bronze baby syndrome.[5] Moreover, phototherapy can decrease serum electrolytes such as calcium, sodium, potassium, and chloride.[6-10]

However, phototherapy-induced changes in serum calcium, sodium, potassium, and chloride are under-

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diagnosed and thus under-reported in our setting. Information regarding the burden and pattern of phototherapy-induced change in electrolytes and calcium is essential for adequately planning and preventing such biochemical abnormalities. Therefore, to fill this information gap, the present study was conducted to determine the effect of phototherapy on serum sodium, potassium, chloride and calcium in NJ patients before and after 48 hours of phototherapy.

Materials and methods

A hospital-based prospective observational study was conducted in the Special Care Newborn Unit (SCANU) Chittagong Medical College Hospital, Chattogram, Bangladesh, from November 2018 to October 2019.

Term babies with average birth weight who presented with NJ and required phototherapy as per American Academy of Pediatrics-based guidelines with normal serum calcium and electrolyte levels before starting phototherapy were included in this study. Preterm (<37 weeks) baby, baby with jaundice admitted after 7 days of age, prolonged jaundice persists beyond 2 weeks, jaundice associated with other diseases like sepsis, moderate birth asphyxia, severe birth asphyxia, abnormal electrolyte findings before phototherapy and baby with major congenital malformations were excluded.

After approval of ethical clearance by the ethical review committee of Chittagong Medical College, parents or legal guardians of the neonate who fulfilled the inclusion and exclusion criteria were invited to participate in the study. Written informed consent was taken from the parents or legal guardians of the patients. A case record form was used to collect all relevant information. Three ml of venous blood samples were collected aseptically and sent to the laboratory immediately for investigations. Serum electrolytes were analyzed using the selective electrode method, a machine named Biolyte 2000, made by Biocare corporation, Taiwan. Serum calcium was estimated by photometric method, machine name Indiko plus, made by Thermo Fisher Scientific, USA. These patients received phototherapy for 48 hours. The babies were monitored for any new symptoms during phototherapy. Blood samples were analyzed before and after 48 hours of phototherapy. The first sample was considered as a control. Comparison was made between these two sample groups to determine the changes in various biochemical parameters.

In term baby, when serum calcium was <8 mg/d, sodium <135 mEq/L, serum sodium > 145 mEq/L, serum potassium < 3.5 mEq/L were defined as hypocalcaemia, hyponatremia, hypernatremia, and hypokalaemia, respectively.

Data were analyzed using Statistical Package for Social Sciences (SPSS) version 23. Continuous data were expressed as mean and standard deviation, and categorical data in frequency and percentage. Paired sample t-test was used to compare mean values between two pre and post-phototherapy measures. Moreover, calcium, sodium and potassium values were categorized into average and low. A two-tailed probability of less than 0.05 was considered significant for all statistical evaluations.

Results

A total of 102 neonates were included in the study, where 66 (64.7%) were male and 36 (35.3%) female. Age at admission was ranged from 5-7 days with a mean age of 6.42 (± 0.67) days.Out of 102 included neonates in the study, 78.4% neonates the age of the onset of jaundice was more than three days before admission according to their parents.

Serum calcium and serum electrolytes were measured before phototherapy and after 48 hours of phototherapy among the studied neonates. The descriptive statistics of these biochemical parameters are shown in Table I.

Table I Descriptive statistics of serum biochemical parameters of the neonates with NH before phototherapy and after 48 hours of phototherapy (n=102)

Parameters	Before phototherapy		After phototherapy	
	Range	Mean ±SD	Range	Mean ±SD
Total bilirubin, mg/dl	18.0 – 20.8	19.2 ± 0.8	11.2 – 13.4	12.1 ± 0.6
Total calcium, mg/dl	8.1 – 9.6	8.8± 0.4	7.7 – 9.3	8.5 ±0.4
Sodium, mmol/L	135.2 – 144.3	138.4 ± 1.8	133.7– 142.1	136.4 ± 1.7
Potassium, mmol/L	3.5 – 5.19	4.1 ± 0.3	3.1 – 4.9	3.8 ± 0.3
Chloride, mmol/L	98.0 – 106.4	104.5 ± 1.6	98.5 – 105.4	102.5 ± 1.3

There was a significant reduction of serum calcium and serum electrolytes parameters after phototherapy in the study (Table II).

Table II Comparison of pre and post phototherapy serum biochemical parameter levels and their statistical significance of differences in 102 neonates with NJ

Parameters	Pre and post phototherapy paired difference				
			95% CI of the difference		
	Mean	SD	Lower	Upper	p value*
Total bilirubin, mg/dl	7.16	0.90	6.98	7.34	<0.001
Total calcium, mg/dl	0.34	0.11	0.32	0.36	<0.001
Sodium, mmol/L	2.04	1.39	1.77	2.31	<0.001
Potassium, mmol/L	0.27	0.18	0.23	0.31	<0.001
Chloride, mmol/L	2.03	0.11	1.80	2.25	<0.001

SD: Standard Deviation, CI: Confidence Interval, *p value reached from paired sample t test.

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After phototherapy, 19.6% of the neonates develop skin rashes, 9.8% were irritable and loose motion was observed in one (1%) neonate (Table III).

Table III Comparison of symptoms and signs before and during phototherapy of the 102 neonates with NJ

Symptoms / signs	Before phototherapy	During phototherapy
Loose stools	0 (0%)	1 (1.0%)
Skin rashes	0 (0%)	20 (19.6%)
Irritability	0 (0%)	10 (9.8%)

After 48 hours of phototherapy session, 21.66%, 25.5%, and 10.8% of the neonates had serum calcium level <8 mg/dl, serum sodium level <135 mmol/l and serum potassium level <3.5 mmol/l, respectively (Figure 1). Forty eight hours after phototherapy treatment 45.1% (46/102) of the patients had abnormal value in the form of hyponatremia, hypokalemia and hypocalcemia and others had serum calcium, sodium, potassium and chlorine within normal range.

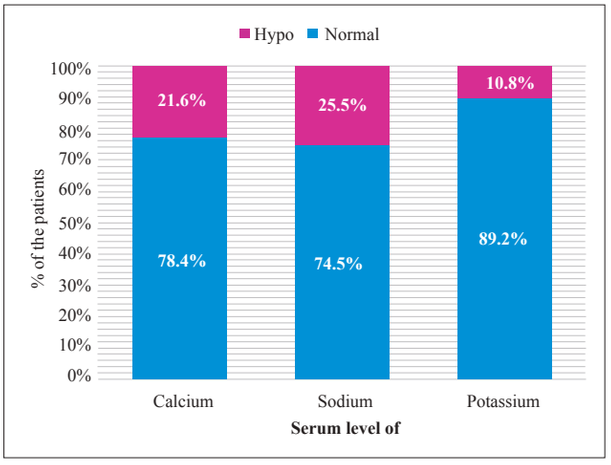

Figure 1 Serum calcium, sodium and potassium levels of the patients 48 hours after phototherapy

Discussion

The effects of phototherapy on serum calcium and electrolytes have yet to be adequately studied, especially in our setting. The present study evaluated the effects of phototherapy on serum calcium and electrolytes in neonates being treated for NJ and noted statistically significant results.

In the present study, the prevalence of hypocalcemia was 21.6%, higher than that found in previous studies, ranging between 6.2% and 14.4%.[6, 11-13] In contrast to these findings, Goyal et al. reported that 35% of the term neonates developed hypocalcemia following phototherapy.[7] The exact reasons for this difference have yet to be discovered. However, it could be lowered because of the sample size and distribution of the study population. In the present study, there was a significant decrease in the calcium level of neonates during phototherapy, which agreed with other studies.[10,11] The etiology of hypocalcemia in infants treated with phototherapy is believed to be caused by a decrease in melatonin levels and corticosterone secretion. Melatonin stimulates the secretion of corticosterone, which decreases calcium absorption by bones. Phototherapy leads to inhibition of the pineal gland by transcranial illumination, resulting in a decline in melatonin levels and as a result, hypocalcemia. Cortisol exerts a direct hypocalcemic effect by decreasing the absorption of calcium and phosphate from the intestine by antivitamin D action by increasing the renal excretion of these ions and accelerating the bone uptake of calcium.[14] In addition, urinary calcium excretion is increased after exposure to phototherapy.[15]

The incidence of hyponatremia in the present study was 25.5%, which was higher than the earlier studies, 11.1% in the study of Bezborua et al. and 3.1% in the study of Kumar et al. and Reddy et al.[6,9,11] There are very few studies regarding the mechanism of phototherapy-induced electrolyte changes. A study stated that water, sodium chloride and potassium absorption were significantly impaired in the patients receiving phototherapy.[16]

The incidence of Hypokalemia in the present study was 10.8%. Bezborua et al. reported in their study that 64.08% of neonates had a decline of serum potassium from the initial value following phototherapy and 4.73% of term neonates had developed Hypokalemia.[11] Reddy et al. found an increment of serum potassium, and only 0.4% of neonates had developed Hypokalemia, which differs from this study.[6] The reason for this is not well known. Still, it might be due to prolonged phototherapy, as the study by Curtis et al. stated that water, sodium, potassium, and chloride absorption was significantly impaired in neonates receiving phototherapy.[16]

Hypocalcemia can cause severe complications like neuromuscular irritability, myoclonic jerks, jitteriness, convulsion, cyanosis, apnea and laryngospasm.[5] In the present study, only irritability was observed in 8.1% of cases, irrespective of electrolyte levels. Other adverse events were loose motion (0.98%) and skin rash (19.61%). Goyal et al. eported 2.86% of neonates with symptomatic hypocalcemia following phototherapy.[7]

However, a few limitations should be considered while considering results. The present study was based on a small sample size with a nonrandom sampling method. Besides phototherapy, biochemical parameters may be influenced by prior and after initiating appropriate treatments, which were not considered in the study.

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Conclusions

The present study concludes that the phototherapy given for 48 hours in term neonates leads to a decrease in serum calcium, sodium, potassium and chloride levels. Incidences of hypocalcemia, hyponatremia and Hypokalemia were 21.6%, 25.5%, and 10.8%, respectively.

Recommendations

Serum electrolytes and calcium should be monitored during the phototherapy period. So that complications related to phototherapy can be timely and appropriately managed.

Disclosure

The authors declared no competing interests.

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