Global Journal of Medicine & Public Health

A study to find out the effects of phototherapy on serum electrolytes in neonatal hyperbilirubinemia

Sandesh Srivastava[1], Mani Kant Kumar[2], Rahul Kumar[3], Money Sachdeva[4]

ABSTRACT

Introduction

Neonatal jaundice is the commonest morbidity in neonatal period during the first week of life. Neonatal hyperbilirubinemia nearly affects 60% of term and 80% of preterm neonates during the first week of life. Phototherapy plays a significant role in the prevention and treatment of hyperbilirubinemia. A lesser-known side effect, but the potential complication of phototherapy is electrolyte imbalance, especially hypocalcaemia.

Aims and objectives

This study aims to evaluate the effects of phototherapy on serum sodium, potassium, chloride, calcium in neonates with neonatal hyperbilirubinemia and also to determine the incidence of hypocalcemia in neonates receiving phototherapy

Materials & methods

After the clearance from the ethical committee, we undertook a prospective observational study to assess the effects of phototherapy in neonatal hyperbilirubinemia in regards to various biochemical parameters over the period of 18 months (from 1st April 2021 to 30thSeptember 2022) in NICU of a tertiary care teaching hospital in a rural area of Bihar.

Results

Our study included 105 neonates. Levels of bilirubin profile were elevated significantly in patients prior to phototherapy and returned to normal generally after 48 hours of phototherapy. There was also a significant decline in the levels of electrolytes such as sodium, potassium, chloride, calcium (p value<0.0001). Incidence of hypocalcemia was in 6.9% of preterm neonates while in term neonates was 23.7%.

Conclusion

This study documented that phototherapy affects the serum sodium, potassium, chloride, and serum calcium. Hence, serial monitoring of serum level of these electrolytes should be considered a high-priority during management of neonatal hyperbilirubinemia.

Keywords: Neonatal Hyperbilirubinemia, Phototherapy, Serum Electrolytes.

GJMEDPH 2024; Vol. 13, issue 1 | OPEN ACCESS

4*Corresponding author Mani Kant Kumar, Professor and Head, Department of Paediatrics, Narayan Medical College and Hospital, Jamuhar, Sasaram, Rohtas, Bihar, PIN-821305, India E-mail-manikant7@yahoo.com; 1.Sandesh Srivastava, 3.Rahul Kumar, 4. Money Sachdeva;[1,3,4]Post Graduate resident. [2]Professor and Head, All from the department Of Paediatrics, Narayan Medical College and Hospital, Jamuhar, Rohtas, Bihar, India

Conflict of Interest—none | Funding—none

INTRODUCTION

Neonatal jaundice is yellowish discoloration of skin, sclera and mucous membrane. Neonatal jaundice is the commonest morbidity in neonatal period during the first week of life. The physical finding like yellowish discoloration of the skin and sclera in newborns is due to the accumulation of unconjugated bilirubin. Unconjugated hyperbilirubinemia is typically a sign of a healthy physiological process in babies. [1] During the first week of life, 60% of term and 80% of preterm newborns experience neonatal jaundice. [2]In the current period of postnatal discharge from the hospital, neonates are most frequently readmitted for neonatal hyperbilirubinemia, which is a reflection of the liver's immature excretory pathway for bilirubin.[3] Conjugated hyperbilirubinemia is a sign of underlying serious illness, and untreated, severe, unconjugated hyperbilirubinemia is possibly neurotoxic. High serum bilirubin levels can be toxic for central nervous system development and may cause behavioural and neurological impairment (Kernicterus) even in term newborns.[4,5]Jaundice can be treated with phototherapy, exchange transfusions, and medications such as phenobarbitone, intravenous immunoglobulins (IVIG), and metalloporphyrins.[6] Phototherapy nowadays standard first line treatment in the treatment of hyperbilirubinemia. It leads to changes in the structure of bilirubin, and the resulting isomers, lumirubin which is radially excreted in bile and urine. [7] Phototherapy is one of the most effective ways available in preventing the neurotoxic complications of indirect hyperbilirubinemia.[8] The downsides of phototherapy include hyperthermia, feed intolerance, loose stools, skin rashes, bronze baby syndrome, retinal abnormalities, dehydration, riboflavin shortage, redistribution of blood flow, genotoxicity, and others. [9, 10, 11] Electrolyte imbalance, particularly hypocalcemia, is a less common side effect of phototherapy but a potential concern.[12,13] Electrolyte alterations might also result from diarrhoea. Hence, Neonatal hyperbilirubinemia is a cause of concern for the parents as well as for the Paediatricians. Therefore, we intended to study what changes occur due to phototherapy and to find out whether there are any significant changes in neonate's serum sodium, potassium, chloride, calcium levels after receiving phototherapy. As hypocalcemia is already a known fact, we also studied the incidence of hypocalcemia in neonates receiving phototherapy admitted for neonatal hyperbilirubinemia receiving phototherapy.

Aims & objectives

1. To evaluate the effects of phototherapy on serum sodium, potassium, chloride and calcium in neonates with neonatal hyperbilirubinemia.
2. To determine the incidence of hypocalcemia in neonates receiving phototherapy

METHODOLOGY

This study was a prospective observational study done on 105 newborns with the laboratory confirmed diagnosis of neonatal hyperbilirubinemia who were admitted in level III Neonatal Intensive Care Unit (NICU), Department of Paediatrics, of a tertiary-care teaching hospital for a period of 18 months from 1st April 2021 to 30th September 2022.

Neonatal hyperbilirubinemia was defined as per Hour-specific Bhutani Nomogram who fulfilled the inclusion criteria were enrolled in this study. Those babies who had surgical problems, chromosomal and congenital anomalies or dysmorphism, babies born with

perinatal asphyxia, born to a diabetic mother, sepsis along with Jaundice, Rh and ABO incompatibility, neonates with conjugated hyperbilirubinemia were excluded from the study.

Approximately 2 ml of the blood was collected from all neonates 2 times with interval of 48 hours from two different sites with full antiseptic and aseptic measures and was sent for serum electrolytes, serum calcium. The samples were immediately transported to the lab and were processed accordingly

Student t-test and SPSS Version 24 were applied for analysis of data. Statistical significance was taken if p value is < 0.05. The study has been approved by the Institute Ethical Committee.

Results

Our study included 105 neonates, with laboratory confirmed diagnosis of neonatal hyperbilirubinemia. Out of 105 neonates, 43 babies were females and 62 babies were males, 29 were preterm and 76 were term babies. The mean bilirubin before phototherapy was 15.5± 2.69 mg/dl and post phototherapy bilirubin was 8.9±2.1 mg/dl (Table 1)

ISSN# 2277-9604

Table 1:Changes in total serum bilirubin after phototherapy

		Mean	N	Std. Deviation	Std. Error Mean	Mean difference	SD	P value
T.Bil (mg/dl)	Before phototherapy	15.524	105	2.6993	.2634	6.5686	2.2378	<0.0001
	After phototherapy	8.955	105	2.1083	.2057			

The mean serum sodium, serum potassium, serum chloride, serum calcium before phototherapy was 141 ± 4.5 mEq/L ,4.9 ±0.7 mEq/L ,109.6 ± 11.1 mmol/L,9.6 ± 1.23 mg/dl respectively while the mean serum sodium, serum potassium, serum chloride, serum calcium after phototherapy was 136.4 ± 4.60 mEq/L, 4.48± 0.65 mEq/L,104.6± 4.0 mmol/L ,8.8 ± 1.1 mg/dl respectively. (table 2)

Table 2. Changes in serum sodium, potassium, chloride and serum calcium after Phototherapy

		Mean	N	Std. Deviation	Std. Error Mean	Mean difference	SD	P value
S. Na (mEq/L)	Before phototherapy	141.061	105	4.5772	.4467	4.6057	5.0092	<0.0001
	After phototherapy	136.455	105	4.6072	.4496			
S. K (mEq/L)	Before phototherapy	4.904	105	.7141	.0697	.42010	.62081	<0.0001
	After phototherapy	4.4837	105	.65322	.06375			
S. Cl (mmol/L)	**Before phototherapy**	**109.637**	**105**	**11.1070**	**1.0839**	**4.9990**	**11.6979**	**<0.0001**
	After phototherapy	104.638	105	4.0076	.3911			
S. S. Ca (mg/	Before phototherapy	9.671	105	1.2351	.1205	.8210	1.0591	<0.001

ISSN# 2277-9604

dl)	After phototherapy	8.850	105	1.17 15	.114 3			

Out of 29 preterm babies, incidence of hypocalcemia was present in 2 babies (6.9%) whereas 27 babies (93.1%) did not develop hypocalcemia while among term neonates, out of 76 term neonates incidence of hypocalcemia was present in 18 babies (23.7%) whereas 58 (76.3%) babies did not develop hypocalcemia, which is statistically significant (P=0.04) and was calculated using chi square test. (table 3)

Table 3 – Incidence of hypocalcemia in neonatal hyperbilirubinemia after receiving phototherapy

			Hypocalcaemia		Total
			Absent	**Present**	
	Preterm	N	27	2	29
		%	93.1%	6.9%	100.0%
	Term	N	58	18	76
		%	76.3%	23.7%	100.0%
Total			85	20	105
			81.0%	19.0%	100.0%
P value					0.040*

There was a significant decline in the levels of electrolytes including sodium, potassium, chloride, calcium (p value <0.0001).

DISCUSSION

In the present study, a total of 105 neonates were enrolled in the study. Phototherapy has been accepted as the most widely used treatment for neonatal jaundice. This study demonstrated that the phototherapy caused significant effect on various biochemical parameters after 48hrs.

In this study, the mean serum sodium before and after phototherapy was 141 ± 4.5 mEq/L and 136.4 ± 4.60 mEq/L respectively giving a significant p value(p<0.0001). Out of 105 babies, incidence of hyponatremia was present in 34 babies (32.3%), whereas incidence of hypernatremia was present in 3 babies (2.8%). Bezboruah and Majumder[14], Jena et al.[15], and Rangaswamy et al[16], Suneja et al. [17] Reddy AT [18] and Shilpa et. al[19]which noted a significant decline in the levels of mean serum Na after 48h of phototherapy (p<0.001).

In our study, the mean serum potassium, before and after phototherapy was 4.9 ±0.7 mEq/L and 4.48± 0.65 mEq/L respectively. The fall in mean serum potassium level was statistically significant (p<0.0001). Out of 105 babies, the incidence of hypokalaemia was present in 3 babies (2.8%), whereas the incidence of hyperkalaemia was present in 6 babies (5.7%). Bezboruah and Majumder[14], Jena et al.[15], and Rangaswamy et al.[16]in their study also found a significant decline in the mean serum K after 48h of phototherapy (p<0.001) which matched with our study findings. However,, Reddy et al.[18] found no significant difference in serum potassium levels.

In our study, the mean serum chloride before and after phototherapy was 109.6 ± 11.1 and 104.6± 4.0 mmol/L respectively giving a significant p value of p<0.0001. Out of 105 babies the incidence of hypochloremia was present in 2 babies (1.9%), whereas the incidence of hyperchloremia was present in 45 babies (42.8%). There are very few studies in the literature that investigated the effect of phototherapy on chloride levels. Curtis et al. [20] reported significant decrease in serum chloride levels due to impaired intestinal chloride absorption during phototherapy which matched with our study findings.

The mean serum calcium before and after phototherapy was 9.6 ± 1.23 mg/dl and 8.8 ± 1.1 mg/dl respectively giving a significant p value of p< 0.0001. Xiong T et al [21], Bezboruah G et al [14], Jena PK et al [15], Rozario CI et al. [22]found a significant decline in the mean serum calcium

ISSN# 2277-9604

after 48h of phototherapy (p<0.0001) which matched with our study findings. Out of 105 babies, 29 were preterm babies and incidence of hypocalcemia was present in 2 babies (6.9%) whereas 27 babies (93.1%) did not develop hypocalcemia. Similarly in 76 term babies incidence of hypocalcemia was present in 18 babies (23.7%) whereas 58 babies did not develop hypocalcemia. P value was 0.040 and was calculated using chi square test.Karamifar H et al. [23]also found similar results and, the incidence of hypocalcemia after 48 h of phototherapy was 15 %.

CONCLUSION

From the present study, we conclude that Neonatal hyperbilirubinemia is thought to be a manageable illness, and with the right treatment, many of its negative effects can be reduced significantly. During phototherapy, the amount of serum electrolytes in infants may vary. After phototherapy, serum calcium, sodium, and chloride levels could decrease. The clinical course of babies receiving phototherapy should take the changes in electrolyte levels into consideration, and the appropriate fluid-electrolyte management should be administered.

ACKNOWLEDGMENT

I am forever indebted and will stay thankful to all my colleagues and entire NICU team for their ongoing support and last but not the least, patients.

REFERENCES

1. Kliegman RM. Jaundice and Hyperbilirubinemia in the Newborn. In: Behrman R, Nelson textbook of Paediatrics. 20th ed. Philadephia: Elsevier. 2015:871- 875.
2. Singh M. Care of the newborn. 7th ed. New Delhi: sagar publications. Chapter 18, Neonatal Jaundice. 2010:254-74.
3. Maisels MJ, Avery GB, eds. Jaundice in Neonatology, pathophysiology and management of newborn, 4th ed.765-820.
4. Kiviahan C, Jams EJ. The natural history of neonatal jaundice. Pediatr. 1984; 74:364-70.
5. Paludetto R, Mansi G, Raimondi F, Romano A, Crivaro V, Bussi MD, et al. Moderate hyperbilirubinemia induces a transient alteration of neonatal behaviour. Pediatr. 2002;110: e50.
6. Ullah S, Rahman K, Hedayati M. Hyperbilirubinemia in neonates: Types, causes, clinical examinations, preventive measures and treatments: a narrative review article. Iran J Public Health. 2016;45(5):558-68.
7. Mesic I, Milas V, Medimurec M, Rimar Z. Unconjugated pathological jaundice in newborns. CollAntropol. 2014;38(1):173-8.
8. Yadav RK, Sethi RS, Sethi AS, Kumar L, Chaurasia OS. The evaluation of the effect of phototherapy on serum calcium level. People's J Sci Res. 2012;5(2):1-4.
9. Maisels MJ, Kring E. Length of stay, jaundice, and hospital readmission. Paediatrics 1998;101: 995–998
10. Gregory MLP, Martin CR, Cloherty JP. Neonatal Hyperbilirubinemia. In: Cloherty JP, Eichenwald EC, Hansen AR, Stark AR (eds.) Manual of neonatal care. 7th ed. Philadelphia: Lippincott Willams and Wilkins; 2012. p304 -339.
11. Narayana S, Aggarwal R, Upadhyay A, Deorari AK, Sindh M, Paul VK. Survival and morbidity in extremely low birth weight (ELBW) Infants. Indian Pediatr. 2003;40(2):130-135.
12. Bowman J. Thirty-five years of Rh prophylaxis. Transfusion. 2003;43: 1661-6.
13. Knox I, Ennever JF, Speck WT. Urinary excretion of an isomer of bilirubin during phototherapy. Pediatr Res. 1985 Feb;19(2):198-201.
14. Bezboruah G, Majumder AK (2019) Electrolyte imbalances resulting from phototherapy in neonatal hyperbilirubinemia. IOSR-JDMS18:51–58. https://doi.org/10.9790/0853-1808015158
15. Jena PK, Murmu MC, Bindhani T (2019) A study on electrolyte changes in neonates receiving phototherapy for neonatal hyperbilirubinemia. J Evolution Med Dent Sci 8:2105–2109.
16. Rangaswamy KB, Yeturi D, Gowda ANBL, Krishna C, Samyuktha. Study of sodium and potassium changes in term neonates receiving phototherapy. Int J ContempPediatr 2019; 6:1076-9.
17. Suneja S, Kumawat R, Saxena R (2018) Effect of phototherapy on various biochemical parameters in neonatal hyperbilirubinemia: a clinical insight. Indian J Neonatal Med Res 6:PO13–PO18
18. Reddy AT, Bai KV, Shankar SU. Electrolyte changes following phototherapy in neonatal hyperbilirubinemia. Int J Sci Res 2015; 7: 752-8
19. Shilpa S, Kumawat R, Saxena R. Effect of phototherapy on various biochemical parameters in neonatal hyperbilirubinaemia: a clinical insight. Indian J Neonatal Med Res 2018; 6: 13-8.
20. Curtis MD, Guandalini S, Fasano A, Saitta F, Ciccimarra F. Diarrhoea in jaundiced neonates treated with phototherapy: role of intestinal secretion. Arch Dis Child 1989; 64: 1161-4.
21. Xiong T, Qu Y, Cambier S, Mu D. The side effects of phototherapy for neonatal jaundice: what do we know? What should we do?.Eur J Pediatr. 2011 Oct 1;170(10):1247-55
22. Rozario CI, Pillai PS, Ranamol T. Effect of phototherapy on serum calcium level in term newborns. Int J Contemp Pediatr.2017;4:1975-9
23. Karamifar H, Pishva N, Amirhakimi GH. Prevalence of Phototherapy Induced Hypocalcemia. Iran J Med Sci 2002; 27: 166-8.