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TO STUDY EFFECT OF PHOTOTHERAPY ON SERUM SODIUM, POTASSIUM AND CHLORIDE LEVELS IN NEONATAL JAUNDICE

Paediatrics

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ABSTRACT

INTRODUCTION The most common morbidity in the first week of life is the jaundice which occurs in 80% of term and 60% of preterm neonates and is the most often causes readmission after the baby is discharged from the hospital. The treatment of neonatal hyperbilirubinemia is phototherapy. Like any other treatment modality, phototherapy also has side effects of which very few studies were done on electrolyte disturbances. Hence present study was designed to determine the serum sodium, potassium and chloride changes in neonates receiving phototherapy for neonatal jaundice.

AIMS AND OBJECTIVES To study the effect of phototherapy on serum sodium, Potassium and Chloride levels in neonates with neonatal hyperbilirubinemia.

MATERIALS AND METHODS This Hospital Based Longitudinal Observational Study was done in the Department of Paediatrics at MMIMSR, Mullana over a period of one and a half year. Serum bilirubin, sodium, Potassium and Chloride levels were measured before initiation of phototherapy and on termination of phototherapy.

RESULTS The study included 100 neonates with hyperbilirubinemia treated with phototherapy with male: female ratio of 58%:42%.The mean gestational age was 37.681.63 weeks and birth weight was 2.790.38kgs. The age of onset of phototherapy and duration of phototherapy were 3.802.50 days and 28.627.02 hours respectively. Before phototherapy, the total serum bilirubin, sodium, potassium and chloride levels were 13.87±1.41,140.72±3.45,4.55±0.44 and 106.08±3.1 respectively which decreased to 9.50±1.60,137.45±3.09,4.20±0.46 and 104.52±3.91 with statistically significant change in bilirubin($p<0.0001$),sodium($p<0.0001$), potassium($p<0.0001$) and Chloride($p=0.0038$).

KEYWORDS

INTRODUCTION

Neonates are defined as infants born between birth and first 28 days of life. Preterm neonates are those who are born before 37 completed weeks of gestational age and term are the ones who are born at 37 to <42 completed weeks of gestational age [1].The most common morbidity in the first week of life is the jaundice which occurs in 80% of term and 60% of preterm neonates and is the most often causes readmission after the baby is discharged from the hospital [2].

Jaundice is defined as yellow discoloration of the eyes and skin caused by elevated serum bilirubin concentration (hyperbilirubinemia). Unconjugated hyperbilirubinemia also termed as indirect hyperbilirubinemia is the most common type of hyperbilirubinemia whereas direct bilirubinemia is termed as conjugated hyper bilirubinemia[3].

Depending on its cause and the degree of elevation, hyper bilirubinemia may be harmful or harmless. Mostly it is physiologic and is self-limiting, but sometimes it may require intervention like phototherapy [4].

Most dangerous consequence of neonatal hyperbilirubinemia is neurotoxicity. Kernicterus is the severe form of neurotoxicity. The pathogenesis of bilirubin encephalopathy is related to the interplay between level of unconjugated bilirubin which is lipid soluble, gestational maturity of the infant and integrity of blood brain barrier [5].

Phototherapy converts unconjugated bilirubin in to water soluble forms by photoisomerisation using blue light, which can be easily and rapidly excreted by the kidneys and liver without glucoronidation. Like any other treatment modality, phototherapy also has side effects like temperature instability, dehydration, loose stools, skin rashes, bronze baby syndrome, retinal damage, riboflavin deficiency, increased red cell osmotic fragility, DNA damage and electrolyte disturbances [6].

AIMS AND OBJECTIVES

To study the effect of phototherapy on serum sodium, Potassium and Chloride levels in neonatal jaundice.

METHODS:-

This was a hospital based longitudinal observational study which included 100 neonates with neonatal hyperbilirubinemia conducted between January, 2020 till June, 2021 in NICU at MMIMSR, Mullana.

Incluson Criteria

1. Neonates with unconjugated hyperbilirubinemia requiring phototherapy

Exclusion Criteria

1. Neonates with hyperbilirubinemia requiring exchange transfusion
2. Birth asphyxia
3. Sepsis
4. Infants born to diabetic mothers
5. Neonates receiving IV Fluid
6. Respiratory distress
7. Congenital malformation
8. Mothers taking anticonvulsant drugs

A prior approval of The Institutional Ethics committee was obtained. The study didn't impose any financial burden on the parents or guardians of the study group and an informed written consent was taken from the parents/guardians of the participants before conducting the study. All participants were ensured confidentiality. The study was not funded by any agency.

Serum Bilirubin, sodium, potassium and chloride levels were assessed for each participant enrolled in this study at the starting and post-phototherapy. Total serum bilirubin is measured by diazo method. Serum sodium, Potassium and Chloride levels are measured by **EasyLyte® automated analyser** by a process known as potentiometry.

Statistical Analysis:

The data was compiled and analyzed using MS Excel (R) office 365, Graph Pad prism 8.4.2 and SPSS version 25. Descriptive statistics were presented in the form of proportions/percentages for categorical variables and mean & standard deviation for continuous data variables. Fisher Exact test/Chi square test was used for the comparison of proportions (Categorical variables).Continuous variables were

analyzed using the Mann Whitney test/student T test (Independent group/Unpaired data) and Wilcoxon sign rank test/Paired T test (for paired data) based on the normality of the data. P value of <0.05 was considered significant.

RESULTS:

Table 1: Demographic profile of the study participants

Variable	Mean
Gestational Age	37.68 ± 1.63 weeks
Birth Weight	2.79 ± 0.38 Kgs
Age of onset of Phototherapy	3.80 ± 2.51 days
Duration of Phototherapy	28.62± 7.02 hours
Mode of Delivery	No of Participants (%)
Male	58(58)
Female	42(42)
Preterm	22(22)
Term	78(78)
Normal Vaginal Delivery (NVD)	42(42)
Lower Segment Caesarean Section (LSCS)	58(58)

Table 2: Overall Change in mean S. Bilirubin and S. Electrolyte Levels

	Pre-phototherapy	Post-phototherapy	significance
S. Bilirubin	13.87±1.41	9.50±1.60	p<0.0001
S. Sodium	140.72±3.45	137.45±3.09	p<0.0001
S. Potassium	4.55±0.44	4,20±0.46	p<0.0001
S. Chloride	106.08±3.1	104.52±3.91	p=0.0038

*Unit: milligram/decilitre (mg/dL)

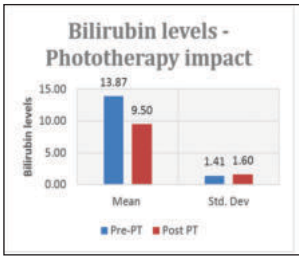

Figure 1: Change in mean S. lirubin

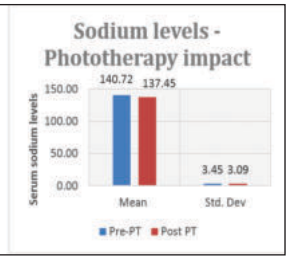

Figure 2: Change in mean S. Sodium

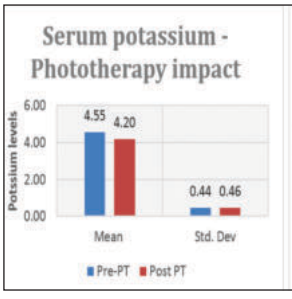

Figure 3: Change in mean S. Potassium

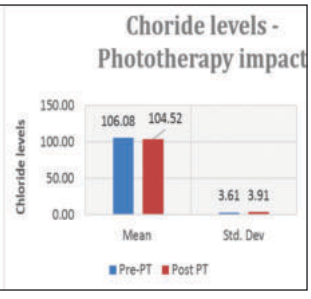

Figure 4: Change in mean S. Chloride

C. Correlations:-

Table 3: Correlation between change in electrolyte levels and period of gestation

Electrolyte levels and POG	Preterm	Term	Grand Total	P value
Na^+ <135	3 (13.63%)	10 (12.82%)	13	0.9202
Na^+ >135 or more	19 (86.37%)	68 (87.18%)	87	
Grand Total	**22**	**78**	**100**	
K+ 3.5-5.5	21 (95.45)	74 (94.87)	95	0.9127
K+ <3.5	1 (4.55)	4 (5.13)	5	
Grand Total	**22**	**78**	**100**	

There was no significant difference in the post phototherapy electrolyte levels on the basis of the status of time of birth (term/preterm).

Table 4: Correlation between change in electrolyte levels and Birth Weight

Electrolyte levels and birth weight	LBW	Not LBW	Grand Total	P value
Sodium < 135	2 (10%)	11 (13.75%)	13	0.1286
Sodium 135 or more	18 (90%)	69 (86.25%)	77	
Grand Total	**20**	**80**	**100**	
K+ 3.5-5.5	76 (95)	19 (98)	95	0.5605
K+ <3.5	4 (5)	1 (5)	5	
Grand Total	**20**	**80**	**100**	

There was no significant difference in the post phototherapy electrolyte levels on the basis of the status of birth weight.

Table 5: Correlation between change in electrolyte levels and Age at phototherapy onset

Electrolyte levels and Age at PT initiation	3 days or less	More than 3 days	Grand Total	P value
Sodium <135	6 (9.23%)	7 (20%)	13	0.6261
Sodium 135 or more	59 (90.77%)	28 (80%)	87	
Grand Total	**65**	**35**	**100**	
K+ 3.5-5.5	63 (96.92)	32 (91.42)	95	0.2313
K+ <3.5	2 (3.08)	3 (8.58)	5	
Grand Total	**65**	**35**	**100**	

We did not observe a significant difference in the post phototherapy electrolyte levels on the basis of age at which the phototherapy was initiated.

Table 6: Correlation between change in electrolyte levels and Duration of phototherapy

Electrolyte levels and PT duration	24 hours	More than 24 hours	Grand Total	P value
Sodium <135	4 (8.16%)	9 (17.64%)	13	0.6564
Sodium 135 or more	45 (91.83%)	42 (82.35%)	87	
Grand Total	**49**	**51**	**100**	
K+ 3.5-5.5	47 (95.91)	48 (94.11)	95	0.9166
K+ <3.5	2 (4.09)	3 (5.89)	5	
Grand Total	**49**	**51**	**100**	

There was no significant difference in the post phototherapy electrolyte levels on the basis of duration of phototherapy.

DISCUSSION

A. Phototherapy induced bilirubin and electrolyte changes

In the present hospital based study, the overall change in mean serum bilirubin levels was from a baseline of 13.87 1.41 mg/dl to 9.50 1.60 mg/dl. This change in the mean value was found to be statistically significant (p < 0.0001). Like our study, **Rangaswamy et al.[7] (2019)** observed the change in serum bilirubin levels from 16.13±2.34 mg/dl to 9.32±1.99 mg/dl which was found to be statistically significant (p<0.01).

In the index study the mean serum sodium level changed from 140.72 3.45 mEq/L to 137.45 3.09 mEq/L. This change in the serum sodium level was found to be statistically significant (p < 0.0001). **Gayatri Bezborauh et al.[8] (2019)** reported a similar change in serum sodium level from a baseline of 141.97 2.795 mEq/L to 140.66 4.751 mEq/L post phototherapy. These results were similar to our study and was statistically significant (p<0.0001).

In the present study the mean serum potassium level changed from 4.55 0.44 mEq/L to 4.20 0.46 mEq/L. This change in the serum potassium level was found to be statistically significant (p <0.0001). **Uzzal Kumar Ghosh et al.[9] (2020)** reported a change in serum potassium level from a baseline of 3.97 0.48 mEq/L to 3.67 0.57 mEq/L post phototherapy. These results were in correlation with our study and was statistically significant (p <0.0001).

In this hospital based study, the mean serum Chloride level changed from 106.08 3.61 mEq/L to 104.52 3.91 mEq/L. This change in the serum Chloride level was found to be statistically significant (p=0.0038). **Shilpa suneja et al.[10] (2018)** reported a change in serum Chloride level from a baseline of 122.46 18.9 mEq/L to 108.55 9.8 mEq/L post phototherapy. These results were similar to our study and was statistically significant (p=0.001).

In the present study the incidence of hyponatremia and hypokalemia was 13% and 5% respectively. No babies were found to be hypochloremic following phototherapy. None of the neonates developed signs and symptoms of electrolyte disturbances.

B. Correlations:

In our study, out of a total 13 neonates who were hyponatremic, higher percentage of preterm neonates (13.63%) were hyponatremic compared to 12.82% term neonates. The result was statistically insignificant with p=0.9202. In a similar study by **Swathi M. et al.** [11] hyponatremia is observed in 11.11% of preterm and 12.73% of term neonates. In a study by **Reddy et al.** [12] 17.6% of preterm and 3.1% of term were hyponatremic.

In the index study 20% of the study participants were low birth weight (<2.5kgs) while 80% were normal birth weight babies (2.5kgs). Amongst the low birth weight babies, 10% developed hyponatremia and 13.7% of the babies with normal birth weight developed hyponatremia. This association was however found to be statistically insignificant (p = 0.1286). **Swathi M. et al.** [11] in their study, reported hyponatremia in 5.13% of low birth weight and 14.8% of normal birth weight babies

In this hospital study, hyponatremia is observed in 9.23% of neonates and 20% of neonates when age of onset of phototherapy is <3days and >3days respectively.

In the present study hyponatremia is seen in 8.16% of neonates when phototherapy is given for 24 hours and 17.64% when phototherapy given for more than 24 hours. This association was found to be statistically insignificant (p = 0.6564). **Phani Krishna M. et al.** [13] in their study, reported hyponatremia in 17.4when duration of phototherapy is >48hours. **Reddy AT et al.** [12] **(2013)** showed hyponatremia in 18.8% of neonates who received phototherapy for >48 hours.

In our study, hypokalemia is seen in 5.13% of term and 4.55% of preterm neonates but the result was statistically insignificant with p=0.9127 and 5% in both low birth weight and normal weight babies which is also statistically insignificant with p=0.5605. With respect to duration of phototherapy, 4.09% and 5.89% had hypokalemia when duration is 24hours and >24hours respectively. Hypokalemia is seen in 3.08% of neonates and 8.58% of neonates when age of onset of phototherapy is <3days and >3days respectively.

CONCLUSION:

In the present study there was a significant change in electrolyte levels with phototherapy and the incidence of phototherapy induced hyponatremia was 11 % and hypokalemia was seen in 5% of the study population. No baby was found to be hypochloremic and there was no significant difference in the post phototherapy electrolyte levels on the basis of period of gestation, birth weight, age of onset of phototherapy and duration of phototherapy. Out of all the babies who developed electrolyte disturbances none were symptomatic.

These results suggest that neonates requiring phototherapy are at risk of developing phototherapy induced electrolyte disturbances.

In the light of the above data, it can be deduced that phototherapy induced electrolyte disturbances is a significant concern and as electrolytes abnormalities result in severe short term and long term adverse effects, prompt recognition and administration of electrolytes may be considered in newborns requiring phototherapy.

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Conflicts of interest: There are no conflicts of interest

Limitations: In our study, the participants were relatively small in number. Thus, the result of this thesis cannot be generalized for a larger population. Therefore, complementary studies with larger sample size and diverse demographic profile are needed.

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