International Journal of Contemporary Pediatrics
Beniwal N et al. Int J Contemp Pediatr. 2022 Jan;9(1):94-99
http://www.ijpediatrics.com
pISSN 2349-3283 | eISSN 2349-3291

DOI: https://dx.doi.org/10.18203/2349-3291.ijcp20214945

Original Research Article

A study on effect of phototherapy in term new-born in a tertiary care centre in south Rajasthan

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Received: 12 November 2021
Revised: 06 December 2021
Accepted: 08 December 2021

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ABSTRACT

Background: Phototherapy is a safe and effective method for management of neonatal hyperbilirubinemia with no serious untoward side effects. Hypocalcemia is a common and lesser observed adverse effect of phototherapy.
Methods: This study was a prospective observational study done in department of pediatrics, RNT Medical College, Udaipur (Rajasthan). Serum calcium level was observed in term neonates admitted for phototherapy.
Results: Out of total 80 neonates included in study 40 received phototherapy and 40 were control. Neonates receiving phototherapy had significantly lower level of serum calcium. Other complication were rashes, loose stool, fever and dehydration.
Conclusions: We can conclude from this study that hypocalcemia is a significant complication of phototherapy in newborn and probably monitoring of serum calcium level in babies under phototherapy is warranted.

Keywords: Phototherapy, Hypocalcemia, Neonates

INTRODUCTION

The term jaundice is derived from French word "Jaune" which means yellow syndrome. Jaundice is characterized by hyperbilirubinemia and deposition of bile pigment in the skin, mucus membrane and sclera which results in yellow appearance of the patient, it is also called "Icterus'.

Jaundice is observed during first week of life in approximately 60% of full-term newborn and 80% of preterm new born.[1]

Serum total bilirubin concentration in premature infants is higher, persist longer, and are more likely to be associated with neurological injury than those in term neonates (Hockitch, 1994).[2] Jaundice can be classified as physiological or non-physiological (pathological). Although nature has supreme wisdom and it has provided useful protection to baby against oxygen free radical triggered neonatal injury as bilirubin has potent antioxidant property.[3] However, untreated severe indirect hyperbiliruninemia is potentially neurotoxic which can lead to kernicterus. Commonly used therapeutic modalities in management of neonatal hyperbilirubinemia are: exchange transfusion, phototherapy and drug therapy.

Phototherapy is an appropriate and relatively safe measure in reducing indirect bilirubin levels in newborn. The pioneer work of Cremer et al on phototherapy revolutionized the management of neonatal hyperbilirubinemia. Phototherapy is now one of the most commonly used method of treatment of hyperbilirubinemia.[4]

Although phototherapy is only most effective and widely accepted method for management of neonatal

hyperbilirubinemia but all type of phototherapy units are having some short and long term adverse effect on neonates.[5-8]

The commonly known adverse effects of phototherapy are loose green stools, hyperthermia, insensible water loss and dehydration, skin rashes and skin burns, photo-retinitis, bronze baby syndrome, haemolytic anemia due to photo-oxidation of red cells, tanning of skin, DNA damage.[5,6,10] Different studies found that phototherapy influences the level of electrolytes and other ions especially on serum calcium and sodium levels during initial 24-72 hours of life.

In particular Romagnoli et al noted the association of hypocalcemia with the use of phototherapy.[11]

Similar finding was confirmed in the study of Hakanson and Bergstron in 1980 and they found that hypocalcemia was accompanied with decreased in serum melatonin level. Based on this observation they proposed that probably light induced hypocalcemia may result from increased calcium uptake by bone when blocking effect of melatonin decreases. This hypothesis further supported by observation that this effect can be prevented by shielding of occiput .[12]

Till date no much data is available, only few studies have documented the effect of phototherapy on serum calcium level in newborn. So, we have planned to study to find out the effect of phototherapy on total serum calcium level and other short term clinical side effect in newborn who are receiving phototherapy.

METHODS

This study was a prospective observational study. Study was done in department of pediatrics, RNT Medical College, Udaipur (Rajasthan) which is a tertiary level hospital. Study was done from July 2020 to December 2020. Ethical approval was taken from institutional ethics committee.

Inclusion criteria

All term neonates admitted for neonatal hyperbilirubinemia whose parents gave consent were included in study. Demographically matched healthy term neonates were included as controls.

Exclusion criteria

Hemodynamically unstable neonates, neonates with major congenital malformation and those whose parents did not give consent were excluded from study.

Total 80 neonates were included in study out of which 40 were given phototherapy and 40 were included as controls. Serum calcium level and other parameters were tested for both cases and controls. Other side effects of phototherapy were also noted. Results were analysed statistically by Statistical package for social sciences (SSPS) version 4.

RESULTS

Total 80 term neonates were included in study. Out of these 40 were having hyperbilirubinemia and were given phototherapy. Forty were included as control. Both groups were comparable in demographic profile like age, sex, gestation and birth weight.

Table 1: Demographic profile of term babies included in study.

Demographic profile	Study group	Control group
Gender		
Male	24	22
Female	16	18
Gestation age	39.7±1.362	39.2±1.573
Birth weight	2.90±0.41	2.94±0.43
Age of onset of jaundice	3.4±0.74	3.5±1.0

Table 2: Distribution of mother blood group in full term babies.

MBG	Full term study group		Full term control group		Total	
	No.	**%**	**No.**	**%**	**No.**	**%**
A+	7	17.5	4	10.00	11	15.00
AB+	0	0.00	4	10.00	4	3.33
B-	0	0.00	4	10.00	4	3.33
B+	11	27.5	16	40.00	27	31.67
O+	22	55.0	12	30.00	34	46.67
Total	40	100	40	100.00	60	100.00

The most common blood group among mother 28 (46.67%) was O+ (positive) with 22 (55%) of the study group and 12 (30%) of control group. Followed by 27 (31.67%) mother were B+(positive) whereas 4 (3.33%) mother were Rh-(negative).

Most common blood group was O+ in 16 (20%) neonates followed by A+ in 12 (16.66%). 14 (35%) neonate in study and 6 (15%) neonate in control group had ABO incompatibility.

The most common complication was rashes in 9 (22.5%) followed by loose stool in 6 (15%), fever in 3 (7.5%) and dehydration in 1 (2.5%). Among these complications one neonate had both fever and loose stool.

Both study and control group showed significant weight loss.

Table 3: Distribution of blood group of full term babies.

BBG	Full term study group		Full term control group		total	
	No.	%	No.	%	No.	%
A+	8	17.50	4	10.00	12	16.66
B-	0	0.00	4	10.00	4	3.33
B+	8	20.00	2	5.00	10	15
O+	8	22.50	8	20.00	16	20
Not available	16	40.00	22	55.00	38	45
Total	40	100.00	40	100.00	80	100

Table 4: Complications of phototherapy in full term babies.

	Full-term study group	Total
Complications	No.	%
Dehydration	1	2.0
Fever	2	5.00
Loose stool	5	12.50
Loose stool, fever	1	2.50
Rashes	9	22.50
Asymptomatic	22	55.00
Total	40	100.00

Table 5: Fall in weight in full-term babies.

Group	Study group		Control group	
	Pre-study	Post-study	Pre-study	Post-study
N	40	40	40	40
Mean	2.912	2.853	2.894	2.863
SD	0.3795	0.3768	0.4267	0.4252
P value	<0.001		<0.001	

Table 6: Change in serum bilirubin in full term babies.

Group	Study group		Control group	
	Pre-study	Post-study	Pre-study	Post-study
N	40	40	20	20
Mean	16.29	11.4	10.78	10.04
SD	1.597	1.93	2.721	2.478
P value	<0.001		0.087	

Daily serum bilirubin level was checked and neonate under phototherapy had statistically significant fall in serum bilirubin level was observed.

The hemoglobin level in full term study group showed a statistically significant (p<0.001) fall after phototherapy with mean from 16.40 gm/dl to 15.50 gm/dl. No significant changes was observed in control group (p=0.28).

Table 7: Change in mean hemoglobin level in full term babies.

Group	Study group		Control group	
	Pre-study	Post-study	Pre-study	Post-study
N	40	40	20	20
Mean	16.4	15.5	16.05	15.82
SD	1.355	1.558	1.534	1.227
P value	<0.001		0.288	

Table 8: Change in mean total serum calcium level in full term babies.

Group	Full term study group		Full term control group	
	Pre-study	Post-study	Pre-study	Post-study
N	40	40	20	20
Mean	8.536	7.546	8.347	8.41
SD	0.5478	0.4687	0.3275	0.3077
P value	<0.001		0.417	

The pre-study mean serum calcium level in the study group was 8.53±0.54 mg/dl and post-study level was 7.54±0.46 mg/dl while pre-study mean serum calcium in control group was 8.34±0.32 mg/dl and post-study level was 8.41±0.30 mg/dl. The decrease in serum calcium in study group was statistically significant (p<0.001). 15% (n=6) neonates developed hypocalcemia of these 50% (n=3) neonates were symptomatic and 50% (n=3) were asymptomatic.

DISCUSSION

Jaundice is the most common abnormal physical finding during first week of life. Mostly this process is benign. Traditionally jaundice is classified into physiological and pathological. Management of jaundice is needed, if it is pathological. The two most common modes of management of hyperbilirubinemia are phototherapy and exchange transfusion.

The pioneer work of Cremer et al on phototherapy revolutionized the management of neonatal hyperbilirubinemia. Efficacy of phototherapy in prevention and management of neonatal hyperbilirubinemia has been well established by several controlled studies. [4,13]

Phototherapy has now replaced the exchange transfusion as preferred modality for management of hyperbilirubinemia in the newborn. This major shift was

because of safety and efficacy of phototherapy in comparison of exchange transfusion. Although phototherapy has enabled medical professionals in avoiding high risk of invasive procedure i.e. exchange transfusion but it has some side effect as well.

The commonly known side effects of phototherapy are loose stools, dehydration, fluid loss, skin rashes, retinal damage, thrombocytopenia, bronze baby syndrome, riboflavin deficiency and DNA damage etc. A lesser studied and commonly neglected but potential side effect of phototherapy is "hypocalcemia". So, we have conducted this study to find out the effect of phototherapy on total serum calcium level and other short term clinical side effects of phototherapy in newborn receiving phototherapy.

The present study was carried out in neonatal unit of a tertiary level hospital in Rajasthan to find out the effect of phototherapy on total serum calcium level in newborn babies. In this study we also compared effect of the phototherapy on total serum calcium level full term (≥37 week) babies.

All the neonates included in this study were within one week of age (2-7 days). The present study included 80 neonates. In study group of full-term babies 60% were male and 40% were female, in control group of full term babies 58.33% male and 41.67% female. This difference was not statistically significant ($p>0.05$). Both groups were comparable. (Table 1)

Mean gestational age in full term study group was 39.7±1.36 weeks and in control group 39.2±1.57 weeks (Table 1). The gestation age was almost same in both study and control with no statistical difference ($p>0.05$).

The mean birth weight in full term study group was 2.90±0.41 kg while mean birth weight in full term control group was 2.94±0.43 kg with a range of 2.4-3.75 kg and 2.3- 3.75 kg respectively with no statistically significant difference ($p>0.05$, Table 1).

We have investigated blood groups of babies and mothers to find out blood group incompatibility. It was observed that majority of mother were O+ (positive) which constituted 46.7% of blood groups. The predominant blood group of neonates also was O+ (positive). ABO incompatibility was present 30% (24) of babies.

All the neonates who had hyperbilirubinemia requiring management of jaundice were included in the study group and subjected to phototherapy for management. This decision was based on curves by Bhutani et al.[14] Those neonates, who had mild jaundice but did not require phototherapy for management, were included in the control group.

In our study most of newborn (50.8%) were delivered to primigravida mother. Mean bilirubin level in full term study group at starting of phototherapy was 16.29±1.597 mg/dl and after 48-72 hours of phototherapy it was 11.40±1.93 mg/dl while in control group initial bilirubin was 10.78±2.72 mg/dl and after 48-72 hours it was 10.04±2.47 mg/dl, statistically significant fall in serum bilirubin was observed under phototherapy ($p<0.001$), (Table 6).

The mean haemoglobin level in study group showed significant fall from 16.40 gm/dl to 15.50 gm/dl ($p<0.001$). But fall in full term control group from 16.05 gm/dl to 15.82 gm/dl was not statistically significant ($p=0.288$) (Table 7).

In our study no serious untoward side effects of phototherapy was reported. The commonly observed side effects of phototherapy in our study were rashes and loose stool. Rashes were present in 22.5%, followed by loose stools which were present in 12.5% of total neonates. (Table 4)

In this study signs of dehydration were reported in 2% of babies who received phototherapy. Other symptom was fever which was 7.5% in full term babies.

Other workers in their studies (Mishra et al 1980, Drew et al 1976, Maisels et al 2008 and Brown et al etc.) also noticed the same adverse effects of phototherapy which are rashes, loose stools fever and dehydration.

The problem of loose stools was first described by Brown et al.[15] John et al also reported watery and green stool in infants receiving phototherapy during their study.

Many researchers had given various theories and pathophysiologies of increased frequency of stool in babies under phototherapy.

Rubaltelli et alshowed reduced intestinal transit time in neonate receiving phototherapy.[16] Bakken observed temporary lactase deficiency and proposed that diarrhoea attributed to this by osmotic mechanism.[17] Curtis et al rejected osmotic mechanism and proposed that pathogenic mechanism of diarrhoea to be traced in secretary nature.[18] Whitington et al showed that unconjugated bile act in intestine as secretogogue.[19]

Drew et al reported that infant developed transient rashes on trunk, face and limbs after exposure to phototherapy. These rashes resemble so called "flea bitten dermatitis".[7]

In our study decrease in weight in full term study group was from 2.91±0.37 kg to2.85±037 kg and in control group from 2.89±0.426 kg to2.86±0.425 kg. (Table 5). Weight loss was observed in study groups as well as in control groups which was statistically significant ($p<0.001$). This observation followed normal weight loss

pattern although exaggerated in babies receiving phototherapy.

Phototherapy is affecting the serum electrolytes including serum calcium. Less known and there are less studies documenting the hypocalcemia a common adverse effect on icteric newborn who are receiving phototherapy. Pathogenesis of hypocalcemia due to phototherapy is not clear exactly.

Hypocalcemia is routinely defined as total serum calcium level <7 mg/dl in neonate. After birth calcium level in newborn falls and nadir of low serum calcium is reached by 36-48 hours.

In this study, the mean total serum calcium level pre-study (before starting of phototherapy) in full term was 8.536±0.547 mg/dl and in full term control group was 8.347±0.237 mg/dl. Post study serum calcium in study group was 7.546±0.468 mg/dl while in control group 8.41±0.307 mg/dl (Table 8). The fall in total serum calcium level was observed in babies received phototherapy and this fall was statistically significant ($p<0.001$) while difference in control group was not statistically significant ($p=0.417$).

6 (15%) neonates in full term study group developed hypocalcemia (serum total calcium <7 mg/dl) and out of these 3 (50%) had symptom of hpocalcemia and 3 (50%) had no symptom. Among the symptomatic neonates 1 neonate had jitteriness, 1 had irritability and 1 neonate had both jitteriness and irritability. Thus, most common symptom was irritability and jitteriness.

Romagnoli et al noted association of hypocalcemia with phototherapy in premature neonates. In this study 22 out of 42 babies developed hypocalcemia in study group i.e. 52.3% while in control group 6 out 49 had hypocalcemia i.e. 12.2%, the difference was statistically significant.

Sethi et al reported hypocalcemia in 90% pre term and 75% in full term received phototherapy. None of neonate developed seizures. Similar to our study jitteriness was commonest symptom of hypocalcemia observed and none hypocalcemic neonate developed convulsion.

Karamifer et al had studied 153 neonates and found that 14.4% neonates developed hypocalcemia when they received phototherapy. There was significant difference between prevalence of hypocalcemia in pre term (22.5%) and full term (8.5%).

As mentioned in above studies hypocalcemia is important complication of phototherapy which occurs in both full term and pre term babies. Our study has also observed the hypocalcemia as a side effect of phototherapy and further strengthening the previous studies.

Limitations

Our study is a single centre study and sample size is small.

CONCLUSION

We can conclude from this study that hypocalcemia is a significant complication of phototherapy in newborn and probably monitoring of serum calcium level in babies under phototherapy is warranted. Phototherapy is a safe and effective method for management of neonatal hyperbilirubinemia with no serious untoward side effects. Hypocalcemia is a common and lesser observed adverse effect of phototherapy.

Recommendations

We recommend supplementation of extra calcium in neonates who receive phototherapy particularly for pre term babies routinely which check phototherapy induced hypocalcemia and also prevent osteopenia of prematurity. As oral calcium preparation does not produces any significant side effects we can safely supplement calcium to full term babies who are receiving phototherapy. We also recommend the monitoring of serum calcium levels and clinical symptoms of hypocalcemia in neonates under phototherapy.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Beniwal N, Dangi N, Sanadhya A, Asif M. A study on effect of phototherapy in term new-born in a tertiary care centre in south Rajasthan. Int J Contemp Pediatr 2022;9:94-9.