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Dr. Girija G

Senior Resident, Department of Pediatrics, Koppal Institute of Medical Sciences, Koppal, Karnataka, India

Dr. Rachan Reddy K

Pediatrician, SNCU In charge, District Hospital, Chikkaballapur, Karnataka, India

Dr. Ravichander B

Professor and HOD, Department of Pediatrics, MVJ Medical College, Bangalore, Karnataka, India

The efficacy of intermittent versus continuous phototherapy in the duration of phototherapy required in the given bilirubin level

Dr. Girija G, Dr. Rachan Reddy K and Dr. Ravichander B

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Abstract

The effectiveness of phototherapy is related to the area of skin exposed, the radiant energy, the sources and wave-length of the light and the cause and severity of jaundice [7]. Continuous phototherapy involves maintaining the jaundiced neonate under phototherapy virtually all the time with only minimal interruptions (e.g. during feeding or cleaning) so as to maximize the time spent under radiant energy and hopefully minimize the duration of phototherapy and hospital stay. The study included 100 in each group including term and late preterm neonates. The study was approved by the Research Ethics Committee. A pre-designed proforma has aided the enrolment of newborns into the study. Mean total serum bilirubin (TSB) at 24 hours follow up in our study were 11.75±2.75mg/dl and 11.93±2.35mg/dl in group A and group B respectively. The percentage of reduction in bilirubin at 24 hours was 33% and 31.3% in group A and group B respectively which was not significant (p=0.29).

Keywords: continuous phototherapy, bilirubin level, mean total serum bilirubin

Introduction

The use of phototherapy was first discovered, accidentally, at Rochford Hospital in Essex, England. The ward sister of the preterm baby unit in the United States firmly believed that the infants under her care benefited from fresh air and sunlight in the courtyard. Although this led to the first noticing of improvement of jaundice with sunlight, further studies progressed when a vial of blood sent for bilirubin measurement sat on a windowsill in the lab for several hours. Further investigation led to the determination that blue light with wavelength of 420-448nm had oxidized the bilirubin to biliverdin which is a soluble product not contributing to kernicterus. Although some paediatricians began using phototherapy in the United Kingdom following Dr. Cremer's publishing the above facts in the Lancet in 1958, most hospitals began to regularly use phototherapy ten years later after an American group made the same discovery [1]. Initially phototherapy was used in low-birth-weight (LBW) and full-term infants primarily to prevent slowly rising serum bilirubin levels from reaching levels requiring exchange transfusion. Phototherapy is often used in full-term and near-term infants who have left the hospital and are readmitted on days 4 to 7 for treatment of total serum bilirubin levels of 20 mg/dL (342 µmol/L) or more. These infants need a full therapeutic dose of phototherapy termed as intensive phototherapy to reduce bilirubin level as soon as possible [2].

The effectiveness of phototherapy is related to the area of skin exposed, the radiant energy, the sources and wave-length of the light and the cause and severity of jaundice [7]. Continuous phototherapy involves maintaining the jaundiced neonate under phototherapy virtually all the time with only minimal interruptions (e.g. during feeding or cleaning) so as to maximize the time spent under radiant energy and hopefully minimize the duration of phototherapy and hospital stay. Intermittent phototherapy involves regular cessation of phototherapy at specific times and for specific duration to reduce exposure to radiant energy and allow ample time for parental-infant interaction. The advantages and disadvantages of intermittent and continuous phototherapy remain controversial [3].

The study by Hodgman comparing intermittent versus continuous therapy showed that continuous phototherapy was more effective but was associated with higher metabolic demands. Vogl *et al.* showed that intermittent phototherapy was as effective as continuous phototherapy. Many others studied on effects of phototherapy on serum levels of individual

Corresponding Author:

Dr. Rachan Reddy K

Pediatrician, SNCU In charge, District Hospital, Chikkaballapur, Karnataka, India

electrolytes and platelets are available, but there are only limited studies where the whole haematological profile and electrolyte abnormalities involving sodium, potassium and calcium and weight changes have been studied in the same subject [4]. Hence the present study is undertaken to find out any significant changes pertaining change in weight, any change haematological parameters and electrolyte levels in the neonates subjected to phototherapy in a rural tertiary care hospital.

Methodology

The study included 100 in each group including term and late preterm neonates. The study was approved by the Research Ethics Committee. A pre-designed proforma has aided the enrolment of newborns into the study.

Inclusion criteria

1. All Term babies and late Preterm weighing more than 2500 gms with neonatal hyperbilirubinemia as defined by AAP charts (2004) requiring phototherapy

Exclusion criteria

1. Babies who were having congenital abnormalities
2. Babies with active hemolysis due to haemolytic diseases of newborn or needing exchange transfusion
3. Neonates on IV fluids, ventilators
4. Neonates not on breast feeding

Sampling Method: Randomised control study

Sample Size - 200

Method of collection of data

Neonates due for phototherapy were evaluated and samples were collected. Total serum bilirubin, Electrolytes and haematological parameters were checked at 0 hours (before starting phototherapy) 24hours and at 48 hours of phototherapy, daily weight checking and duration of phototherapy was noted by the researcher. Comparative study were made between these two groups to determine the changes in weight, TSB, electrolytes, haematological parameters and the duration of phototherapy. Phototherapy were initiated as per AAP guidelines in term and late preterm neonates (born at or after 34 weeks of gestation)

All neonates subjected to phototherapy as per AAP criteria were randomised to one of two groups

Group A- Phototherapy (PT) on continuous basis as per standard protocol

Group B- Phototherapy on intermittent basis consisting of 2hr PT followed by 1 hour of rest with mother

Investigations Required

1. Total bilirubin, Indirect Bilirubin and Direct Bilirubin.
2. Electrolytes (Sodium, Potassium, Calcium).
3. Hematological parameters (Hemoglobin, PCV, platelet

- count)
4. All these parameters were done as per routine protocol and no extra test were done for study purpose.
5. Blood group of newborn analyzed by antisera method.

Statistical analysis

Data was entered into Microsoft excel data sheet and was analyzed using SPSS 22 version software. Categorical data was represented in the form of Frequencies and proportions. Chi-square test or Fischer’s exact test (for 2x2 tables only) was used as test of significance for qualitative data. Continuous data was represented as mean and standard deviation. Independent t test was used as test of significance to identify the mean difference between two quantitative variables. Paired t test is the test of significance for paired data such as before and after for quantitative data.

Graphical representation of data: MS Excel and MS word was used to obtain various types of graphs such as bar diagram.

p value: (Probability that the result is true) of <0.05 was considered as statistically significant p value<0.01 as strongly significant, after assuming all the rules of statistical tests.

Results

Table 1: Parity Distribution between two groups

		Continuous Phototherapy		Intermittent Phototherapy	
		Count	%	Count	%
Parity	Multi	50	50.00%	56	56.00%
	Primi	50	50.00%	44	44.00%

$\chi^2 = 0.723$. $df = 1$. $p = 0.395$

In Continuous Phototherapy group, 50% were Multigravida and 50% were Primigravida, in Intermittent Phototherapy group, 56% were Multigravida and 44% were Primigravida. There was no significant difference in parity status between two groups.

Table 2: Mean Duration of PT in hrs Comparison between two groups

	Continuous Phototherapy		Intermittent Phototherapy		P value
	Mean	SD	Mean	SD	
Duration of PT (hrs)	22.79	8.06	19.68	6.72	0.003*

Mean duration of Phototherapy in Continuous Phototherapy group was 22.79 ± 8.06 hrs and in Intermittent Phototherapy group was 19.68 ± 6.72 hrs.

There was significant difference in mean duration of Phototherapy between two groups ($p=0.003$)

Table 3: Mean Pre PT Weight. Post 24hrs PT Weight and Post 48hrs Weight Comparison between two groups

	Continuous group		Intermittent group		P value
	Mean	SD	Mean	SD	
Pre PT Weight (kgs)	2.76	.20	2.76	.19	0.874
Post 24hrs PT Weight (kgs)	2.74	.20	2.75	.19	0.781
Post 48hrs Weight (kgs)	2.74	.20	2.77	.21	0.261

In Continuous Phototherapy group mean Pre PT Weight was 2.76 ± 0.20 and in Intermittent Phototherapy mean Pre PT Weight was 2.76 ± 0.19 .

There was no significant difference in mean Pre PT Weight between two groups. Similarly there was no significant difference in mean Post 24hrs PT Weight and Post 48hrs Weight between two groups.

Table 4: Mean Pre TSB. Post 24hrs TSB and Post 48hrs TSB Comparison between two groups

	Continuous Phototherapy		Intermittent Phototherapy		P value
	Mean	SD	Mean	SD	
Pre TB	17.44	1.02	17.31	1.04	0.371
Post 24hrs TSB	11.75	2.75	11.93	2.35	0.629
Post 48hrs TSB	8.41	.59	8.28	.65	0.14

In the study there was no significant difference in mean Pre Total serum bilirubin, post 24 hrs TSB and post 48 hrs TSB between two groups and there was significant difference in percentage of decrease in bilirubin between the groups

Table 5: Mean Pre HB. Post 24hrs HB and Post 48hrs HB Comparison between two groups

	Continuous Phototherapy		Intermittent Phototherapy		P value
	Mean	SD	Mean	SD	
Pre HB	17.24	.78	17.29	.80	0.643
Post 24hrs HB	17.00	.81	17.04	.82	0.709
Post 48hrs HB	17.11	.77	17.09	.80	0.851

In the study there was no significant difference in mean Pre HB, Post 24 hrs HB and Post 48 hrs HB between two groups.

Table 6: Mean Pre PLT. Post 24hrs PLT and Post 48hrs PLT, Comparison between two groups

	Continuous Phototherapy		Intermittent Phototherapy		P value
	Mean	SD	Mean	SD	
Pre PLT	3.70	0.50	3.69	0.54	0.850
Post 24hrs PLT	3.31	0.52	3.26	0.59	0.604
Post 48hrs PLT	3.20	0.52	3.24	0.57	0.550

In the study there was no significant difference in mean Pre platelet count, Post 24 hrs platelet count and Post 48 hrs platelet count between two groups

Table 7: Calcium levels Comparison between two groups at different periods of follow up

	Continuous Phototherapy		Intermittent Phototherapy		P value
	Mean	SD	Mean	SD	
Pre Ca	10.56	.45	10.51	.50	0.45
Post 24hrs Ca	10.46	.47	10.44	.56	0.78
Post 48hrs Ca	8.89	.47	9.00	.55	0.13

No significance difference between mean Pre Calcium, post 24 hrs, Post 48hrs Calcium between groups

Mean total serum bilirubin (TSB) at 24 hours follow up in our study were 11.75+2.75mg/dl and 11.93+2.35mg/dl in group A and group B respectively compared with other similar studies by Niknaf *et al.* which showed 11.06+2.06mg/dl in continuous group and 10.86+2.13mg/dl in intermittent group. The percentage of reduction in bilirubin at 24 hours was 33% and 31.3% in group A and group B respectively which was not significant (p=0.29) which was similar to other studies by Niknaf *et al.*, Abdul *et al.*, Houshmandi *et al.*, Zhou *et al.*

Discussion

48 hours serum bilirubin levels were done to know the rebound bilirubin, the mean total serum bilirubin (TSB) at

48 hours follow up in our study was 8.41+0.59 mg/dl and 8.28+0.65 mg/dl in group A and group B respectively, the percentage of decrease in bilirubin was 51.75% in group A and 52.16% in group B from baseline at 48 hours which was statistically not significant between two groups but there is significant decrease in bilirubin from the baseline bilirubin which was comparable with other studies by Niknaf *et al.* [5] which showed 8.93+1.26 mg/dl in continuous group and 9.3+1.43 mg/dl in intermittent group.

Abdul *et al.* [6] study also shows that bilirubin at 48hrs was significantly less than baseline 9.78+1.72, 11+1.7, 8.15+0.19 in continuous group, where as in intermittent group it was 9.24+1.64, 11.2+1.5, 8.2+0.20mg/dl respectively which is similar to our study.

Our results of this study were similar to those of Niknaf *et al.* [5], in that there was statistically no significant difference in the effectiveness (mean decrease in serum bilirubin) of both types of phototherapy. Although we applied phototherapy for prolonged duration (2 hours on and 20 minutes off for continuous, and two hour on and one hour off for intermittent group) compared to the above mentioned study (2 hours on and 30 minutes off for continuous and one hour on and one hour off for intermittent group). In their study the mean serum bilirubin level before the start of phototherapy was 16.60mg/dl±1.67 for continuous and 16.33mg/dl±1.46 for intermittent group, and the mean serum bilirubin at 48 hours was 8.9mg/dl±1.23mg/dl for continuous and 9.3±1.43mg/dl for intermittent group, while in our study the mean serum bilirubin before the start of phototherapy was 17.44mg/dl±1.02mg/dl for continuous and 17.31mg/dl±1.04mg/dl for intermittent group, and the mean serum bilirubin at 48hrs was 8.41mg/dl±0.59 mg/dl for continuous and 8.28mg/dl±0.65mg/dl in intermittent group.

According to Sachdeva *et al.* [7] in the neonatal intensive care unit of jaundice neonatal irradiation treatment study, it was found that the clinical efficacy between intermittent single-light irradiation in the treatment of neonatal hyperbilirubinemia and continuous single-light irradiation were consistent. However, Lamola *et al.* [8] found that there was no significant difference in serum bilirubin levels between the intermittent and continuous phototherapy at 12, 24, 36 and 48 h after treatment (P>0.05), which further proved our research results. Moreover, in the case of small difference in efficacy, intermittent phototherapy can save medical costs and reduce the anxiety of family members [8]

Lau *et al.* [9] studied the effectiveness of continuous phototherapy and intermittent phototherapy in 34 Icteric full term infants with birth weight over 2500 grams. In Comparison of continuous group with intermittent group with 2 different method of phototherapy (4 hrs. on & 4 hrs. off cycles of phototherapy and 1 hr on and 3 hrs. off cycles of phototherapy), significant differences were not found between groups for reduction of bilirubin level. The results showed that continuous phototherapy to reduce bilirubin were more effective than intermittent phototherapy that was introduced as a standard procedure. While intermittent phototherapy as a complementary technique to reduce mother-infant separation was appropriate.

In contrast to our study Houshmandi *et al.* [10], shows continuous phototherapy is more efficacious in terms of percentage of decrease in bilirubin compared to intermittent phototherapy though both intervention decreased bilirubin after phototherapy, similar results were observed by Hodgman *et al.*, study the intermittent phototherapy cycle

with 12 hrs. on and 12 hrs. off.

It seems in longer period of phototherapy discontinuing would make more intense bilirubin rebound and stronger rebound, theoretically increases the effect of phototherapy, but in preterm infants it might increase requiring phototherapy

Photoisomerization of bilirubin occurs primarily in skin layers and the restoration of the bilirubin pool in the skin takes approximately 1 to 3 hours. Thus a prolonged on-off schedule may not be as effective as continuous therapy, but an on-off cycle of less than one hour is apparently as effective as continuous treatment.

The study was conducted on "Serum bilirubin kinetics in intermittent phototherapy of physiological jaundice" at Japan with the objectives of to treat the babies in the easiest way to minimize hospital duration Thirty-four term babies with physiological jaundice were subjected to continuous phototherapy and to two regimens of intermittent phototherapy. The difference in serum bilirubin kinetics between the three groups of treated babies was insignificant. Comparing results of different studies is difficult because characteristics of the groups were completely different like race, age, birth weight, pre-term or full-term infant, initial level of bilirubin, type of phototherapy lights and on and off time for phototherapy all can be effective in determining the decrease in bilirubin level.

In our study the mean weight at admission to phototherapy was 2760±200 grams in continuous group 2750±190grams in intermittent group which was comparable with Houshmandi *et al.*^[10], where 2944±379 grams in continuous group and 2999±395 grams in intermittent group in contrast to Zhou *et al.*^[11], 3920±270grams in continuous group and 3880±380grams in intermittent group this because of difference in race, age, sex, religion.

In the study percentage of weight reduction in group A was 0.61%±0.25% and in group B 0.18%±0.65% (p value <0.001). There was significant difference in mean percentage of weight reduction between two groups after phototherapy compared to Pre weight. Percentage reduction of weight was high in continuous phototherapy compared to intermittent phototherapy. By promoting breastfeeding during off hours of phototherapy decreases the chances of dehydration, which is a known side effect of phototherapy and practicing kangaroo mother care during off hours of phototherapy helps in decreasing the percentage of weight loss and encouraging mothers for breastfeeding there by decreases the weight loss following phototherapy^[12].

Conclusion

In our study there was significant difference in duration of phototherapy in group A and group B. Shorter duration of exposure to phototherapy was noted in intermittent group compared to continuous phototherapy group.

In our study, there was significant reduction in weight following phototherapy compared to pre phototherapy weight, percentage of weight reduction was more in group A compared to group B.

In our study there was statistically significant reduction of platelet count after phototherapy in both the groups, but there was no significant difference between two groups.

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