THREE HUNDRED SIXTY DEGREE PHOTOTHERAPY VERSUS CONVENTIONAL PHOTOTHERAPY IN NEONATAL INDIRECT HYPERBILIRUBINEMIA

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ABSTRACT

Background

Phototherapy is the mainstay of treatment of hyperbilirubinemia. The efficacy of phototherapy depended on the light spectrum (wavelength), intensity of and type of the light and surface area of the infant exposed to phototherapy and distance of the light from the baby. A measure of the efficacy of phototherapy is the rate of decline in total serum bilirubin per hour and the dramatic reduction in the number of exchange transfusions being performed.

Objectives

To determine the efficacy of increasing surface area of phototherapy (360◦) compared with conventional single surface fluorescent phototherapy

Patients and Methods

A prospective study was done for 214 neonates, who were admitted to neonatal care unit at Raprin teaching hospital in a period of 6 months from the first of January till the thirty of July 2013. Neonates were presented with significant indirect hyperbilirubinemia that needed phototherapy, less than two weeks of age were included in this study. According to the level of total serum bilirubin and availability of highly intensive phototherapy the cases were divided in to two groups.

Results

The mean starting TSB in group I was 15.03±2.53 mg/dl while in group II 19.65±3.34 mg/dl and the percentage of decline after 12 hour in group I was 19.17±13.08% ,while in group II was 39.37±10.31% , and it was statistically significant ($p<0.001$). The decline rate after 12 hour ,regarding group I was 0.23 ± 0.21 mg/dl/hr ,while in group II was 0.50 ± 0.33 mg/dl/hr which was statistically significant ($p<0.001$). There was a significant decline in the number of exchange transfusion in 2013 when the highly intensive 360 degree phototherapy started to be used

Conclusion

Increasing surface area of exposure increase the rate of reducing of the serum bilirubin, and decreases rate of exchange transfusion as well.

Keywords: *Indirect hyperbilrubinemia, Intensive and conventional phototherapy.*

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INTRODUCTION

Jaundice is caused by elevated serum bilirubin concentrations. It is apparent in infants when the serum bilirubin value is greater than 4 to 5 mg/dL(68.4 to 85.5 mmol/L). Total Serum bilirubin is measured in the laboratory as the sum of two components: unconjugated ("indirect") and conjugated ("direct") fractions [1]. Because of the potential toxicity of indirect bilirubin, newborn infants must be monitored to identify those who might develop severe hyperbilirubinemia and. In rare cases, acute bilirubin encephalopathy or kernicterus, fortunately, current interventions make such severe sequelae rare [2]. Phototherapy has remained the standard of care for the treatment of hyperbilirubinemia in infants for four decades [3].

Efficient phototherapy rapidly reduces the serum bilirubin concentration. The formation of lumirubin, a water-soluble compound, is the rate limiting step in the elimination of bilirubin by phototherapy [4]. A number of different light sources are commercially available and it effectiveness of phototherapy depend on different factors including intensity of the light to produce an appreciable effect in reducing the neonate's bilirubin level [5] and on effective surface area in which as much of the neonate's skin as possible should be illuminated by light of an effective wave band and sufficient irradiance [6].

The aim of this study was to compare the efficacy of 360 degree phototherapy with conventional phototherapy in decrease indirect hyperbilirubinemia, and to show the efficacy of 360 degree phototherapy in decreasing the rate of exchange transfusion.

PATIENTS AND METHODS

A prospective study was conducted in neonatal care unit at Raparin pediatrics teaching hospital, in Erbil – Iraq. Duration of the collection data of study was in period between the 1st of January till the 30th of July 2013. The study was approved by ethics committee, and informed consent was obtained from all families before the infants were included in the study. Infants admitted to neonatal care unit, who developed significant indirect hyperbilirubinemia that need phototherapy, less than two weeks of age were included in this study, they were term and preterm (≥35 wk gestational age). Data from 214 neonates were none randomly analyzed. According to the level of TSB and availability of highly intensive phototherapy the cases divided in to two groups. The first group: 112 newborns who received conventional phototherapy and the second group include 102 newborns who received highly intensive 360° phototherapy. Informations were collected from parents of the babies' anthropometric measurement and full examination done for all. The decision to the choice of type of phototherapy made by depending on Hyperbilirubinaemia Guidelines of the Academy of Paediatrics (AAP) [7] in which its applied at our NICU for the management of hyperbilrubinemia during the study period. Bilirubin levels were measured and recorded at the 4th, 12th, 24th, 48th hours of the phototherapy and at the end of the treatment and phototherapy. Chi squire test used for analysis of data and P value regarded positive when less than 0.05

RESULTS

Two hundreds and fourteen neonates with indirect hyperbilirubinemia were included in this study. All infants were treated with phototherapy, 112 infants received conventional phototherapy (Group I), and the other 102 treated with 360 degree phototherapy (Group II). Demographic data and Anthropometric measurement is shown in table below. Mean TSB (mg/dl) was 17.4±3.67. The mean of absolute duration of phototherapy in CP was 16.57 hr while in 360 degree was 15.65 hr and P value 0.49 which was statically not significant, as shown in table 1.

Total serum bilirubin was measured frequently for both groups, regarding those who were treated by Conventional Phototherapy (group I) at admission their mean TSB was 15.30±2.53 mg/dl, after initiation of phototherapy TSB decline to 14.09±2.52 mg/dl, 12.23±2.49 mg/dl , 11.22±2.51 mg/dl, 11±2.73 mg/dl at 4 ,12 ,24 ,48 hours respectively. On the other hand those who were treated with 360 degree Phototherapy (group II) mean TSB at admission was 19.65±3.34 mg/dl and then decline to 15.64±3.78 mg/dl, 12.01±2.65 mg/dl, 10.74±2.78 mg/dl, 9.08±0.75 mg/dl at 4, 12, 24, 48 hours respectively, as in table 2.

The declining levels TSB in mg/dl/hr were calculated in both groups and found that regarding CP 0.30 ± 0.33 mg/dl/hr, 0.23 ± 0.21 mg/dl/hr, 0.10 ± 0.11 mg/dl/hr, 0.03 ± 0.05 mg/dl/hr were respectively, while those with 360 degree 1.00 ± 0.56 mg/dl/hr, 0.50 ± 0.33 mg/dl/hr, 0.27 ± 0.16 mg/dl/hr, 0.07 ± 0.07 mg/dl/hr were respectively, and P-value was <0.001 which is statically highly significant at 0-4, 4-12,12-24 while at 24-48 P-value was 0.193 which is statically not significant as show in table 3.

When we did a comparison of percent of TSB decline between the two groups, the result was as shown in table 4, the percentage of declining per hour in CP was about 0.9 mg/dl/hr. and in 360 degree was about 2 mg/dl/hr. and P-value was <0.001 which is statically highly significant.

After introducing of 360 degree phototherapy to NCU at present hospital, there was a decrease in the number of exchange transfusion than usual in which among 224 neonates only 10 cases underwent exchange transfusion (which were not enrolled in this study) and the other 214 neonates were treated by phototherapy.

Table 1. Demographic data and Anthropometric measurement of studied sample.

	Frequency	%
Gestational age(weeks)		
37>	47	21.9
37-41	167	78.1
Gender		
male	127	59.5
Female	87	40.5
Family history		
jaundice	68	31.6
phototherapy	57	26.5
exchange	11	5.1
Type of feeding		
Breast	111	52.1
Bottle	15	7.0
Mixed	88	40.9
	Mean±SD	
Age at admission(in hours) mean ± SD	122±58.77	
Weight of neonate(kg) mean ± SD	3 ± 0.56	
Age onset of jaundice(hours) mean ± SD	58±35.40	
TSB at admission(mg/dl) mean ± SD	17.4±3.67	
PCV at admission (%) mean ± SD	56.51±8.09	
Absolute duration of Phototherapy (hr)		
Conventional	16.57±10.40	
360 degree	15.65±9.37	

Table 2. Mean and SD Different TSB reading within period of admission.

	TSB at admission	TSB after 4 hrs	TSB after 12 hrs	TSB after 24 hrs	TSB after 48 hrs	Total
CP (Mean ± SD)	15.30±2.53	14.09±2.52	12.23±2.49	11.22±2.51	11±2.73	112
360 degree (Mean ± SD)	19.65±3.34	15.64±3.78	12.01±2.65	10.74±2.78	9.08±0.75	102

Table.3 Mean and SD for difference of TSB decline in mg/dl/hr. between CPand 360 degree.

Type of Phototherapy	Mean ± SD	P value
Decline (mg/dl/h) 0-4h		
conventional	0.30 ± 0.33	<0.001
360 degree	1.00 ± 0.56	
Decline (mg/dl/h) 4-12h		
conventional	0.23 ± 0.21	<0.001
360 degree	0.50 ± 0.33	
Decline (mg/dl/h) 12-24h		
conventional	0.10 ± 0.11	<0.001
360 degree	0.27 ± 0.16	
Decline (mg/dl/h) 24-48h		
conventional	0.03 ± 0.05	0.193
360 degree	0.07 ± 0.07	

Table 4. Mean and SD of Percentage of TSB Decline in both two groups.

	% of bilirubin decline after 4hr	% of bilirubin decline after 12hr	% of bilirubin decline after 24hr	% of bilirubin decline after 48hr	p. value
Conventional Phototherapy Mean±SD	7.74±8.24	19.17±13.08	22.96±15.75	19.19±19.09	<0.001
360 degree Phototherapy Mean ± SD	20.77±10.60	39.37±10.31	48.38±13.58	51.24±4.39	

DISCUSSION

Neonatal jaundice, in general, if infants became significantly jaundiced, they were treated with single-surface phototherapy and if they did not respond, the further treatments were increasing phototherapy unit beside or beneath the infant or exchange transfusion [8]. This is what was used in this neonatal care unite until new intensive 360 degree with special blue light fluorescent tube used since the beginning of 2013. The result of the present study was consistent with previous studies using double phototherapy compared with single phototherapy, but different in bilirubin reduction. Holtrop PC et al [9] found bilirubin reduction after 18 hours of double phototherapy was 2.9 ± 1.1 mg/dl (31 ± 11%) vs. 1.6 ± 1.4 mg/dl (16 ±15%) from single phototherapy. The reduction rate for double phototherapy of Holtrop's study was approximately 0.16 mg/dl/h, whereas the reduction rate of the present study was 0.50 mg/dl/h.

The differences of bilirubin reduction in the present study from the previous studies were probably due to the difference of their radiance of the light, type of light sources and mainly due to increasing the surface area exposed to phototherapy around 360 ° and this fact proved by previous studies [10].

After 24 hrs, it was found that the mean differences of decline in TSB between the initial and after 24 hrs. In CP was 3.68±2.37 mg/dl (22.96±15.75%), while in 360 degree was 11.30±3.58 mg/dl (48.38±13.58%). This was agreed withTan11 and de Carvalho et al [11] who achieved an average 50% decrement in bilirubin levels at the end of 24 hours with a high-intensity phototherapy. While if we compare the rate of reduction mg/dl / hr. after 24hr in CP was 0.10±0.11 mg/dl/hr., while in 360 degree was 0.27±0.16 mg/dl/hr. The result was comparable with Nuntnarumit P and Naka C [10] reduction of bilirubin 0.22 mg/dl/h result however he used adapted-double phototherapy and almost the same rate of reduction of the present study (0.27 mg/dl/h).

During our study, we observed that the rate of exchange transfusion declined compared with the previous year in which only 10 neonates (4.46%), (from total 224 neonates), treated with exchange transfusion, while 214 neonates treated with phototherapy. Our observation was in agreement with Amira A. E. in which she found that in the presence of intensive phototherapy, only 19 (10.4%) out of 188 cases required exchange transfusion [12].

In conclusion increasing surface area of exposure to light more effective than single-surface conventional phototherapy in reducing bilirubin level in the treatment of hyperbilirubinemia.

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