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Article · January 2016

DOI: 10.15761/PD.1000128

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Research Article

Declining pattern of bilirubin in the first and second six hours of intensive versus double phototherapy in neonatal jaundice

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Abstract

Background: Although phototherapy has been used in clinical practice for 50 years, there is still much debate about how the most efficacious phototherapy application can be provided.

Objective: This study aimed to define the most effective hours of declining serum bilirubin in two types of phototherapy (double versus intensive phototherapy) in treatment of severe hyperbilirubinemia of neonates.

Materials and methods: A total of 100 healthy full-term neonates with no hemolytic hyperbilirubinemia (total serum bilirubin between 20 to 25 mg/dl) were compared in a historically controlled study. The first group received double phototherapy (DP) (8 lamps) and the second group received intensive phototherapy (IP) (12 lamps).

Results: The mean serum bilirubin decline in IP group was statistically significant in comparison with DP group in the first 6 hours of phototherapy (4.65 ± 2.02 mg/dl versus 3.59 ± 1.86 mg/dl, $P=0.008$). The mean serum bilirubin decline was not statistically significant ($P=0.277$) in the second 6 hours of phototherapy between two groups.

Conclusion: This study showed IP declined bilirubin level more than DP statistically in the first 6 hours of phototherapy. As there was no difference between DP and IP in the rate of bilirubin decline in the second 6 hours of phototherapy, DP can be used instead of IP if total bilirubin is high but under exchange transfusion level in the second 6 hours of phototherapy.

Background

Neonatal hyperbilirubinemia is one of the most common diseases worldwide and can be treated effectively by phototherapy [1,2]. Although it is usually benign in term and preterm neonates [3], severe hyperbilirubinemia is a medical emergency because bilirubin is neurotoxic substance [4] that can cause neurologic defects [5]. Management of hyperbilirubinemia in neonates is still a critical issue. For several decades phototherapy has been known as a standard therapy for neonatal hyperbilirubinemia [6]. Some variables like wave length of light, energy output or irradiance, exposed surface area to the light, the distance between the body and the source of radiation may influence the efficacy of phototherapy [7]. Accordingly, several studies have been done to compare the efficacy of different modes of phototherapy [9].

The aim of this study was to compare the declining pattern of serum bilirubin in the first 6 hours and 12 hours after Intensive phototherapy (IP) versus double phototherapy (DP) in severe neonatal hyperbilirubinemia.

Materials and methods

This is a historically controlled study conducted in Neonatal ward of Bahrami Children Hospital (Tehran University of Medical Sciences),

Tehran, Iran, between January 2012 to January 2013. The study group consisted of neonates admitted to our neonatal ward to be treated with IP during the study period. These neonates were compared with a historical control group who had been admitted between January 2011 to January 2012 and treated with conventional DP.

Infants who met the following inclusion criteria were assessed: healthy term newborns with birth weight equal to or more than 2500 gr, normal hemoglobin and hematocrit, normal reticulocyte count and total serum bilirubin level of 20-25 mg/dl. Exclusion criteria included any congenital malformations or infections, evidence of hemolysis or blood group incompatibility, history of exchange transfusion and presence of acidosis, hypoglycemia, hypoalbuminemia, sepsis and

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Key words: double phototherapy, intensive phototherapy, neonatal hyperbilirubinemia

Received: August 08, 2016; **Accepted:** August 23, 2016; **Published:** August 25, 2016

G6PD deficiency.

One thousand fifty five icteric newborns had the mentioned criteria. Of these, 508 subjects were treated with IP and 547 with DP. According to $\alpha = 0.05$, $Z1 - \alpha/2 = 1.96$, power = 80%, $Z1 - \beta = 0.8$, $S1 = 8.5$, $S2 = 14.7$, $\mu1 = 31.2$, $\mu2 = 38.98$, 38 cases were selected from each group. In order to increase the power of the study, the number of 50 patients was considered in each group.

All infants in DP group were in bassinets and two single phototherapy (4 lamps) devices were used: one was placed with 25 cm distance from the bed above the bassinet and the other was placed in line with its length with oblique angle (35 cm distance from the bed). In IP group, two phototherapy sets, each consisted of 6 phototherapy lamps, were used. One set was placed above and the other one was placed below the infant with 25 cm distance from the bed. All fluorescent lamps were made by Royal Philips Electrics, Inc (Amsterdam), the Netherlands, with 20 w powers.

The newborns in both groups had eye patches and disposable diapers folded to allow maximum skin exposure to phototherapy. Phototherapy was administered continuously except for minor procedures such as feeding and taking blood sampling.

Total and direct serum bilirubin levels were measured at admission, 6 and 12 hours after beginning of phototherapy. Bilirubin was measured by the conventional indirect diazo method.

The study protocol was approved by research and ethics committee of Tehran University of Medical Sciences. Consent forms were given to the parents and gathered after filling.

Statistical analysis was done by using SPSS software for Windows, version 21.0 (SPSS Inc., Chicago, IL, USA). Independent sample T Test was used to compare quantitative data and the normality of continuous data was checked by Kolmogorov-Smirnov. The Asymp. Sig. (2-tailed) number was calculated 0.628 (>0.05) that showed normality of continuous data. Statistical significance was considered as $P < 0.05$.

Results

A total of 100 new born entered the study (50 patients in each group). The patients' characteristics are presented in Table 1. There was no significant difference between patients' sex ratio, birth weight, postnatal age, serum bilirubin level, hematocrit and haemoglobin. Comparison of total serum bilirubin before phototherapy in intensive and double groups showed no significant differences. Phototherapy, either intensive or double, was effective in decreasing bilirubin level but the rate of bilirubin decline was more significant in intensive group than double group. In our study the overall decline rate of 0.65 ± 0.25 mg/dl/h (2.74 ± 1.03 %/h) in DP was less than the overall decline rate of 0.78 ± 0.18 mg/dl/h (3.44 ± 0.78 %/h) in IP with $p = 0.08$ versus $p < 0.01$ (Table 2).

In spite of significant decline rate of serum bilirubin in intensive

Table 1. Clinical and laboratory data of study groups.

Variable	Intensive phototherapy (n=50)	Double phototherapy (n=50)
Male to female ratio	31/19	36/14
Birth weight (g)	3209.70 ± 362.03	3189.40 ± 349.20
Bilirubin (mg/dl)	22.67 ± 1.91	23.63 ± 2.16
Hemoglobin (mg/dl)	18.20 ± 2.11	18.01 ± 1.82
Hematocrit	52.72 ± 5.27	53.75 ± 5.32
Post natal age (d)	6.30 ± 3.5	7.12 ± 3.3

Variable	Intensive phototherapy	Double phototherapy	P
Mean serum bilirubin (mg/dl)	22.67 ± 1.91	23.63 ± 2.1	0.09
Decrease of serum bilirubin after the first 6 hours (mg/dl)	4.65 ± 2.02	3.59 ± 1.86	0.008
Decrease of serum bilirubin after the second 6 hours (mg/dl)	4.47 ± 1.86	4.32 ± 1.79	0.277
Decrease of serum bilirubin after 12 hours (mg/dl)	9.36 ± 2.22	7.86 ± 3.02	0.008
Overall decline rate of bilirubin (mg/dl/h)	0.7 ± 0.18	0.65 ± 0.25	0.008
Overall decline rate of bilirubin (percent/h)	3.44 ± 0.78	2.74 ± 1.03	<0.001

Table 2. The response of groups to phototherapy (Value are given as mean ± SD).

group in comparison with double group in the first 6 hours of phototherapy, the decline rate of serum bilirubin in the second 6 hours of phototherapy had no significant difference between the two groups ($P = 0.27$).

Discussion

In this study we compared the efficacy of IP and DP for declining rate of serum bilirubin in 6 and 12 hours of therapy. There was a significant difference in the speed of bilirubin decline rate between the two groups. The patients who received IP showed more decline rate of serum bilirubin after 6 hours in comparison with DP. The decline rate of serum bilirubin was statistically significant in the first 6 hours in IP group ($P = 0.008$) versus the second 6 hours ($P = 0.277$) in comparison with DP group.

Naderi's study [10] compared the benefits, complications and length of hospitalization between double and triple phototherapy in term new borns with indirect hyperbilirubinemia. He showed triple phototherapy had no particular benefit to double phototherapy and had no significant difference in overall decline rate of serum bilirubin. In this study the third phototherapy set was placed in the line with width of the bassinet, and a 35 cm distance from the bed that obviously decreased the efficacy of phototherapy (2009).

Zahed Pasha [11] compared the efficacy of single, double and intensive phototherapy for declining of serum bilirubin. In spite of significant decrease of serum bilirubin in 3 types of phototherapy, intensive phototherapy was more effective than single and safer than double phototherapy in reduction of bilirubin. The change of body temperature as a complication phototherapy was significant in DP but not in IP (2006). His findings confirmed our results. [12,13] studies showed that that double phototherapy reduced serum bilirubin concentration more rapidly than single one. Nuntnarumit and Naka confirmed the same results (2002) [4].

Several studies like [14-16] studies have proven the rapid decline of bilirubin by different kinds of IP. In our study the overall bilirubin decline rate of 0.65 ± 0.25 mg/dl/h (2.74 ± 1.03 %/h) in DP was less than the overall bilirubin decline rate of 0.78 ± 0.18 mg/dl/h (3.44 ± 0.78 %/h) in IP with $p = 0.08$ versus $p < 0.01$. The mean decline rate of bilirubin in IP was also more significant in the first 6 hours of phototherapy than the second 6 hours. There was no significant difference in the mean decline rate of bilirubin between DP and IP in the second 6 hours of phototherapy (Table 2). It seems when the serum bilirubin level is high, it is optimal to reduce it more rapidly in a short time, so IP is the first choice when available. When serum bilirubin falls to lower levels, there is no superiority of IP for decreasing bilirubin in comparison to DP. If IP is not available, DP can also decrease the high bilirubin level effectively.

There are different overall decline rate of bilirubin (mg/dl/h and %/h) between DP and IP in various studies because of different kinds of DP and IP devices, phototherapy lamps and distances from the patients.

Our results show that IP (12 phototherapy lamps divided equally above and below the baby) is more effective than DP (8 phototherapy lamps all above the baby) for declining of serum bilirubin level especially in the first 6 hours of phototherapy in apposite to the second 6 hours of phototherapy.

Conclusion

This study showed IP declined bilirubin level more than DP statistically in the first 6 hours of phototherapy. As there was no difference between DP and IP in the decline rate of bilirubin in the second 6 hours of phototherapy, DP can be used instead of IP if total bilirubin is high but under exchange transfusion level in the second 6 hours of phototherapy.

Authorship and contributorship

Study concept and design: Peymaneh Alizadeh Taheri; Acquisition of data: Mehdi Asadi, Analysis and interpretation of data: Peyman Salamat, Drafting of the manuscript: Negar Sajjadian and Peymaneh Alizadeh Taheri, Critical revision of the manuscript for important intellectual content: Peymaneh Alizadeh Taheri, Statistical analysis: Peyman Salamat and Mehdi Asadi, Administrative, technical, and material support: Peymaneh Alizadeh Taheri, Study supervision: Peymaneh Alizadeh Taheri

Acknowledgment

The authors wish to thank the nursing and laboratory staff of Bahrami Children hospital. We also express our gratitude to Research Development Center of Bahrami Children hospital.

Funding information

We received no financial support and the costs of this research were paid by the researchers.

Competing interest

The authors declare that they have no competing interests.

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