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Effect of Feeding Type on the Efficacy of Phototherapy

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Objectives: *The objective of this study was to assess the efficacy of phototherapy for nonhemolytic hyperbilirubinemia and rebound bilirubin levels in breast-fed newborns as compared with mixed-fed (breast milk and formula) newborns.* ***Study Design/Setting:*** *Prospective study of effects of feeding type on response to phototherapy in newborns.* ***Methods:*** *The subjects were 53 full-term healthy newborns with nonhemolytic hyperbilirubinemia [defined as total serum bilirubin 12 mg/dL (³ 205.2 µmol/L) in the first 48 hours of life or 15 mg/dl (³ 256.5 µmol/L), on subsequent days]. Groups were formed according to type of feeding. Group 1 consisted of 28 breast-fed newborns and group 2 consisted of 25 mixed-fed newborns. Phototherapy was terminated when total serum bilirubin concentration fell to 14 mg/dL (<239.4 µmol/L). Rebound bilirubin measurements were obtained 24 hours after phototherapy ended.* ***Results:*** *The groups were comparable with respect to age at the start of phototherapy. The amount of weight loss (relative to birth weight) recorded at the start of phototherapy was significantly greater in group 1 than in group 2 (8.1 ± 3.9% vs. 5.4 ± 2.6%; p = 0.004). The duration of phototherapy was significantly longer in group 1 than in group 2 (38.6 ± 12.6 h vs. 26.8 ± 9.4 h; P <0.001). The 24-hour rate of decrease in bilirubin concentration in group 2 was significantly higher than that in group 1 [5.4 ± 2.2 mg/dL/d (92.3 ± 37.6 µmol/L/d) vs. 4 ± 1.3 mg/dL/d (68.4 ± 22.2 µmol/L/d); p = 0.01]. The overall rate of decrease in bilirubin concentration in group 1 was significantly lower than that in group 2 [0.16 ± 0.05 mg/dL/h (2.73 ± 0.85 µmol/L/h) vs. 0.22 ± 0.09 mg/dL/h (3.76 ± 1.53 µmol/L/h); p = 0.01]. There was no significant difference between the two groups with respect to rebound bilirubin concentration (P = 0.184). Conclusion: Phototherapy effectively reduced bilirubin levels in breastfed newborns with hyperbilirubinemia, but these patients show significantly slower response to this treatment than mixed-fed newborns.*

Key words: *Breast-feeding, Hyperbilirubinemia, Newborn, Phototherapy.*

Breastfed newborns have a higher incidence of hyperbilirubinemia and exhibit earlier onset and often longer duration of this condition than formula-fed newborns(1-3). Phototherapy is effective and widely used for treating neonatal hyper-bilirubinemia and breast-fed newborns respond well(4,5). To date, only one objective study has examined the link between breast-feeding and efficacy of phototherapy in healthy full-term newborns with hyperbilirubinemia(6).

The aim of this investigation was to determine whether type of feeding affects response to phototherapy and rebound bilirubin levels in full-term newborns with nonhemolytic hyper-bilirubinemia.

Subjects and Methods

Seventy full-term consecutive newborns requiring phototherapy for jaundice were admitted to the neonatal intensive care unit of Baskent University Adana Teaching and Research Center between August 2004 and February 2005. Fifty-three full-term healthy newborns requiring phototherapy for nonhemolytic hyperbilirubinemia were included in the study. This disease status was confirmed by absence of blood group incompatibility (Rh or ABO), negative direct Coombs' test, hematocrit above 40%, normal hemogram, normal reticulocyte count, and normal glucose-6-phosphate dehydrogenase activity. Newborns with blood group incompatibility, direct hyperbilirubinemia, excessive bruising or cephalohematoma, infection, or any type of congenital malformation were excluded. The 53 newborns were divided into two groups according to type of feeding at the time of admission to the hospital for phototherapy: Group 1 newborns (n = 28) were breast-fed and Group 2 newborns (n = 25) were breast-fed and received additional formula supplementation (approximately 75 mL/kg/d; mixed-fed). Both types of feeding had started at birth and continued throughout the study period. Type of feeding was mother's preference. The frequency of feeding was not altered during phototherapy.

Phototherapy was initiated when the total serum bilirubin concentration was 12 mg/dL in the first 48 hours of life or 15 mg/dL on subsequent days7. Conventional phototherapy was delivered with a phototherapy unit that consisted of 7 overhead daylight fluorescent lamps (Philips TL18W/54, Philips Lighting Co., The Netherlands) which provided an average irradiance on the infant skin of 403 $\mu W/cm^2/nm$ in the 400-480 nm range, 205 $\mu W/cm^2/nm$ in the 425-475 nm range, 107 $\mu W/cm^2/nm$ in the 440-480 nm range. The unit was placed 35 cm above the naked newborn (the eyes and genitals were shielded). Each newborn's total serum bilirubin concentration was measured by direct spectrophotometry (Bilirubin Analyzer Bil Micro Meter Erme Inc., Kohsoku Denki Co, Ltd, Tokyo, Japan) every 12 hours (or more often if indicated) using capillary blood samples.

TABLE I–*Clinical and Laboratory Data. Values are Mean ± SD*

	Group 1 Exclusively breast-fed (n = 28)	Group 2 Mixed (formula + breast milk) (n = 25)	p value
Sex, male/female	16/12	15/10	
Age			
Gestational (weeks)	38.8 ± 0.9	38.7 ± 0.7	>0.05
Postnatal (at start of phototherapy) (h)	116.1 ± 22.1	100.9 ± 41.9	>0.05
Weight (g)			
At birth	3313.2 ± 512	3212 ± 517	>0.05
At start of phototherapy	3040.2 ± 475	3027 ± 496	>0.05
At end of phototherapy	3073 ± 465	3089 ± 512	>0.05
Weight loss at start of phototherapy (%)	8.1 ± 3.9	5.4 ± 2.6	0.004
Hematocrit (%)	46.7 ± 5	49 ± 5	>0.05
Bilirubin concentration (mg/dL)			
At start of phototherapy	19.1 ± 1.8	18.2 ±2.9	>0.05
At end of phototherapy	12.8 ±0.9	12.4 ±1.4	>0.05
Rebound bilirubin (mg/dL)	12 ± 1.8	12.6 ± 1.8	>0.05

The efficacy of phototherapy was assessed according to the following criteria: duration of phototherapy (hours), the 24-hour rate of decrease in total bilirubin concentration; (mg/dL/d), and the overall rate of decrease in total bilirubin concentration (mg/dL/h) for the duration of phototherapy. Phototherapy was terminated when total serum bilirubin was 14 mg/dL. A rebound bilirubin measurement was made 24 hours after phototherapy ended.

Statistical analyses were performed using the software SPSS for Windows, version 11.0. Quantitative variables were compared using the Student's t-test and qualitative variables were compared using the chi-square test. Relationships between variables were assessed using Pearson's correlation coefficient. Values are expressed as mean ±SD. p values <0.05 were considered to indicate statistical significance.

Results

Of the 70 newborns initially enrolled in the study, 17 were excluded for the following reasons: ABO or Rh incompatibility (10 and 4, respectively), cephalhematoma (2) and congenital mal-formation(1). The clinical and laboratory data of the 53 newborns that were included in the study are shown in *Table I.*

Phototherapy was effective at decreasing total bilirubin levels in both groups; however, the response to phototherapy was significantly greater in Group 2 than in Group 1. In Group 2, the duration of exposure to phototherapy was significantly shorter (p < 0.001) and the 24-hour rate of decrease in bilirubin concentration was significantly higher than the corresponding rates in group 1 (p = 0.01; *Table II*). There was no significant difference between the two groups with respect to rebound bilirubin concentration (p = 0.184, *Table I*). No additional phototherapy was required for rebound hyperbilirubinemia.

Discussion

There is a strong association between breast-feeding and jaundice in healthy newborns during the first week of life(3,7,8). Adams *et al*.(1) found that the incidence of hyperbilirubinemia (>15 mg/dL) in breast-fed newborns was significantly higher than that in formulafed newborns (12% versus 2%, respectively). Similarly, Maisels and Gifford(3) found that 9% of breastfed newborns had elevated serum bilirubin (12.9 mg/dL) compared with only 2.2% of formulafed newborns. There are several ways in which breastfeeding could contribute to marked neonatal hyperbilirubinemia. The most likely contributing factors in this setting include lower fluid intake, lower calorie intake, greater weight loss, and increased enterohepatic circulation of bilirubin. These can promote hyperbilirubinemia separately or in concert. Breast-fed newborns lose more weight (and, presumably, receive fewer fluid and calories) in the first few days of life than formula-fed newborns. Associations between weight loss and hyperbilirubinemia have been documented, and there is an inverse relationship between oral caloric intake and serum bilirubin concentration, particularly in newborns who weigh less than 2000g(3,9,10). In our study, we observed significantly greater weight loss (relative to birth weight) in the breast-fed newborns than in the mixed-fed newborns, and found a significant positive correlation between weight loss and severity of hyperbilirubinemia. Our data confirm the striking association between weight loss and hyperbilirubinemia.

A phototherapy study conducted by the National

TABLE II *–Response to Phototherapy. Values are listed as mean ± SD*

	Group 1 Exclusively breast-fed (n = 28)	Group 2 Mixed (formula + breast milk) (n = 25)	p value
Duration of phototherapy (h)	38.6 ± 12.6	26.8 ± 9.4	< 0.001
24-hour rate of TBil decrease (mg/dL/d)	4.0 ± 1.3	5.4 ± 2.2	0.01

TBil: serum total bilirubin concentration

What this Study Adds

- Phototherapy effectively reduces bilirubin levels in breast-fed newborns with hyprobilirubinemia, but these patients show significantly slower response to treatment than mix-fed newborns.

Institute of Child Health and Human Development revealed that newborns who were receiving (<90 Cal/kg/d had significantly higher peak bilirubin concentrations than those fed >90 Cal/kg/d, and showed that phototherapy was much less effective when caloric and fluid intakes were low(11).

Tan(6) found that breast-fed full-term healthy newborns with nonhemolytic hyperbilirubinemia showed slower response to phototherapy and required a longer duration of treatment than newborns fed strictly formula or a mix of formula and breast milk. The same study also revealed greater weight loss (relative to birth weight) in the breast-fed newborns than in the other groups. The author suggested that weight loss in breast-fed newborns might contribute to the reduced response to phototherapy observed in hyperbilirubinemic newborns. In our study, we found that phototherapy was highly effective at controlling hyperbili-rubinemia in both groups; however, the response to phototherapy was significantly slower in the breast-fed newborns than in the mixedfed group. Specifically, compared with mixed-fed newborns, the breast-fed group had a 25.8% slower 24-hour rate of decrease in bilirubin concentration and a 27.3% slower overall rate of decrease. In line with this, the duration of phototherapy was also significantly longer in the breastfed group. As well, we found that the breastfed newborns showed a significantly greater degree of weight loss (relative to birth weight) at the start of phototherapy, and that this relationship held true at the end of phototherapy as well. Our study also demonstrated a significant positive correlation between degree of weight loss recorded at the start of phototherapy and duration of phototherapy. Based on the results, we suggest that phototherapy is less effective in exclusively breast-fed newborns, who tend to have low fluid intake and low caloric intake.

Lazar and coworkers(12) and the American Academy of Pediatrics (AAP)(7) have recommended that phototherapy may be discontinued in healthy, full-term newborns once total serum bilirubin falls below 14 mg/dL to 15 mg/dL. The AAP has also advised that newborns need not be detained in hospital to measure rebound bilirubin levels after phototherapy is completed. As well, other published data suggest that significant rebound after discontinuation of phototherapy is rare(13-15). In our study, the mean rebound bilirubin concentrations in the breastfed and mixed-fed groups were comparable, and no newborn in either group required a second round of phototherapy. Our findings suggest that type of feeding has no effect on rebound bilirubin levels in healthy, full-term newborns treated for nonhemolytic hyperbilirubinemia. They also indicate that it is not necessary to measure rebound bilirubin levels after discontinuation of photo-therapy in this patient group.

In summary, our results indicate that phototherapy effectively reduces bilirubin levels in breast-fed newborns with hyperbilirubinemia, but that these patients show significantly slower response to this treatment than mixed-fed newborns. Breast milk continues to be strongly recommended as the preferred food for newborns, with rare exceptions. Although, suplementation of breast-feeding with formula was shown to enhance the response to phototherapy and shorten the exposure time period, increasing the frequency of breast-feeding to ensure adequate fluid intake would be a rather appropriate recommendation in breast-fed newborns with excessive weight loss.

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