

Effects of the Different Light-Source Distances from the Skin Surface in Conventional Phototherapy

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Abstract

Phototherapy is a conventional method of lowering serum bilirubin in newborn jaundice. We evaluated the short distance in relation to conventional long distance phototherapy between the light-source and the skin surface. Healthy jaundiced neonates undergoing phototherapy were randomized into two groups. The distance between the light-source and the newborn's skin was 20 and 40 centimeters (G20; n=381 and G40; n=393) respectively. Newborns with any history of herbal or Phenobarbital administration were excluded. Bilirubin level was checked 24 hrs after cessation of phototherapy. Both groups were compared regarding the duration of the exposure and its effect on serum bilirubin level and of G6PD deficiency. The respective mean duration of phototherapy in G20 and G40 were 66 ± 22 and 81.6 ± 24.6 hrs ($P < 0.001$). Twenty-four hrs after cessation of phototherapy, 56.1% of G20 newborns had higher levels of rebound bilirubin in contrast with 38.5% of G40 cases. The type of milk had no influence on bilirubin levels. Exposure from 20 cm distance had no side effects on the neonates of various gestational ages and birth weights. This method proved to be safe, rapid and more effective in reducing bilirubin than phototherapy from a longer distance.

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Keywords • Newborn jaundice • Phototherapy • G6PD deficiency

Introduction

Jandice is one of the most common problems that newborn infants are confronted with during the first few days of life. To combat the potentially life-threatening hazards of severe hyperbilirubinemia, phototherapy has proved to be an effective means of lowering serum bilirubin. The efficacy of phototherapy depends on the type of the light-source and its intensity and the exposed skin surface.¹ This study was conducted to compare the effects of the conventional phototherapy units adjusted for 20 and 40 cm from the neonates skin-surface and to evaluate their impacts on the duration of exposure, rebound bilirubin and G6PD deficiency.

During a period of one year, all jaundiced but otherwise healthy newborn infants, referred to The Nemazee hospital affiliated with Shiraz University of Medical Sciences in Shiraz Iran, who met the criteria for phototherapy, were randomized into two groups. The exclusion criteria were history of traditional herbal treatment,² administration of phenobarbital,³ septicemia, hepatomegaly regardless of the cause,⁴ cholestasis,

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direct hyperbilirubinemia as well as suspected cases of congenital metabolic disorders, and hemolysis severe enough to need exchange transfusion.

In total 774 jaundiced neonates (479 male and 295 female) were enrolled in the study, randomized and completely matched except for the distance between the light-source and the skin surface which was 20 cm (G20; n=393) and 40 cm (G40; n=381). The age on admission in both groups was between 3 to 7 days. Maternal and neonatal Rh and blood groups, direct Coombs' and G6PD screening tests were performed on admission. The neonate's blood samples were also sent for determination of hemoglobin, hematocrit, peripheral smears as well as direct and total serum bilirubin. Serum bilirubin was measured by conventional diazo-method. Twenty-four hrs after cessation of phototherapy, 448 newborns (248 in G20, and 200 in G40) were referred for determination of the rebound serum bilirubin levels. During phototherapy the neonates' weights were measured and capillary blood samples collected twice per day by heel prick for the determination of total bilirubin. The conventional phototherapy was performed using four standard Phillips blue lamps, Toosan company.⁵ The light intensities were regularly measured on alternate days by photoradiometer to keep the emission in an acceptable irradiance of 400 $\mu\text{W}/\text{cm}^2$ in the 400–480 nm band range (YON DON-model YD–L.M-Yondon Net. Co. Ltd). All newborns were exposed in supine position and their eyes were covered with appropriate eye patches.⁶⁻⁹ The neonates were either breast or bottle-fed on demand and did not receive iv therapy except for those under 1500 g. Twenty-four hrs after cessation of phototherapy all newborns were recalled for the measurement of capillary total bilirubin. The infants in both groups were compared during the period of phototherapy and 24 hrs after cessation of phototherapy for its effects on serum bilirubin level, rebound of bilirubin, and G6PD deficiency.

There were no significant statistical differences between the two groups regarding the baseline data such as birth weight, sex ratio, gestational age, initial hematocrit level, cause of hyperbilirubinemia, age at start of phototherapy, and proportion of the breast or bottle-fed infants. The mean duration of phototherapy in G20 and G40 were 66 \pm 22 and 81.6 \pm 24.6 hrs respectively ($P<0.001$). The mean periods of phototherapy for different weight subgroups are also shown in Table 1. Rebound bilirubin was higher in 56.1% of G20 and 38.5% of G40 twenty-four hrs after cessation of phototherapy.

G6PD screening test was performed on 727 newborns (372 in G20 and 355 in G40). No particular difference was observed between

Table 1: Duration of phototherapy (hrs) in different weight subgroups.

| | <1500 g | 1500-2500 g | >2500 g |
|-----|---------------|-----------------|-----------------|
| G20 | 76 \pm 24 | 72.4 \pm 23.2 | 66 \pm 22 |
| G40 | 112 \pm 32. | 80.1 \pm 25.3 | 81.3 \pm 24.6 |

G6PD deficient and the neonates of either group. Altogether, 179 newborns (24.6%) had G6PD deficiency of which 86 were in G20 (23.1%) and 93 (26.1%) in G40 and included 147 males (82.1%) and 32 (17.8%) females. The type of milk had no influence on bilirubin levels.

The majority of published studies in recent decade have dealt mostly with the effects of double versus conventional single phototherapy source.¹⁰⁻¹¹ Serum bilirubin levels were reduced more effectively by double phototherapy systems and with fiber optic blankets. However, these are rather impractical, unavailable or expensive.⁵ In this study we took a new look at an old problem by bringing the light-source as close to the neonates as 20 cm. In the newborns of various birth weights and gestational ages, the 20 cm distance between the light-source and the skin surface provides a rapid and more effective bilirubin reduction than 40 cm with a shorter duration of phototherapy which is most probably due to higher spectral irradiance.

Exposure from 20 cm distance was well tolerated and no significant differences were observed between phototherapy side effects such as troublesome skin rashes, burns, clinical dehydration or lethargy in either group. The bilirubin levels were unaffected by the neonates genders, regardless of their body weight, or light intensity.

Oral agar has been found to be as effective as phototherapy in the treatment of neonatal jaundice.² We did not change the infants' position during phototherapy, as there is little data available in support of this practice.⁶⁻⁷ Furthermore, a significantly larger decline in the serum bilirubin level was found when infants were in supine position.⁶⁻⁷ This in turn required a shorter duration of light exposure.⁷ In spite of the fact that phototherapy through its photooxidation mechanism may elevate bilirubin in G6PD deficient neonates,¹⁰ in our study, no meaningful increment in bilirubin level was found among the enzyme deficient neonates in either group.

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