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Journal of the Chinese Medical Association 80 (2017) 729−732

www.jcma-online.com

Original Article

# Ocular findings on follow-up in children who received phototherapy for neonatal jaundice

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Received April 19, 2016; accepted November 22, 2016

**Abstract**

*Background*: To evaluate the ocular findings in children between 3 and 5 years of age who had received phototherapy in the neonatal period and to investigate whether they had phototherapy-related permanent ocular damage clinically.
*Methods*: The phototherapy group ($n = 57$) consisted of children who had undergone phototherapy for at least 24 h, and the control group ($n = 43$) comprised children who had not received phototherapy. Ophthalmic examinations consisted of assessment of visual acuity, convergence near point, ocular movements, ocular alignment, dynamic retinoscopy, cycloplegic refraction and biomicroscopic examination of anterior segment and posterior segment (using a 90 D lens in the latest).
*Results*: All children were orthophoric and had normal eye movements. A significant difference was found between the phototherapy group and control group regarding convergence near point 3.0 (2.0−5.0) vs 3.0 (2.0−5.0) ($p = 0.018$), right cycloplegic spherical equivalent 1.0 (0.0−3.0) vs 0.75 (0.0−4.75) ($p = 0.011$) and left cycloplegic spherical equivalent 1.0 (0.075−3.0) vs 0.75 (0.0−5.25) ($p = 0.006$).The study groups were similar according to cycloplegic spherical and cylindrical refractions. However, no significant difference was found between the groups regarding the need for eye glasses.
*Conclusion*: Although there were significant differences between the phototherapy and the control groups according to the convergence near point and right and the left eye cycloplegic spherical equivalent, the similarity between the groups regarding the need for eyeglasses suggested that difference was clinically insignificant.


*Keywords:* Dynamic retinoscopy; Neonatal jaundice; Phototherapy; Refraction; Spherical equivalent; Strabismus

## 1. Introduction

Jaundice is a common problem, accounting for more than half (60%) of term babies and the majority (80%) of preterm babies.[1,2] Hyperbilirubinemia is the most frequent reason for newborns' re-admission to the hospital after they have been discharged from the hospital following delivery.[3] The jaundice usually appears within the first week in the healthy term babies. Early diagnosis and treatment of jaundice is important to prevent damage to brain, vision, and hearing. Close monitoring of babies with jaundice, encouraging breastfeeding, phototherapy, and exchange transfusion in severe cases remain as therapeutic options.[1] The eyes of the newborns are protected with specific patches during the phototherapy procedure, and the newborns are monitored for procedure-related ocular irritation, purpura, and bullous eruptions.[1] The likelihood of retinal injury has been the subject of interest for researchers ever since phototherapy became available for

Conflicts of interest: The authors declare that they have are no conflicts of interest related to the subject matter or materials discussed in this article.

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http://dx.doi.org/10.1016/j.jcma.2017.08.003

treatment. Experimental animal studies demonstrating the harmful effects of phototherapy on retina, particularly at the microscopic level, have highlighted the need for protecting the eyes during the phototherapy procedure.[4] Although follow up visits are recommended for monitoring ocular function, the number of studies on this subject is limited.[4,5] The aim of the present study was to evaluate the ocular findings of children between 3 and 5 years of age who had received phototherapy in the neonatal period, and to investigate whether they had phototherapy-related permanent ocular damage or not.

## 2. Methods

Hospital records were retrospectively evaluated, and the children who had been hospitalized for hyperbilirubinemia in the neonatal period were included in the study. Approval of the Ethics Committee of Ankara Training and Research Hospital was obtained. After having informed the parents about the study, informed consent was obtained from those who wished to participate in the study. The phototherapy group consisted of children who had undergone phototherapy for at least 24 h, and the control group consisted of children who had not received phototherapy. Children with bilirubin level of >25 mg/dL, those with sepsis, those born at <36 weeks gestational age, those with a birth weight <1500 g, those with ocular findings on examination (cataract, etc.), those with history of metabolic disease, and those with severe ocular disease in the parents or siblings were excluded from the study. Children who had been assigned to the study were contacted for ophthalmological examination.

Data from children who were adherent to the examination were used in the study. Visual acuity was evaluated by the E chart and optotypes, as well as the HOTV chart, in children who were not adherent to either of the former tests. All children underwent dynamic retinoscopy, and their eye movements were evaluated in all directions of vision. The convergence near point was observed using a fixation object with the help of a ruler. Ocular alignment measurement was performed by the cover test and the cover/uncover test for near and far vision separately; a prism was used to measure the angle of deviation. Examination of cycloplegic refraction was performed using a hand-held auto refractometer and retinoscope 45 min after administering 1% cyclopentolate HCl (Siklopleglik, Mefar Pharmaceuticals Ltd., Istanbul, Turkey) 3 times at 5-min intervals. Spherical equivalent was obtained by summing up the spherical refraction with half of the cylindrical refraction. Examination of the anterior segment was performed using the biomicroscope, whereas the examination of the posterior segment was performed using a biomicroscope together with 90 D aspheric lens, as well as by indirect ophthalmoscope in case of non-compliance with the examination.

Data were analyzed using the Statistical Package for the Social Sciences (SPSS, Inc., Chicago, IL, USA) version 15.0. Since the numerical variables were not distributed normally, descriptive statistics were expressed as median (minimum–maximum) and the difference between the two medians was compared using the Mann Whitney-U test. Categorical variables were expressed as percentages and frequencies, and were compared using either the Chi-square test or Fisher's exact test.

## 3. Results

The study comprised a total of 100 children, 57 of whom (mean age 3.5 ± 0.5 years, 54.4% were male) were in the phototherapy group and 43 (mean age 4.1 ± 4.1 years, 34.9% were male) were in the control group. With regard to the characteristics of the children in the neonatal period, all infants had low birth weight. Only one infant (in the phototherapy group) had developed hypoglycemia; however, none of the infants had either developed meconium aspiration syndrome or undergone exchange transfusion. None of the infants had undergone resuscitation and/or meningitis, and none had a history of medication use or trauma. The characteristics of the study groups are presented in Table 1. The neonatal characteristics of the phototherapy group were similar to those of the control group, except for the rate of children staying in an incubator being higher and the duration of incubation being longer in the phototherapy group.

Ophthalmological examination revealed that all children in both the phototherapy and the control groups were orthophoric and had normal eye movement. The prism cover test (near and far) was normal in all children. Biomicroscopic examination of anterior segment and fundoscopic findings by the retinal examination via +90 Diopter lens after pupillary dilatation were normal in all cases. Amblyopia was not detected in any of the children. Anisometropia was present in one child only (in the phototherapy group). Cyclopentolate-induced delirium was not observed in any of the children. Other

Table 1
General characteristics of the study groups.

| | Control group (n = 43) | Phototherapy group (n = 57) | *p* |
|---|---|---|---|
| Age, years | 4.1 ± 4.1 | 3.5 ± 0.5 | 0.413 |
| Gender, n (%) | | | |
| Boys | 15 (34.9) | 31 (54.4) | 0.053 |
| Girls | 28 (65.1) | 26 (45.6) | |
| Presence of maternal diabetes, n (%) | 2 (4.7) | 6 (10.5) | 0.460 |
| Premature membrane rupture, n (%) | 2 (4.7) | 1 (1.8) | – |
| Type of delivery | | | |
| Spontaneous vaginal, n (%) | 25 (58.1) | 36 (63.2) | 0.610 |
| Cesarean section, n (%) | 18 (41.9) | 21 (36.8) | |
| Gestational age at birth, weeks | 38.63 ± 1.7 | 38.70 ± 2.0 | 0.649 |
| Birth weight, g | 3116.7 ± 366.0 | 3135.6 ± 528.3 | 0.841 |
| Staying in incubator, n (%) | 3 (7.0) | 53 (93.0) | **<0.001** |
| Duration of incubation, days | 0.28 ± 1.1 | 3.16 ± 3.2 | **<0.001** |
| Duration of breastfeeding, months | 13.14 ± 8.66 | 15.91 ± 9.36 | 0.118 |
| Duration of vitamin D use, months | 9.5 ± 7.3 | 12.0 ± 7.5 | 0.086 |
| Total bilirubin, mg/dl | 9.87 ± 4.3 | 15.64 ± 10.5 | 0.074 |

ophthalmological findings are summarized in Table 2. A statistically significant difference was found between the groups in terms of convergence near point and the right and left cycloplegic spherical equivalent. In the phototherapy group and in the control group, convergences near point were respectively 3.0 (2.0–5.0) and 3.0 (2.0–5.0) ($p = 0.018$), right cycloplegic spherical equivalents were 1.0 (0.0–3.0) and 0.75 (0.0–4.75) ($p = 0.011$) and left cycloplegic spherical equivalents were 1.0 (0.075–3.0) and 0.75 (0.0–5.25) ($p = 0.006$). The study groups were similar in terms of cycloplegic spherical and cylindrical refractions. However, no significant difference was found between the groups in terms of the need for eye glasses.

## 4. Discussion

Phototherapy is a non-invasive, easily applicable, and reliable method used widely for more than half a century in the treatment of neonatal jaundice.[6] In general, it has been agreed that the adverse events of phototherapy are not serious and are well-controllable. Nevertheless, unfavorable effects of phototherapy include interruption of the mother-baby relationship, impairment of the circadian rhythm, hypothermia/hyperthermia and dehydration due to the altered thermal environment of the baby, electrolyte imbalance (e.g. hypocalcaemia), bronze baby syndrome, allergic diseases (e.g. asthma, rhinitis, conjunctivitis), melanotic nevus and skin cancers, patent ductus arteriosus, and retinal damage.[7]

A variety of methods are used to protect the eyes against the potential harmful effects of phototherapy.[8,9] Nevertheless, the number of studies investigating the further effects of phototherapy applied in the neonatal period on the eye are quite limited. Bhupathy et al.[10] performed electroretinographic examination in 28 newborns who had undergone phototherapy within the first few days of life and in 22 control newborns when both groups were approximately 15 days old. They reported that the routine fundoscopy results were normal in both groups and that amplitudes of a and b waves under dark- and light-adapted states were similar. In another study conducted in 172 premature newborns, Hakeem et al.[11] monitored all newborns by ophthalmological examinations performed weekly or every two weeks after they became 4 weeks old. They found no significant difference between premature newborns with and without retinopathy in terms of phototherapy application. Dobson et al.[12] evaluated retinal functions in the children 4 years of age who had received continuous phototherapy in the neonatal period for at least 42 h and found that their retinal functions were similar to those of the control group, and that there was no permanent ophthalmological damage. Krishan et al.[13] evaluated 114 infants and children via ophthalmological examination including ocular movements, Hirschberg test, cover test, synoptophore, convergence, accommodation test, Maddox rod test, Worth's four dot test, visual acuity, and fundus examination. Although there are studies reporting phototherapy-related retinal damage at the microscopic level, on the clinical level, damage has not been reported.[11–13] Similarly, in our study, retinal on fundoscopic evaluations of all children were normal. Although electrophysiological evaluation can reveal more subtle changes that are clinically undetectable, our study lacked it, which is a limitation. Krishan et al.[13] compared the results of 56 children having a bilirubin level higher than 15 mg/dl in the neonatal period with the results of 58 healthy controls. They detected strabismus in 19.71% of the children in the hyperbilirubinemia group and in 3.45% of children in the control group; however, regarding bilirubin levels and exposure to phototherapy, they concluded that strabismus was associated with hyperbilirubinemia rather than phototherapy. Visual acuity and color vision abnormalities were not found in any of the children, and refraction abnormalities were not found to be associated with neonatal hyperbilirubinemia.

The groups were similar regarding the need for eye glasses. Thus, this led us to conclude that the significant difference between the groups in terms of right cycloplegic spherical equivalent and left cycloplegic spherical equivalent was coincidental and clinically insignificant.

Although convergence near point was statistically significant between the groups, it ranged from 2 to 5 cm, which remained in normal limits. This indicates that this statistical significance was clinically insignificant.

In this study, most of the evaluated parameters were statistically similar between the groups, and those which were statistically significant were clinically insignificant. Although this can be interpreted as the study lacking statistically significant finding, similarity is also a statistical findings showing

Table 2
Ophthalmological findings of the study groups.

| | Control group (n = 43) Median (min–max) | Phototherapy group (n = 57) Median (min–max) | *p* |
|---|---|---|---|
| Convergence near point (cm) | 3.0 (2.0–5.0) | 3.0 (2.0–5.0) | **0.018** |
| Cycloplegic spherical equivalent, right (D) | 0.75 (0.0–4.75) | 1.0 (0.0–3.0) | **0.011** |
| Cycloplegic spherical equivalent, left (D) | 0.75 (0.0–5.25) | 1.0 (0.075–3.0) | **0.006** |
| Cycloplegic spherical refraction, right (D) | 0.75 (0.0–4.0) | 1.0 (0.0–3.0) | 0.859 |
| Cycloplegic spherical refraction, left (D) | 0.5 (0.0–4.5) | 1.0 (0.0–3.0) | 0.063 |
| Cycloplegic cylindrical refraction, right (D) | 0.5 (0.0–2.5) | 0.5 (0.0–2.25) | 0.968 |
| Cycloplegic cylindrical refraction, left (D) | 0.5 (0.0–1.5) | 0.5 (0.0–3.75) | 0.737 |
| Need for eyeglass, n (%) | 5 (11.6) | 9 (15.8) | 0.553 |

that the groups were similar in terms of evaluated parameters. In this situation, statistical similarities are important in showing the safety of phototherapy, regarding ocular health on clinical level.

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