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Original Article

Comparing the Effect of Oil Massage on Phototherapy Efficacy in Term Neonates with Hyperbilirubinemia: A Randomized Controlled Trial

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ABSTRACT

Purpose: This study aimed to evaluate the efficacy of oil massage as an adjunct therapy for neonatal jaundice during phototherapy.
Methods: A total of 160 neonates with unconjugated hyperbilirubinemia were enrolled and randomly allocated into two study groups using a computer-generated random number table. Group 1 (Intervention Group) consisted of 84 patients who received both phototherapy and massage therapy, while Group 2 (Control Group) consisted of 76 patients who received only phototherapy. The intervention group underwent massage therapy three times daily for 20 minutes over two consecutive days. Transcutaneous bilirubin levels were measured every eight hours. Additionally, the total duration of phototherapy and the 24-hour stool and urine output frequency were recorded in both groups.
Results: There were no significant differences in the demographic characteristics between the two groups. However, stool frequency and urine output were significantly higher in the intervention group. The average duration of phototherapy was 19.4±4.17 hours in the intervention group compared to 28.4±6.58 hours in the control group (p<0.001). The rate of Transcutaneous bilirubin reduction was significantly higher in the intervention group during the first 24 hours. A rebound increase in bilirubin levels was observed at 40 and 48 hours in both groups after phototherapy was discontinued.
Conclusion: Phototherapy combined with massage significantly reduced total bilirubin levels in newborns with neonatal hyperbilirubinemia, making it a valuable adjunct treatment for the rapid reduction of bilirubin in neonates.

Keywords: Phototherapy; Neonatal hyperbilirubinemia; Massage

INTRODUCTION

Neonatal jaundice affects 60% of healthy newborns and accounts for 75% of hospitalizations during the first week of life. This condition arises from an imbalance between excessive bilirubin production and the immature liver's limited capacity to clear bilirubin from the blood [1]. While most cases of neonatal jaundice are physiologic and do not require treatment, they should still be monitored. However, some cases fall within the pathologic

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The authors have no financial conflicts of interest.

range, where phototherapy is the standard treatment for unconjugated hyperbilirubinemia. In severe cases, exchange transfusions may be required to prevent acute bilirubin encephalopathy or kernicterus [2,3]. Phototherapy, however, carries potential risks and adverse effects for newborns, necessitating its judicious use during treatment and care.

Infant massage is a common tradition in India and many other countries. Research consistently demonstrates that infant massage promotes weight gain, improves sleep patterns, supports growth and development, and optimizes autonomic nervous system function, while also reducing colic and infant mortality rates [4-8]. Moreover, massage therapy provides emotional benefits by alleviating infant stress and fostering a positive emotional bond between parents and infants [9]. Previous studies have shown that infant massage reduces bilirubin levels in neonates with hyperbilirubinemia and helps alleviate neonatal jaundice [10,11]. Although earlier clinical studies have supported the use of massage to reduce neonatal jaundice, its impact on jaundiced neonates undergoing phototherapy has not been thoroughly explored. Therefore, our objective was to evaluate the effect of infant massage on neonatal jaundice in neonates receiving phototherapy.

MATERIALS AND METHODS

This randomized controlled trial was conducted in the Neonatal Intensive Care Unit (NICU) of Uttar Pradesh University of Medical Sciences, Saifai, Etawah, India, between January 2021 and July 2022. The study included term neonates (37–42 weeks of gestation) with a birth weight over 2500 grams and less than seven days old, admitted to the NICU for unconjugated hyperbilirubinemia requiring phototherapy, as per the American Academy of Pediatrics (AAP) bilirubin nomogram [1]. Neonates with the following conditions were excluded: ABO incompatibility, Rh incompatibility, cephalhematoma, subgaleal hemorrhage, glucose-6-phosphate dehydrogenase deficiency, biliary atresia, congenital malformations, unstable vitals, prior exposure to oil massage, prior phototherapy before admission, admission after seven days of birth, diseases disrupting skin integrity or severe skin diseases such as Pemphigus Vulgaris, Stevens-Johnson Syndrome, Toxic Epidermal Necrolysis, or Staphylococcal Scalded Skin Syndrome, direct hyperbilirubinemia, serum bilirubin levels in the exchange transfusion range as per the AAP bilirubin nomogram, deranged liver function, or severe illness.

Previous studies have validated transcutaneous bilirubin measurements by comparing them with serum bilirubin levels [12-16]. Therefore, we utilized transcutaneous bilirubin measurements to monitor bilirubin levels, supplemented by an initial serum bilirubin test to rule out direct hyperbilirubinemia.

The sample size was calculated using the formula for a randomized controlled trial:

$$\text{Sample size} = \frac{2SD^2\left(Z_{ALPHA/2} + Z_{BETA}\right)^2}{d^2}$$

Using the difference in serum bilirubin with standard deviation from a previous study [17], an alpha error of 5%, and a beta error of 20%, the calculated sample size was 73.84 participants per group. Therefore, we included 74 participants as the minimum number in each group. A total of 160 neonates were enrolled during the study period, with 84 randomly assigned to Group 1 and 76 to Group 2.

The research protocol was reviewed and approved by the university's ethics committee (UPUMS/Dean(M)/184/2020-21). Written, informed consent was obtained from the parents or guardians before enrolling each neonate. Detailed antenatal and natal histories were recorded. Following consent, a comprehensive history was taken, and a clinical examination was conducted using a pre-designed and pre-structured proforma. The New Ballard Score was used to assess gestational age.

When jaundice was clinically evident, blood samples were collected and sent to the central laboratory for serum bilirubin (total and differential) testing along with other relevant investigations. Only neonates with serum bilirubin levels above the phototherapy cut-off, per the AAP nomogram chart [1], were included. Baseline transcutaneous bilirubin was measured 5–10 minutes before initiating phototherapy using a bilirubinometer (Dräger JM-105, Draeger Medical Systems, Inc., Lübeck, Germany), which has a measurement range of 0.0 mg/dL to 20 mg/dL (0 μmol/L to 340 μmol/L). All measurements were performed using a single device following the manufacturer's recommendations.

Neonates were randomly assigned to one of two groups using a computer-generated random number table. Group 1 (Intervention group) included 84 neonates who received both phototherapy and massage therapy, while Group 2 (Control group) included 76 neonates who received only phototherapy. Neonatal massages in Group 1 were performed by three staff nurses trained by the researcher using audio-visual methods and physical demonstrations.

All neonates underwent double-surface phototherapy, maintaining a distance of 35 cm between the infant and the light source. Irradiance levels were measured regularly to ensure a minimum of 15 μW/cm^2/nm within the wavelength range of 460 to 490 nm. The neonates' positions were changed hourly during phototherapy to optimize skin exposure. Eye shields were used to prevent retinal damage, and diapers were used to cover male genitalia. Transcutaneous bilirubin (TCB) measurements were repeated every 8 hours until levels fell below the phototherapy threshold per the AAP nomogram chart [1].

In Group 1, massage therapy was administered by trained nurses following the International Association of Infant Massage guidelines [18]. Coconut oil (Marico Industries) was used, and nurses followed a specific protocol, including washing hands, testing the oil on the baby's wrist, and monitoring for adverse skin reactions for 30 minutes. The massage technique involved circular motions on the head and face, gentle rubbing of the periorbital region, and specific movements on the chest and abdomen, with the oil evenly spread over the skin.

Each massage session lasted 15–20 minutes and was performed three times daily. Massage therapy was administered during a 15–20 minute interval when phototherapy was paused, ensuring that neonates received at least 6 hours of phototherapy exposure before the next massage.

In Group 2, neonates did not receive massage therapy. However, phototherapy was also paused for the same duration as Group 1's massage sessions. The total duration of phototherapy and the 24-hour stool and urine output frequencies were recorded in both groups.

Statistical analysis

Demographic and clinical characteristics were compiled for all neonates. Descriptive statistics included means±standard deviation. for numerical variables and frequencies/percentages for categorical variables. Data analysis was performed using IBM SPSS Statistics

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for Windows, Version 25.0 (IBM Co.). Inferential statistics included Student's *t*-test, Chi-square test, Fisher's exact test, and one-way ANOVA. Post hoc Tukey tests were applied to significant ANOVA results. Statistical significance was defined as $p<0.05$.

RESULTS

A total of 160 term neonates with unconjugated hyperbilirubinemia were evaluated and divided into two groups. **Table 1** shows the demographic characteristics of the neonates in both groups. The average postnatal age at admission was 47.58±24.89 hours in the intervention group and 46.35±24.06 hours in the control group. No significant differences were observed in the demographic characteristics between the two groups.

The effect of the intervention on stool frequency and urine output was statistically significant ($p<0.05$). However, no significant difference was found in feeding frequency between the two groups. The average duration of phototherapy was 19.4±4.17 hours in the intervention group and 28.4±6.58 hours in the control group, which was also significant ($p<0.001$). The rebound phenomenon was observed in both groups, without any significant difference (**Table 2**).

Table 1. Demographic characteristics of the study population

Parameters	Intervention group (N=84)	Control group (N=76)	*p*-value
Postnatal age at the time of admission (h)	47.58±24.89	46.35±24.06	0.31
Sex			0.91
Male	48 (57.1)	42 (55.3)	
Female	36 (42.9)	34 (44.7)	
Mean gestational age (wk)	39.1±1.27	39.3±1.19	0.25
Mean weight (g)	2,993±140	2,977±131	0.11
Mode of delivery			0.89
NVD	34 (40.5)	30 (39.5)	
LSCS	50 (59.5)	46 (60.5)	
Type of feeding given			0.491
Exclusive breastfeeding	38 (45.2)	37 (48.7)	
Formula feeding	21 (25.0)	15 (19.7)	
Mixed feeding	25 (29.8)	24 (31.8)	

Values are presented as mean±standard deviation or number (%).
NVD: normal vaginal delivery; LSCS: lower segment caesarean section.

Table 2. Comparison of other factors in the intervention and control groups

Parameters	Intervention group (N=84)	Control group (N=76)	*p*-value
Feeding frequency			
8–12 feeds	70 (83.3)	55 (71.1)	0.095
<8 feeds	14 (16.7)	21 (29.0)	
Stool frequency			
First 24 h	4.48±0.719	2.84±0.767	<0.001
Next 24 h	5.33±0.577	3.00±0.701	<0.001
Urine output (mL/kg/h)			
First 24 h	2.32±0.47	1.72±0.35	<0.001
Next 24 h	2.60±0.265	1.66±0.343	<0.010
Serum bilirubin before starting phototherapy (mg/dL)	16.8±0.752	17.1±0.798	0.19
Duration of phototherapy (h)	19.4±4.17	28.4±6.58	<0.001
Rebound phenomenon	5 (6.0)	9 (11.8)	0.300

Values are presented as number (%) or mean±standard deviation.

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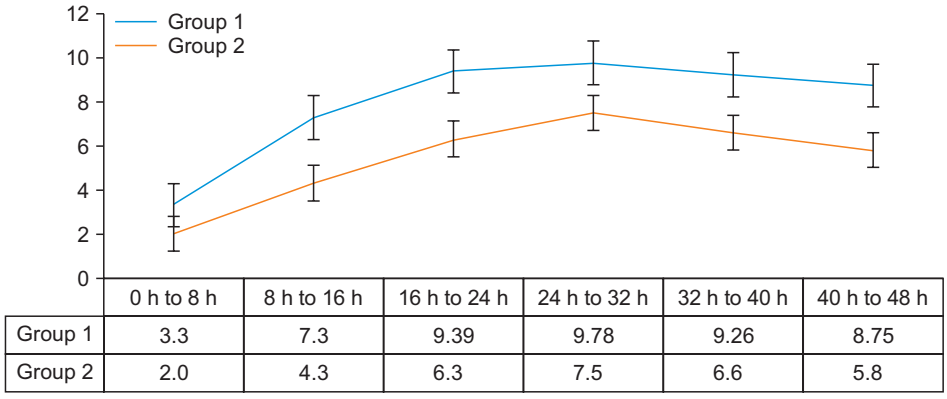
Table 3. Eight-hourly comparisons of transcutaneous bilirubin in the intervention and control groups

Timings	Intervention group (N=84)		Control group (N=76)		*p*-value
	Bilirubin level	Mean reduction in bilirubin level	Bilirubin level	Mean reduction in bilirubin level	
At admission	18.1±0.923	-	18.5±1.87	-	0.07
At 8 h	14.9±1.71	3.3±0.78	16.5±1.14	2.0±0.62	<0.001
At 16 h	10.9±1.58	4.0±0.13	14.2±1.2	2.3±0.81	<0.001
At 24 h	8.81±1.37	2.1±0.48	12.2±1.69	2.0±0.47	0.01
At 32 h	8.43±1.36	0.38±0.01	11.0±1.63	1.2±0.09	0.091
At 40 h	8.95±1.52	−0.52±0.18	10.1±1.77	−0.9±0.07	0.11
At 48 h	9.46±1.77	−0.51±0.05	10.9±2.45	−0.8±0.33	0.04

Values are presented as mean±standard.



	0 h to 8 h	8 h to 16 h	16 h to 24 h	24 h to 32 h	32 h to 40 h	40 h to 48 h
Group 1	3.3	7.3	9.39	9.78	9.26	8.75
Group 2	2.0	4.3	6.3	7.5	6.6	5.8

Fig. 1. Post-Hoc Tukey test comparing changes in mean transcutaneous bilirubin levels during phototherapy in both groups.

Table 3 presents the mean TCB reduction every eight hours in both groups. The rate of TCB reduction was significantly higher in the intervention group compared to the control group during the first 24 hours. However, after stopping phototherapy, a rebound increase in bilirubin was observed at 40 and 48 hours in both groups.

The Post-Hoc Tukey test further compared the eight-hourly TCB changes in both groups, showing that the rate of TCB reduction was significantly higher in the intervention group at 8, 16, 24, and 32 hours compared to the control group (**Fig. 1**).

DISCUSSION

In this study, 160 neonates with unconjugated hyperbilirubinemia were analyzed, divided into intervention and control groups. The demographic characteristics of the groups were comparable, with no statistically significant differences. However, the intervention group showed a greater reduction in bilirubin levels after the first 24 hours of phototherapy combined with massage therapy. A significantly higher bilirubin reduction rate, stool frequency, and urine output were observed in the intervention group compared to the control group, resulting in a shorter duration of phototherapy for the intervention group.

The findings revealed a statistically significant difference in bilirubin reduction during the first 24 hours of phototherapy, which was more pronounced in the intervention group. This difference began to decline after 32 hours, as mean bilirubin levels slightly rebounded in

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both groups. This rebound may be associated with higher breastfeeding frequency and urine output in the intervention group.

Previous studies have also shown that combining infant massage with phototherapy accelerates bilirubin reduction in neonates with unconjugated hyperbilirubinemia [10,11,19]. Shahbazi et al. [20] conducted a meta-analysis showing a dose-response association between massage therapy and phototherapy efficacy. However, Karbandi et al. [21] reported that massage was ineffective in reducing bilirubin until the fifth day.

Several studies have consistently demonstrated that infants receiving massage and phototherapy exhibit significantly higher bowel movement frequency compared to controls [10,11,22-24]. Clinical evidence suggests that massage therapy enhances vagal tone, improving gut motility and facilitating meconium passage [4,25]. Increased stool frequency reduces bilirubin reabsorption, although neonatal intestinal mechanisms remain immature due to suboptimal nutritional intake and digestive enzyme activity. Massage with oil promotes gut motility, aiding in the excretion of bilirubin broken down through phototherapy. Additionally, massage improves blood circulation, lymphatic flow, and the elimination of waste products like bilirubin [10].

Bilirubin is also metabolized to urobilin, which is excreted in urine [26]. The mean urine output after 24 hours was 2.32 mL/kg/hr in the intervention group and 1.72 mL/kg/hr in the control group, a statistically significant difference (p<0.001) comparable to other studies [17]. Massage therapy increases renal perfusion by improving blood flow and lymphatic circulation. Nangia et al. [27] reported reduced trans-epidermal water loss after applying coconut oil, as used in our study, potentially contributing to increased urination. Massage therapy may also increase feeding frequency, which further enhances urination and urobilin excretion. However, Jeong et al. [28] found no significant difference in 24-hour urine volume between massage intervention and control groups.

The primary limitation of this study was the lack of blinding, as the researcher conducting the massage intervention also implemented the study. Additionally, serum bilirubin levels could not be measured frequently due to the impracticality of repeated blood sampling. Other limitations included less detailed obstetric histories and the inability to quantify breast milk intake, which was excluded from the analysis. Conducted over 48 hours, the study recommends extending the duration to explore the long-term effects of massage and phototherapy on serum bilirubin levels.

In conclusion, combining phototherapy with massage significantly reduced bilirubin levels in neonates with neonatal hyperbilirubinemia. This dual approach serves as a valuable complement to phototherapy, expediting bilirubin reduction. Additionally, massage therapy eases financial burdens on families, promotes bonding between mothers and infants, reduces parental stress, and minimizes exposure to phototherapy.

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