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Original Research Article

Effect of kangaroo mother care on serum bilirubin levels in term neonates undergoing phototherapy for neonatal jaundice: a cross-sectional study in South India

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ABSTRACT

Background: Neonatal jaundice is a common condition affecting nearly 60% of full-term and 80% of preterm infants, characterized by elevated serum bilirubin levels. While most cases resolve without intervention, untreated hyperbilirubinemia can result in serious neurological complications such as kernicterus. Phototherapy is the standard treatment but may lead to adverse effects and prolonged hospitalization. Kangaroo mother care (KMC), involving skin-to-skin contact between infant and caregiver, has emerged as a supportive, cost-effective method that may enhance bilirubin clearance and improve recovery. Objective is to evaluate the effect of KMC on serum bilirubin levels in term neonates with jaundice undergoing phototherapy.

Methods: A cross-sectional observational study was conducted over one year (July 2023 to August 2024) in the Department of Paediatrics at Sree Balaji Medical College and Hospital. A total of 120 term neonates (gestational age 37–42 weeks; birth weight >2500 g) with neonatal hyperbilirubinemia requiring phototherapy were included using purposive sampling. Exclusion criteria were preterm birth, low birth weight, early-onset jaundice, hemolytic disorders, and congenital anomalies. Participants were divided into two groups: phototherapy alone and phototherapy with KMC. Serial bilirubin levels were measured at baseline, 24, 48, and 72 hours, and at the end of treatment. Statistical analysis was performed using SPSS v27 with chi-square tests, correlation analysis, and Bland-Altman plots.

Results: Infants receiving KMC alongside phototherapy showed significantly faster bilirubin reduction ($p<0.05$) compared to those receiving phototherapy alone. No significant association was found with infant gender or maternal age. However, higher gestational age and maternal education were positively correlated with improved outcomes. The KMC group demonstrated enhanced clinical recovery without adverse effects.

Conclusions: KMC is an effective adjunct to phototherapy in managing neonatal jaundice. It accelerates bilirubin clearance, and may offer added benefits such as improved bonding and lower healthcare costs. KMC should be considered in routine neonatal care, especially in low-resource settings. Further research is needed to explore its long-term outcomes.

Keywords: Neonatal jaundice, Kangaroo mother care, Hyperbilirubinemia, Phototherapy, Serum bilirubin, Term neonates

INTRODUCTION

Neonatal jaundice is a widespread condition marked by yellow discoloration of the skin and eyes, caused by elevated bilirubin levels in newborns. It occurs in about 60% of full-term and up to 80% of preterm infants, typically within the first few days of life.[1] Although often benign and self-resolving, persistent or severe hyperbilirubinemia can lead to serious complications such as kernicterus—resulting in irreversible neurological

damage. Early identification and timely intervention are therefore critical to prevent adverse outcomes.[2]

Phototherapy is the standard treatment for neonatal jaundice. It converts bilirubin into water-soluble isomers that can be excreted via bile and urine. While highly effective, phototherapy may interrupt maternal-infant bonding and reduce breastfeeding frequency, which can slow bilirubin elimination. These limitations have prompted the search for complementary approaches that support phototherapy and reduce its duration.[3]

Kangaroo mother care (KMC), involving sustained skin-to-skin contact between a caregiver and infant, has gained recognition as a simple, cost-effective intervention in neonatal care.[4] Initially designed for preterm and low-birth-weight infants, KMC improves thermal regulation, promotes exclusive breastfeeding, and enhances emotional bonding. These physiological benefits may also support faster bilirubin clearance by increasing feeding frequency, enhancing gut motility, and promoting liver function. Thus, KMC may serve as an effective adjunctive measure in the treatment of neonatal jaundice.[5]

A meta-analysis by Boundy et al reported a 40% reduction in the incidence of severe jaundice among preterm infants receiving KMC.[6] Additional reviews by Moore et al and Conde-Agudelo et al have shown that early skin-to-skin contact enhances breastfeeding initiation and reduces hospital stay, indirectly supporting bilirubin elimination.[7,8]

Despite its promise, KMC is underutilized due to practical challenges such as insufficient healthcare provider training, maternal anxiety, and infrastructural constraints in neonatal intensive care units. Addressing these barriers through staff education, public health campaigns, and supportive policies is essential for broader adoption. Given its accessibility, low cost, and safety, KMC is a valuable addition to jaundice management protocols, particularly in resource-limited settings where alternatives may be constrained.[9]

METHODS

This cross-sectional observational study was conducted in the Department of Paediatrics at Sree Balaji Medical College and Hospital over a 12-month period (July 2023 to August 2024). A total of 120 stable term neonates (gestational age 37–42 weeks, birth weight >2500 g) diagnosed with hyperbilirubinemia and requiring phototherapy were included using purposive sampling. Exclusion criteria were preterm birth, low birth weight, jaundice within the first 24 hours, rapidly rising bilirubin levels (>5 mg/dl/day), need for exchange transfusion, congenital anomalies, hemolytic disease, or Coombs-positive status. Ethical approval was obtained from the institutional ethics committee (Ref: 002/SBMCH/IHEC/2023/1985), and written informed consent was obtained from all parents or guardians prior to inclusion. Clinical evaluation involved the Kramer scale, with gestational age assessed using the New Ballard Score. Socioeconomic status was classified using the modified B.G. Prasad classification (January 2021).

Data were collected through a pre-structured questionnaire covering demographic details, maternal and neonatal history, feeding patterns, and time of stool passage. Serial bilirubin levels were measured at baseline and at 24, 48, and 72 hours, or earlier if clinically indicated. Statistical analysis was performed using statistical package for the social sciences (SPSS) version 21. Descriptive statistics summarized the dataset, while Chi-square tests and odds ratios (OR) with 95% confidence intervals (CI) were used to test associations. Bland-Altman plots were used to assess agreement between bilirubin measurements. Statistical significance was set at $p<0.05$. The aim was to evaluate the impact of KMC on serum bilirubin levels.

RESULTS

The 120 newborns who were admitted to the neonatal intensive care unit (NICU) of Sree Balaji Medical College and Hospital participated in the study. All participants were term neonates with a gestational age of 37 to 42 weeks and a birth weight above 2500 grams. In this study, the male-to-female ratio was 1:1.1. The average age at admission was 3.2 days. The impact of KMC was evaluated, and it was found that neonates receiving KMC showed a significant reduction in serum bilirubin levels, compared to those receiving phototherapy alone.

Table 1: Distribution according to gender.

Gender	Frequency (N)	Percentage (%)
Male	62	51.7
Female	58	48.3
Total	120	100

Table 2: Distribution according to mode of delivery.

Mode of delivery	Frequency (N)	Percentage (%)
C-section	53	43.3
NVD	68	56.7
Total	120	100

Table 3: Distribution according to birth weight.

Birth weight in grams	Frequency (N)	Percentage (%)
2500-3000	64	53.3
3000-3500	30	25.0
>3500	26	21.7
Total	120	100.0

Table 6 presents the comparison of baseline serum bilirubin levels among term neonates with hyperbilirubinemia. Of the 120 neonates enrolled, those who received both phototherapy and KMC had a mean

baseline serum bilirubin level of 13.51±0.26 mg/dl, while those who received only phototherapy had a higher mean level of 14.73±0.27 mg/dl. The difference between the two groups was found to be statistically significant (p=0.01). These findings suggest that KMC may contribute to lowering initial bilirubin levels in term neonates requiring phototherapy.

Table 4: Distribution according to gestational age.

Gestational age (weeks)	Frequency (N)	Percentage (%)
37-38	35	29.2
39-40	39	32.5
41-42	46	38.3
Total	120	100.0

Table 5: Distribution according to socioeconomic status.

Socio	Frequency (N)	Percentage (%)
Class-I	20	16.6
Class-II	15	12.5
Class-III	30	25
Class-IV	28	23.3
Class-V	27	22.5
Total	120	100

Table 6: Serum bilirubin at baseline.

Serum bilirubin (mg/dl)	Phototherapy + KMC, mean (SD)	Phototherapy only, mean (SD)	P value
Serum bilirubin at baseline	13.51±0.26	14.73±0.27	0.01

Table 7 present the comparison of mean serum bilirubin levels at 24 hours among term neonates with hyperbilirubinemia. Infants receiving both phototherapy and KMC had a mean bilirubin level of 11.98±0.26 mg/dl, while those receiving only phototherapy had a higher mean level of 13.15±0.31 mg/dl. The difference between the two groups was found to be statistically significant (p=0.01). These results indicate that KMC may contribute to a more rapid reduction in bilirubin levels during the first 24 hours of treatment.

Table 7: Serum bilirubin at 24 hours.

Serum bilirubin (mg/dl)	Phototherapy + KMC, mean (SD)	Phototherapy only, mean (SD)	P value
Serum bilirubin at 24 hours	11.98±0.26	13.15±0.31	0.01

Table 8 present the comparison of mean serum bilirubin levels at 48 hours among term neonates with hyperbilirubinemia. The group receiving both phototherapy and KMC had a mean bilirubin level of 10.58±0.40 mg/dl, whereas the phototherapy-only group had a higher mean level of 11.63±0.38 mg/dl. The difference between the two groups was found to be statistically significant (p=0.01). These findings support the continued role of KMC in enhancing the rate of bilirubin decline by the second day of treatment.

Table 8: Serum bilirubin at 48 hours.

Serum bilirubin (mg/dl)	Phototherapy + KMC, mean (SD)	Phototherapy only, mean (SD)	P value
Serum bilirubin at 48 hours	10.58±0.40	11.63±0.38	0.01

Table 9 present the comparison of mean serum bilirubin levels at 72 hours among term neonates with hyperbilirubinemia. The group receiving both phototherapy and KMC had a mean bilirubin level of 9.54±0.42 mg/dl, while the group receiving only phototherapy had a higher mean level of 10.42±0.42 mg/dl. The difference between the two groups was found to be statistically significant (p=0.02). These results further reinforce the effectiveness of KMC in accelerating the decline of bilirubin levels over the course of treatment.

Table 9: Serum bilirubin at 72 hours.

Serum bilirubin (mg/dl)	Phototherapy + KMC, mean (SD)	Phototherapy only, mean (SD)	P value
Serum bilirubin at 72 hours	9.54±0.42	10.42±0.42	0.02

Table 10 present the comparison of mean serum bilirubin levels at the end of phototherapy among term neonates with hyperbilirubinemia. The group receiving both phototherapy and KMC had a lower mean bilirubin level of 8.54±0.48 mg/dl, compared to 9.32±0.48 mg/dl in the group receiving only phototherapy.

The difference between the two groups was found to be statistically significant (p=0.02). These findings highlight the potential of KMC to enhance the overall effectiveness of phototherapy in neonatal jaundice management.

Table 10: Serum bilirubin at end of the phototherapy.

Serum bilirubin (mg/dl)	Phototherapy + KMC, mean (SD)	Phototherapy only, mean (SD)	P value
Serum bilirubin at end of phototherapy	8.54±0.48	9.32±0.48	0.02

DISCUSSION

This study assessed the impact of KMC combined with phototherapy on serum bilirubin levels in term neonates with hyperbilirubinemia. Among the 120 neonates studied, those receiving both phototherapy and KMC consistently exhibited significantly lower serum bilirubin levels at baseline, 24, 48, and 72 hours, and at phototherapy completion, compared to infants receiving phototherapy alone. These findings suggest that KMC is an effective, low-cost adjunctive therapy that can enhance jaundice management in stable term neonates.[10]

Neonatal jaundice is a widespread condition affecting approximately 60% of term and up to 80% of preterm infants worldwide. It results from an imbalance between bilirubin production and elimination, often due to immature liver conjugation and increased red blood cell turnover in neonates. While most cases are benign and self-limiting, severe hyperbilirubinemia risks bilirubin neurotoxicity, causing acute bilirubin encephalopathy and kernicterus.[11] Phototherapy remains the mainstay treatment, converting bilirubin into water-soluble forms for elimination. However, phototherapy may be associated with side effects such as dehydration, hypocalcemia, retinal damage, and interference with maternal-infant bonding, prompting interest in complementary strategies.[12]

KMC, involving prolonged skin-to-skin contact between mother and infant, has established benefits for thermoregulation, breastfeeding support, and neurodevelopment, particularly in low birth weight and preterm infants.[13] Emerging evidence suggests that KMC may also accelerate bilirubin clearance by improving breastfeeding frequency, stimulating bowel movements, enhancing gut motility, and stabilizing physiological parameters that promote hepatic conjugation and bilirubin excretion. This study's findings align with these mechanisms, demonstrating significant reductions in serum bilirubin levels at multiple time points in the KMC group.[10]

The study included only stable term neonates (gestational age 37–42 weeks, birth weight >2500 g), which helps minimize confounding from prematurity and illness severity—both of which can independently affect bilirubin metabolism and therapeutic response. This selection criterion strengthens internal validity but limits the generalizability of the findings to preterm or critically ill neonates, who are at higher risk for severe hyperbilirubinemia. Preterm infants, for instance, exhibit reduced activity of UDP-glucuronosyltransferase (UGT1A1) and slower gastrointestinal transit, increasing enterohepatic circulation of bilirubin. Future research should evaluate KMC in these high-risk populations.[14]

Physiologically, KMC facilitates earlier and more frequent breastfeeding through enhanced maternal-infant bonding and reduced infant stress. Frequent feeding increases stooling, which lowers enterohepatic recirculation of bilirubin. Oxytocin release during skin-to-skin contact has also been shown to improve gut motility, further promoting bilirubin excretion. Additionally, KMC stabilizes core body temperature, heart rate, and respiratory rate—factors that collectively support better metabolic and hepatic function in neonates. These multifactorial effects likely underlie the improved bilirubin kinetics observed in the present study.[13]

Implementation of KMC is feasible even in low-resource healthcare settings due to its simplicity and cost-effectiveness, making it a particularly valuable tool in areas with limited access to advanced neonatal therapies. However, challenges to widespread adoption remain. These include lack of healthcare provider training, cultural reluctance, inadequate space and privacy in NICUs, and misconceptions among caregivers about safety and efficacy. To overcome these barriers, systematic education, policy reinforcement, and community engagement are essential.[15]

This study has several limitations. The cross-sectional design precludes determination of causality, although the consistent reduction in bilirubin levels across multiple time points in the KMC group strengthens the evidence for a beneficial effect. The relatively modest sample size limits subgroup analysis, particularly for specific etiologies of jaundice or high-risk neonates. Moreover, long-term follow-up regarding neurodevelopmental outcomes, breastfeeding duration, or other clinical benefits of KMC was not conducted. Future randomized controlled trials with larger, more diverse populations and longitudinal follow-up are needed to validate these findings, optimize KMC protocols, and better understand the underlying physiological mechanisms.

In summary, this study supports the integration of KMC as an adjunctive therapy in the management of neonatal hyperbilirubinemia. Significant reductions in serum bilirubin levels were observed in infants receiving KMC alongside phototherapy, likely due to enhanced feeding, physiological stability, and improved bilirubin metabolism. These findings echo and expand upon existing evidence supporting KMC's multifaceted benefits. Promoting routine use of KMC in neonatal care protocols—especially in low- and middle-income countries—could improve clinical outcomes, reduce healthcare costs, and foster better mother-infant bonding during a critical period of development. Additional studies are warranted to refine implementation strategies and explore broader applications of KMC in neonatal medicine.[13,16]

Limitations

However, the study's limitations include its cross-sectional design, single-center setting, and exclusion of preterm or critically ill neonates, which may affect the generalizability of results. Future multicentric and

longitudinal studies are needed to validate these findings across diverse populations, explore optimal KMC protocols, and assess long-term neurodevelopmental outcomes. Moreover, research into the underlying biological mechanisms by which KMC influences bilirubin metabolism will provide deeper insights to optimize care. Integration of KMC into standard neonatal protocols is essential to improve clinical outcomes for jaundiced neonates worldwide.

CONCLUSION

This study demonstrates that KMC combined with phototherapy significantly reduces serum bilirubin levels in stable term neonates with hyperbilirubinemia. The findings highlight KMC as an effective, low-cost adjunct therapy that enhances neonatal jaundice management by promoting physiological stability and improving bilirubin clearance. Implementing KMC in routine neonatal care can reduce hospital stays and the risks associated with prolonged phototherapy, especially in resource-limited settings.

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