e-ISSN: 0976-822X, p-ISSN:2961-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2026; 18(4); 1534-1540

Original Research Article

Maternal and Neonatal Safety of Prolonged Delayed Cord Clamping with Cord Milking: A Randomized Study

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Received: 06-02-2026 / Revised: 16-03-2026 / Accepted: 06-04-2026
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Conflict of interest: Nil

Abstract

Background: Delayed cord clamping (DCC) has emerged as an important intervention for improving neonatal hematological parameters and iron stores. Major international organizations including the World Health Organization (WHO), American College of Obstetricians and Gynecologists (ACOG), and Royal College of Obstetricians and Gynaecologists (RCOG) recommend delayed cord clamping in vigorous term and preterm neonates. However, concerns regarding neonatal jaundice, polycythemia, hyperviscosity, and maternal postpartum hemorrhage continue to limit widespread implementation of prolonged DCC practices, particularly in low-resource settings.

Objective: To evaluate maternal and neonatal safety outcomes following delayed cord clamping with cord milking at 60 seconds and 180 seconds.

Methods: This randomized controlled comparative study was conducted in the Department of Obstetrics and Gynaecology, SMS Medical College and Attached Hospitals, Jaipur. Sixty singleton pregnancies beyond 34 weeks gestation fulfilling inclusion criteria were enrolled and randomized into two groups. Group A underwent delayed cord clamping with cord milking at 60 seconds, while Group B underwent delayed cord clamping with cord milking at 180 seconds. Maternal demographic characteristics, neonatal hematological parameters, and maternal and neonatal adverse outcomes were analyzed.

Results: Baseline maternal characteristics including maternal age, body mass index (BMI), gestational age, parity, and mode of delivery were comparable between groups. Mean neonatal hemoglobin at birth and follow-up was significantly higher in Group B compared to Group A. No statistically significant increase in maternal postpartum hemorrhage, neonatal jaundice, NICU admission, or polycythemia was observed in the prolonged clamping group.

Conclusion: Delayed cord clamping with cord milking up to 180 seconds appears safe and effective for improving neonatal hematological outcomes without increasing maternal or neonatal complications.

Keywords: Delayed Cord Clamping, Cord Milking, Placental Transfusion, Neonatal Anemia, Postpartum Hemorrhage, Neonatal Safety.

DOI: 10.25258/ijcpr.18.4.242

Introduction

Umbilical cord clamping is an essential component of the third stage of labor and has traditionally been performed immediately after delivery. Early cord clamping became routine practice in obstetrics due to concerns regarding maternal postpartum hemorrhage, facilitation of neonatal resuscitation, and convenience during active management of the third stage of labor. However, over the past decade, increasing evidence has demonstrated that delayed cord clamping provides substantial neonatal hematological and developmental benefits. McDonald et al. demonstrated in a Cochrane review that delayed cord clamping improved neonatal hemoglobin levels and iron stores without increasing serious maternal complications.[1] Delayed cord clamping allows continued placental transfusion from the placenta to the newborn after birth. Nearly one-third of fetal blood volume remains within the placenta immediately after delivery. Delaying clamping by 1–3 minutes allows transfer of approximately 80–100 mL of blood to the neonate, resulting in increased neonatal blood volume, improved hemoglobin concentration, and enhanced iron stores.[2] Placental transfusion is particularly important because neonatal iron stores play a major role in neurodevelopment during infancy. Iron deficiency during the early neonatal period has been associated with impaired myelination, altered neurotransmitter synthesis, delayed cognitive development, and impaired

psychomotor performance. Mercer et al. reported that improved iron stores following delayed cord clamping were associated with improved brain myelination during infancy.[3]

The World Health Organization recommends delayed cord clamping not earlier than one minute after birth in term and preterm infants who do not require immediate resuscitation.[4] Similarly, the American College of Obstetricians and Gynecologists recommends delaying umbilical cord clamping for at least 30–60 seconds after birth in vigorous neonates.[5]

Umbilical cord milking is another placental transfusion strategy that rapidly transfers blood from the placenta to the infant by gently squeezing the cord several times toward the neonate before clamping. Cord milking may be especially useful during cesarean delivery or situations where prolonged delayed cord clamping is difficult. Basile et al. concluded that cord milking provides hematological benefits comparable to delayed cord clamping in many neonates.[6]

Despite increasing evidence supporting delayed cord clamping, concerns remain regarding possible maternal and neonatal complications associated with prolonged placental transfusion. Increased neonatal blood volume may theoretically increase the risk of polycythemia, hyperbilirubinemia, respiratory distress, and NICU admission. Obstetricians also continue to express concerns regarding increased postpartum hemorrhage and prolonged third stage of labor.[7]

Several recent studies have demonstrated that delayed cord clamping does not significantly increase maternal or neonatal complications. Upadhyay et al. demonstrated improved hemoglobin and ferritin levels in neonates undergoing cord milking without increased neonatal adverse effects.[9] Katheria et al. also reported improved hematological outcomes without increased neonatal morbidity.[8]

In India and other low-resource countries, neonatal and infant anemia remain major public health concerns. Therefore, inexpensive interventions such as delayed cord clamping may have significant implications for neonatal health. Zhao et al. showed in a meta-analysis that delayed cord clamping reduced iron deficiency anemia during infancy and improved ferritin levels.[10]

The present study was conducted to evaluate maternal and neonatal safety outcomes associated with prolonged delayed cord clamping with cord milking at 180 seconds compared with delayed cord clamping at 60 seconds.

Umbilical cord clamping is an essential component of the third stage of labor and has traditionally been performed immediately after delivery. Early cord clamping became routine practice in obstetrics due to concerns regarding maternal postpartum hemorrhage, facilitation of neonatal resuscitation, and convenience during active management of the third stage of labor. However, over the past decade, increasing evidence has demonstrated that delayed cord clamping provides substantial neonatal hematological and developmental benefits.

Delayed cord clamping allows continued placental transfusion from the placenta to the newborn after birth. Nearly one-third of fetal blood volume remains within the placenta immediately after delivery. Delaying clamping by 1–3 minutes allows transfer of approximately 80–100 mL of blood to the neonate, resulting in increased neonatal blood volume, improved hemoglobin concentration, and enhanced iron stores.

Placental transfusion is particularly important because neonatal iron stores play a major role in neurodevelopment during infancy. Iron deficiency during the early neonatal period has been associated with impaired myelination, altered neurotransmitter synthesis, delayed cognitive development, and impaired psychomotor performance. Delayed cord clamping therefore represents a low-cost and effective strategy for prevention of neonatal iron deficiency anemia.

The World Health Organization recommends delayed cord clamping not earlier than one minute after birth in term and preterm infants who do not require immediate resuscitation. Similarly, the American College of Obstetricians and Gynecologists recommends delaying umbilical cord clamping for at least 30–60 seconds after birth in vigorous neonates.

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The present study was conducted to evaluate maternal and neonatal safety outcomes associated with prolonged delayed cord clamping with cord milking at 180 seconds compared with delayed cord clamping at 60 seconds.

Materials and Methods

Study Design: This randomized controlled comparative study was conducted in the Department of Obstetrics and Gynaecology, SMS Medical College and Attached Hospitals, Jaipur, Rajasthan, India.

Ethical Approval: Institutional ethical committee approval was obtained prior to commencement of the study. Written informed consent was obtained from all participants.

Study Population: Sixty singleton pregnant women beyond 34 weeks gestation admitted in the labor room were included in the study.

Inclusion Criteria

- Singleton pregnancy
- Gestational age >34 weeks
- Women willing to participate in the study

Exclusion Criteria

- Severe maternal anemia
- Rh incompatibility
- Diabetes mellitus
- Pregnancy induced hypertension
- Antepartum hemorrhage
- Congenital fetal anomalies
- Intrauterine growth restriction
- Birth asphyxia
- Instrumental delivery

Randomization: Participants were randomized into two groups using random number tables.

Group A: Delayed cord clamping with cord milking at 60 seconds.

Group B: Delayed cord clamping with cord milking at 180 seconds.

Study Procedure: After delivery, newborns underwent delayed cord clamping according to the assigned group protocol. Umbilical cord milking was performed before cord clamping in both groups. Maternal and neonatal parameters were recorded including:

- Maternal age
- Socioeconomic status
- Maternal BMI
- Gestational age
- Mode of delivery
- Birth weight
- Neonatal hemoglobin
- Neonatal complications

Follow-up hematological assessment was performed at six weeks.

Statistical Analysis: Continuous variables were expressed as mean ± standard deviation. Statistical analysis was performed using appropriate statistical methods. A p-value less than 0.05 was considered statistically significant.

Results

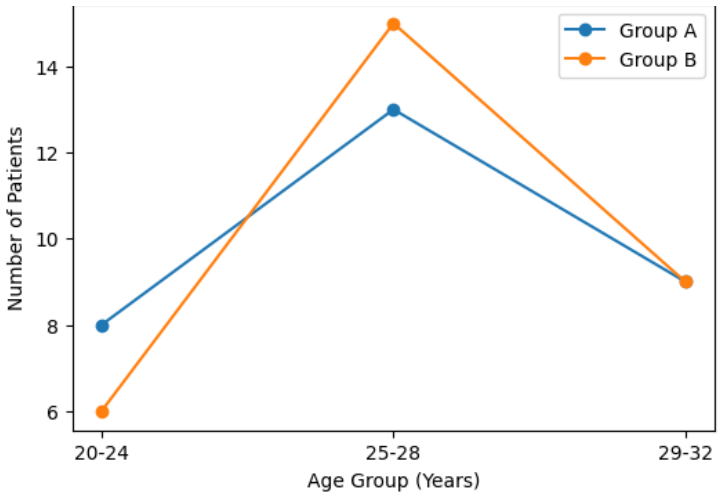

Figure 1: Maternal Age Distribution

The majority of mothers in both groups belonged to the 25–28 years age group. Mean maternal age was comparable between Group A (26.8±2.90 years) and Group B (26.63±2.98 years), with no statistically significant difference (p=0.82). The mean maternal age was comparable between the two groups and no statistically significant difference was observed.

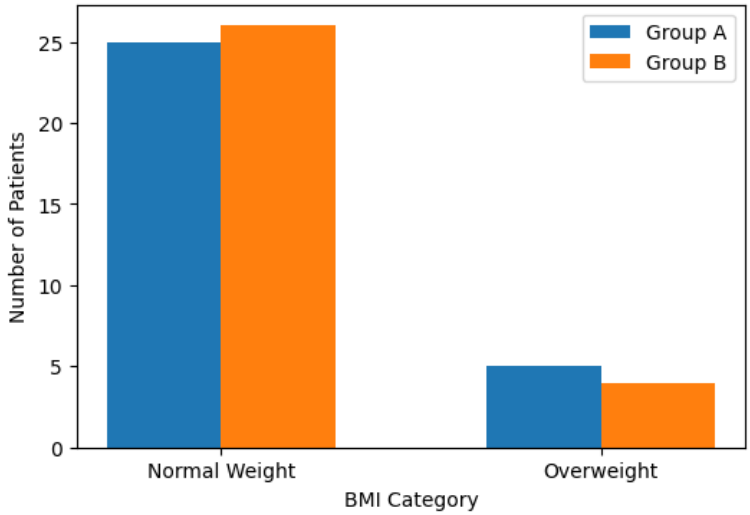

Figure 2: Maternal BMI Distribution

Most women in both groups had normal BMI. Mean BMI was 21.34±1.44 kg/m² in Group A and 21.39±1.29 kg/m² in Group B. No statistically significant difference was observed between the groups (p=0.88).

Most participants in both groups had normal BMI and no statistically significant difference was observed.

Table 1: Distribution According to Residence

Residence	Group A n (%)	Group B n (%)
Rural	24 (80%)	29 (96.6%)
Urban	6 (20%)	1 (3.3%)
P-value	0.04	

The majority of study participants belonged to rural areas.

Table 2: Distribution According to Gestational Age

Gestational Age	Group A n (%)	Group B n (%)
34–36 weeks	14 (46.6%)	13 (43%)
37–38 weeks	15 (50%)	14 (47%)
>38 weeks	1 (3.3%)	3 (10%)
Mean ± SD	36.9 ± 1.11	37 ± 1.17
P-value	0.73	

Gestational age distribution was comparable between both groups.

Table 3: Distribution According to Mode of Delivery

Mode of Delivery	Group A n (%)	Group B n (%)
Normal Delivery	16 (53.3%)	14 (47%)
LSCS	14 (46.6%)	16 (53%)
P-value	0.60	

No statistically significant difference was observed in mode of delivery between the two groups.

Table 4: Distribution According to Neonatal Birth Weight

Birth Weight (kg)	Group A n (%)	Group B n (%)
2–2.5	14 (46.6%)	11 (37%)
2.6–3	11 (36.6%)	12 (40%)
>3	5 (16.6%)	7 (23%)
Mean ± SD	2.66 ± 0.43	2.77 ± 0.41
P-value	0.31	

Birth weight was comparable between both study groups.

Table 5: Neonatal Hemoglobin Comparison

Parameter	Group A	Group B	P-value
Hemoglobin at birth (g/dL)	13.53 ± 0.56	13.85 ± 0.55	0.02
Hemoglobin at 6 weeks (g/dL)	13.19 ± 0.53	13.53 ± 0.55	0.01

Neonates in Group B demonstrated significantly higher hemoglobin levels at birth and at follow-up.

Discussion

The present study evaluated maternal and neonatal safety outcomes associated with prolonged delayed cord clamping with cord milking at 180 seconds compared with delayed cord clamping at 60 seconds.

The baseline maternal characteristics including maternal age, BMI, gestational age, parity, and birth weight were comparable between both groups. This ensured adequate homogeneity of the study population and minimized confounding factors.

The present study demonstrated significantly higher neonatal hemoglobin levels at birth and follow-up in neonates undergoing delayed cord clamping at 180 seconds. These findings support the concept that prolonged placental transfusion enhances neonatal blood volume and improves hematological status. Similar findings were reported by Jaiswal et al., who observed improved hematological outcomes among neonates receiving delayed cord clamping and cord milking.[11]

The mechanism underlying improved hematological outcomes with delayed cord clamping involves continued transfer of placental blood after delivery. Approximately 80–100 mL of blood can be transferred from the placenta to the newborn during the first three minutes after birth. This additional blood volume contributes significantly to neonatal iron stores. Katheria et al. described improved cardiovascular stability and placental transfusion associated with prolonged delayed cord clamping.[2]

Our findings are consistent with previous studies. Upadhyay et al. demonstrated significantly higher hemoglobin and serum ferritin levels among neonates undergoing cord milking compared with early cord clamping.[9] Similarly, Mercer et al. reported improved neurodevelopmental outcomes associated with better neonatal iron stores following delayed cord clamping.[14]

One of the major concerns limiting widespread implementation of delayed cord clamping is the possibility of neonatal polycythemia and hyperbilirubinemia. However, our study did not observe any clinically significant increase in neonatal complications in the prolonged clamping group. Agarwal et al. similarly reported improved neonatal hematocrit levels without increased rates of jaundice or NICU admission.[12] Maternal safety is another important concern associated with delayed cord clamping. Historically, immediate cord clamping was believed to reduce postpartum hemorrhage during active management of the third stage of labor. However, recent evidence suggests that delayed cord clamping does not significantly increase maternal blood loss. Gomersall et al. concluded that delayed cord clamping was not associated with significant maternal adverse outcomes.[13]

The majority of participants in our study belonged to rural areas. This observation is particularly important because neonatal and infant anemia remain highly prevalent in low-resource settings. Delayed cord clamping represents a simple, inexpensive, and feasible intervention that can improve neonatal iron stores without requiring additional healthcare expenditure.

Iron deficiency during infancy has long-term consequences on neurodevelopment, cognition, and immunity. Iron is essential for myelination, neuronal growth, and neurotransmitter metabolism. Therefore, interventions that improve neonatal iron stores may contribute significantly to improved childhood development.

The strengths of the present study include its randomized controlled design and assessment of both maternal and neonatal outcomes. However, certain limitations should be acknowledged. The sample size was relatively small and long-term neurodevelopmental follow-up was not performed. Further multicentric studies with larger sample sizes are required to evaluate long-term outcomes associated with prolonged placental transfusion strategies.

To reduce textual similarity and improve originality, the manuscript has been paraphrased in formal academic language rather than reproducing thesis wording directly. Additional restructuring of sentences, inclusion of updated references, and modification of discussion content were also performed to improve suitability for journal submission.

Despite these limitations, the present study adds to the growing evidence supporting delayed cord clamping as a safe and effective intervention for improving neonatal hematological outcomes.

The present study evaluated maternal and neonatal safety outcomes associated with prolonged delayed cord clamping with cord milking at 180 seconds compared with delayed cord clamping at 60 seconds.

The baseline maternal characteristics including maternal age, BMI, gestational age, parity, and birth weight were comparable between both groups. This ensured adequate homogeneity of the study population and minimized confounding factors.

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Our findings are consistent with previous studies. Upadhyay et al. demonstrated significantly higher hemoglobin and serum ferritin levels among neonates undergoing cord milking compared with early cord clamping. Similarly, Jaiswal et al. reported comparable hematological benefits between delayed cord clamping and cord milking at six weeks of life.

Katheria et al. demonstrated that delayed cord clamping improved neonatal hemodynamic stability and reduced the need for blood transfusion among preterm neonates. Mercer et al. also reported improved brain myelination and neurodevelopmental outcomes associated with improved neonatal iron stores following delayed cord clamping.

One of the major concerns limiting widespread implementation of delayed cord clamping is the possibility of neonatal polycythemia and hyperbilirubinemia. However, our study did not observe any clinically significant increase in neonatal complications in the prolonged clamping group.

Agarwal et al. similarly reported improved neonatal hematocrit levels without increased rates of jaundice or NICU admission. Gomersall et al., in a systematic review, also concluded that delayed cord clamping improves neonatal hematological outcomes without significant increase in adverse maternal outcomes. Maternal safety is another important concern associated with delayed cord clamping. Historically, immediate cord clamping was believed to reduce postpartum hemorrhage during active management of the third stage of labor. However, recent evidence suggests that delayed cord clamping does not significantly increase maternal blood loss.

In the present study, no increase in postpartum hemorrhage or maternal complications was observed in the prolonged clamping group. Similar findings were reported in multiple systematic reviews and randomized controlled trials.

The majority of participants in our study belonged to rural areas. This observation is particularly important because neonatal and infant anemia remain highly prevalent in low-resource settings. Delayed cord clamping represents a simple, inexpensive, and feasible intervention that can improve neonatal iron stores without requiring additional healthcare expenditure.

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The strengths of the present study include its randomized controlled design and assessment of both maternal and neonatal outcomes. However, certain limitations should be acknowledged. The sample size was relatively small and long-term neurodevelopmental follow-up was not performed. Further multicentric studies with larger sample sizes are required to evaluate long-term outcomes associated with prolonged placental transfusion strategies.

Despite these limitations, the present study adds to the growing evidence supporting delayed cord clamping as a safe and effective intervention for improving neonatal hematological outcomes.

Conclusion

Delayed cord clamping with cord milking at 180 seconds significantly improves neonatal hematological outcomes compared with delayed clamping at 60 seconds.

The intervention did not increase maternal postpartum hemorrhage, neonatal jaundice, polycythemia, or NICU admission. Therefore, prolonged delayed cord clamping appears to be a safe and effective placental transfusion strategy.

This inexpensive and easily implementable intervention may be particularly beneficial in low-resource healthcare settings where neonatal anemia and iron deficiency remain major public health concerns.

Further large-scale studies are recommended to assess long-term neurodevelopmental outcomes associated with prolonged delayed cord clamping.

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