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A comparative assessment of immediate cord clamping, delayed cord clamping, and umbilical cord milking in term infants delivered by cesarean section to inform neonatal care strategies

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Abstract
Background: Umbilical cord management during the immediate postnatal period plays a crucial role in determining neonatal hematological and metabolic outcomes. While early cord clamping (ECC) has been traditionally practiced, delayed cord clamping (DCC) and umbilical cord milking (UCM) have gained attention for their potential benefits in improving neonatal hemoglobin levels and iron stores. However, comparative evidence regarding these techniques in term infants delivered by cesarean section remains limited.
Objectives: To compare the effects of immediate cord clamping, delayed cord clamping, and umbilical cord milking on neonatal hemoglobin levels at birth and on Day 3 of life, and to assess their impact on serum bilirubin levels in term infants delivered by cesarean section.
Methods: This prospective analytical study was conducted at SMGS Hospital, Government Medical College, Jammu, over one year (May 2024-April 2025). A total of 144 term neonates delivered by cesarean section were enrolled and allocated into three groups: umbilical cord milking (Group 1), delayed cord clamping for 30-180 seconds (Group 2), and early cord clamping (Group 3). Hemoglobin levels were measured at birth and on Day 3, while serum bilirubin levels were assessed at the same time points. Statistical analysis was performed using ANOVA with post-hoc testing, and a p-value <0.05 was considered significant.
Results: Baseline maternal and neonatal characteristics were comparable across groups. Neonates in the DCC and UCM groups demonstrated significantly higher hemoglobin levels at birth compared to the ECC group ($p<0.001$). By Day 3, the DCC group maintained the highest hemoglobin levels and was the only group showing a positive rise in hemoglobin. Serum bilirubin levels at birth and Day 3 were significantly lower in the DCC group compared to ECC, with UCM showing intermediate values. DCC was associated with the smallest rise in bilirubin levels over time.
Conclusion: Delayed cord clamping demonstrated superior and sustained hematological benefits with a favorable bilirubin profile in term cesarean-delivered neonates. These findings support DCC as the preferred umbilical cord management strategy to optimize early neonatal outcomes.

Keywords: Cord Clamping, Immediate, Delayed cord clamping, Hb, Bilirubin

Introduction
The immediate postnatal period is a critical phase in neonatal care, during which the management of the umbilical cord plays a pivotal role in determining the health outcomes of newborns. The umbilical cord, which connects the fetus to the placenta, serves as a conduit for oxygen, nutrients, and blood throughout pregnancy [1]. After birth, the timing and technique of cord clamping influence the volume of blood transferred from the placenta to the newborn, significantly impacting hematological and metabolic parameters [2].
Traditionally, early cord clamping (ECC) has been the standard practice in many obstetric settings, often performed within 15 to 30 seconds after delivery [3]. However, recent evidence suggests that delaying cord clamping (DCC) or employing techniques such as umbilical cord milking (UCM) can improve neonatal outcomes by facilitating placental transfusion, which enhances blood volume, red blood cell count, and iron stores in the newborn [4]. In cesarean section deliveries, the dynamics of cord management differ from vaginal births due to immediate surgical priorities and potential concerns about maternal and neonatal health stability [5].

Despite these challenges, studies have shown that appropriate cord management practices in cesarean sections can yield comparable benefits to those observed in vaginal deliveries [6]. Furthermore, the clinical significance of hemoglobin and bilirubin levels in newborns underscores the importance of optimizing cord clamping practices. Hemoglobin levels are indicative of oxygen-carrying capacity and overall blood health, while bilirubin levels need careful monitoring to prevent neonatal jaundice, a common condition in newborns [7]. Balancing these outcomes is particularly crucial in cesarean-born infants, who may have different physiological adaptations compared to those born via vaginal delivery. Although delayed cord clamping and umbilical cord milking have shown promising results in improving neonatal hemoglobin levels and reducing iron deficiency anemia, concerns about hyperbilirubinemia have been raised [8-9]. Current literature lacks robust evidence comparing these practices comprehensively in the context of cesarean sections, necessitating further research to establish optimal guidelines.

The timing of umbilical cord clamping significantly affects neonatal outcomes, with delayed cord clamping (DCC) and umbilical cord milking (UCM) shown to improve blood volume, hemoglobin levels, and reduce anemia risk. Despite these benefits, DCC is rarely practiced in cesarean sections (CS) due to concerns about maternal bleeding [10]. Given the rising global Cesarean section rates, which now account for over 21% of all births [11], many neonates may miss the benefits of placental transfusion. UCM offers a rapid alternative with potential outcomes comparable to DCC. However, evidence on its effectiveness and safety in Cesarean section remains limited. This study aims to compare immediate cord clamping, DCC, and UCM in term infants born via Cesarean section, providing essential insights for improving neonatal care practices in surgical deliveries. The objectives of the study are as below

1. To compare the effect of milking of umbilical cord v/s delayed cord clamping v/s early cord clamping on haemoglobin levels in term infants delivered by cesarean section.
2. To study its effect on bilirubin levels on day 3 of term infants delivered by cesarean section.

Material and Methods

This prospective analytical study was conducted at the Department of Obstetrics and Gynaecology, SMGS Hospital, Government Medical College, Jammu, over a period of one year from 1st May 2024 to 30th April 2025. Institutional approval was obtained, and informed written consent was secured from each participant prior to their inclusion in the study.

Inclusion Criteria

a. Healthy singleton pregnancy
b. Uncomplicated pregnancy
c. Term pregnancy (≥37 weeks of gestation)
d. Informed written consent obtained from the participants

Exclusion Criteria

a. Rh-negative pregnancy
b. Diagnosis of pre-eclampsia
c. Presence of diabetes mellitus
d. Smoking during pregnancy
e. Multiple pregnancies (e.g., twins or higher-order multiples)
f. Substance abuse during pregnancy
g. HIV-positive status in the mother

Sample size: A total of at least 144 patients were included in the study, based on appropriate power calculations.

Group allocation: The study participants were divided into three groups based on the method of umbilical cord management during delivery:

- **Group 1:** Participants in this group underwent milking of the intact umbilical cord.
- **Group 2:** Participants in this group underwent delayed cord clamping, with the cord clamping performed between 30 to 180 seconds after delivery.
- **Group 3:** Participants in this group underwent early cord clamping, where the cord was clamped immediately after delivery.

Outcome Parameters

1. The effect of umbilical cord milking, delayed cord clamping, and early cord clamping on hemoglobin levels in term infants delivered by cesarean section.
2. The impact of the same three techniques on bilirubin levels on Day 3 of life in these infants.

Reference values

1. Normal bilirubin level on Day 0 after which jaundice appears: 8-10 mg/dL
2. Normal bilirubin level on Day 3 after which jaundice appears: 16-18 mg/dL
3. Normal hemoglobin level in term infants: 17-18 gm%

This comprehensive methodology was designed to explore the influence of different cord management techniques on key clinical parameters in neonates, providing valuable insights into the optimal practices for managing the umbilical cord at the time of birth.

Statistical Methods

The recorded data was compiled and entered in a spreadsheet (Microsoft Excel) and then exported to data editor of SPSS Version 20.0 (SPSS Inc., Chicago, Illinois, USA). Statistical software SPSS (version 20.0) and Microsoft Excel were used to carry out the statistical analysis of data. Data were expressed as Mean±SD. Analysis of variance (ANOVA) was employed for inter group analysis of data and for multiple comparisons, least significant difference (LSD) test was applied. A P-value of less than 0.05 was considered statistically significant.

Results

The age distribution of mothers in the three study groups umbilical cord milking (Group 1), delayed cord clamping (Group 2), and early cord clamping (Group 3) is presented in Table 1. The groups were comparable in terms of maternal age, gestational age (Weeks) and birth weight (Kg) minimizing potential confounding effects related to age on the study outcomes (table 1).

Table 1: Age, gestational age (Weeks) and birth weight (Kg) of study patients in three groups

Group	Mean	SD	P-value
Group 1	26.65	3.856	0.107
Group 2	27.58	5.656	
Group 3	25.63	3.722	
	Mean Gestational Age (in weeks)	**SD**	
Group 1	38.43	0.693	0.107
Group 2	38.24	0.789	
Group 3	38.48	0.489	
	Mean Birth Weight (in kg)	**SD**	
Group 1	2.68	0.358	0.353
Group 2	2.79	0.443	
Group 3	2.79	0.504	

Statistical comparisons between the groups revealed that the difference between Group 2 and Group 3 was highly significant ($p<0.001$), as was the difference between Group 1 and Group 3 ($p<0.001$), indicating that both delayed cord clamping and umbilical cord milking resulted in significantly higher initial hemoglobin levels than early cord clamping. However, the comparison between Group 1 and Group 2 was not statistically significant ($p = 0.157$), suggesting comparable hemoglobin levels at birth between umbilical cord milking and delayed cord clamping (table 2). Statistical analysis revealed that the differences in hemoglobin levels between the groups were highly significant, with p-values of <0.001 for all pair wise comparisons (Group 1 vs Group 2, Group 2 vs Group 3, and Group 3 vs Group 1), indicating a clear advantage of delayed cord clamping in maintaining higher hemoglobin levels in neonates by Day 3.

Table 2: Comparison based on hemoglobin (gm/dl) at Day 0 and 3 in three groups

Group	Mean	SD	95% CI For Mean	Group Comparison	P-value
Group 1	18.92	1.618	18.45-19.39	1 vs 2	0.157
Group 2	19.24	0.531	19.08-19.43	2 vs 3	<0.001*
Group 3	16.65	0.784	16.42-16.89	3 vs 1	<0.001*
Day 3					
Group 1	17.54	0.797	17.31-17.76	1 vs 2	<0.001*
Group 2	19.55	0.804	19.32-19.78	2 vs 3	<0.001*
Group 3	15.12	0.614	14.94-15.31	3 vs 1	<0.001*

*Statistically Significant Difference (P-value<0.05); CI: Confidence Interval

Statistical analysis revealed that the differences in hemoglobin change between Group 1 and Group 2, and between Group 2 and Group 3, were both highly significant ($p<0.001$), underscoring the favourable effect of delayed cord clamping in maintaining or even improving hemoglobin levels during the early neonatal period. However, the comparison between Group 1 and Group 3 was not statistically significant ($p = 0.475$), suggesting a similar degree of hemoglobin decline in these two groups (table 3).

Table 3: Comparison based on change in hemoglobin from Day 0 to Day 3 in three groups

Group	Mean	SD	95% CI For Mean	Group Comparison	P-value
Group 1	-1.39	1.455	-1.81 to -0.96	1 vs 2	<0.001*
Group 2	0.31	0.467	0.18 to 0.45	2 vs 3	<0.001*
Group 3	-1.53	0.692	-1.73 to -2.90	3 vs 1	0.475

*Statistically Significant Difference (P-value<0.05); CI: Confidence Interval

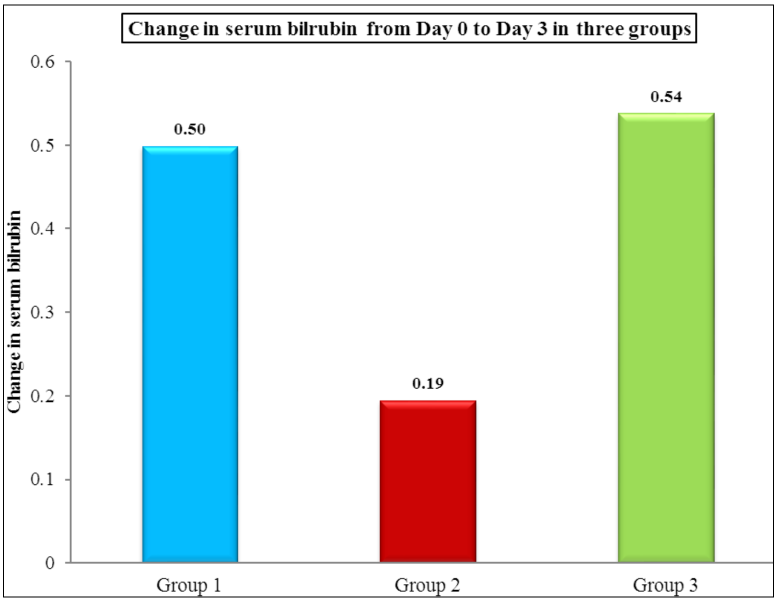
Statistical comparisons revealed that the differences in mean bilirubin levels between Group 2 and Group 3 ($p<0.001$), as well as between Group 3 and Group 1 ($p<0.001$), were highly significant. However, the comparison between Group 1 and Group 2 did not reach statistical significance ($p = 0.216$). These findings suggest that early cord clamping is associated with significantly higher serum bilirubin levels at birth compared to both delayed cord clamping and umbilical cord milking, with the latter two interventions demonstrating comparable and more favourable bilirubin profiles (table 4). The results also indicate that delayed cord clamping is associated with significantly lower serum bilirubin levels by Day 3, while early cord clamping is linked to the highest levels, with umbilical cord milking presenting intermediate values. This highlights the potential of DCC in minimizing the risk of hyperbilirubinemia in the early neonatal period.

Table 4: Comparison based on serum bilrubin (mg/dl) at Day 0 and 3 in three groups

Group	Mean	SD	95% CI For Mean	Group Comparison	P-value
Group 1	0.90	0.212	0.84-0.96	1 vs 2	0.216
Group 2	0.82	0.298	0.74-0.91	2 vs 3	<0.001*
Group 3	1.27	0.366	1.17-1.38	3 vs 1	<0.001*
Day 3					
Group 1	1.40	0.458	1.26-1.53	1 vs 2	<0.001*
Group 2	1.02	0.229	0.95-1.08	2 vs 3	<0.001*
Group 3	1.81	0.425	1.69-1.93	3 vs 1	<0.001*

*Statistically Significant Difference (P-value<0.05); CI: Confidence Interval

Statistical analysis revealed a highly significant difference between Group 1 and Group 2 ($p<0.001$) and between Group 2 and Group 3 ($p<0.001$), indicating that the rise in bilirubin was significantly lower in the DCC group. However, the comparison between Group 1 and Group 3 was not statistically significant ($p = 0.567$), suggesting a similar pattern of bilirubin increase in the UCM and ECC groups. These findings reinforce the favourable profile of DCC in limiting the rise of serum bilirubin in the early neonatal period (graph 1).



Graph 1: Change in serum bilrubin from Day 0 to Day 3 in three groups

Discussion

In our study, the mean maternal ages across the three groups umbilical cord milking (Group 1: 26.65 ± 3.86 years), delayed cord clamping (Group 2: 27.58 ± 5.66 years), and early cord clamping (Group 3: 25.63 ± 3.72 years) were comparable, with no statistically significant differences ($p = 0.107$). This uniformity in maternal age distribution ensures that age-related confounding factors are minimized, allowing for a more accurate assessment of the effects of different cord management techniques on neonatal outcomes. The significance of controlling for maternal age is underscored by numerous studies highlighting its impact on obstetric outcomes. For instance, a study of Cleary-Goldman J *et al.*, (2005) [12] on 36,056 women revealed that increasing maternal age was significantly associated with adverse pregnancy outcomes. Research by Vandekerckhove M *et al.*, (2021) [13] showed that unfavourable pregnancy outcomes tripled with age, rising from 5% in women aged 25-34 to 16% in those over 45, highlighting the impact of maternal age on perinatal outcomes. Similarly, Ratiu D *et al.*, (2023) [14] found that women aged 40 and above faced higher rates of cesarean deliveries (54.1% vs 42.9%; p-value <0.0001), preterm births (16.6% vs 4.6%; p-value <0.0001), and low birth weight infants (8.8% vs. 3.2%; p-value <0.0001), underscoring the risks associated with advanced maternal age.

At baseline, both DCC and UCM groups demonstrated substantially higher hemoglobin concentrations compared to the ECC group. Specifically, the DCC group (Group 2) recorded the highest mean hemoglobin level (19.24 ± 0.531 g/dL), followed by the UCM group (Group 1) at 18.92 ± 1.618 g/dL, while the ECC group (Group 3) exhibited the lowest value (16.65 ± 0.784 g/dL). The differences between DCC vs ECC and UCM vs ECC were highly statistically significant ($p<0.001$), whereas the comparison between DCC and UCM was not statistically significant ($p = 0.157$), indicating that both DCC and UCM are comparably effective in enhancing immediate neonatal hemoglobin levels. These observations are consistent with the physiological premise that placental transfusion allows for additional blood transfer from the placenta to the neonate, thereby increasing blood volume and hemoglobin concentration at birth. On Day 3, the trend not only persisted but became more pronounced. The DCC group maintained the highest hemoglobin level (19.55 ± 0.804 g/dL), followed by the UCM group (17.54 ± 0.797 g/dL), and the ECC group (15.12 ± 0.614 g/dL). The intergroup differences were again highly statistically significant ($p<0.001$), with DCC showing the most sustained hematologic advantage.

These results are consistent with findings from Shao H *et al.*, (2021) [15], who observed significantly higher Day 3 hemoglobin levels in neonates undergoing DCC compared to ECC (195.66 ± 22.95 g/L vs. 183.48 ± 22.03 g/L; $p<0.05$). Similarly, Jafra B *et al.*, (2023) [16] reported a notable difference at 24 hours, with DCC infants exhibiting higher hemoglobin (19.28 ± 2.16 g/dL) than those who underwent ECC (16.16 ± 1.70 g/dL), further supporting the consistency of our findings with international and regional literature. Importantly, when analyzing the trend of hemoglobin levels from Day 0 to Day 3, only the DCC group demonstrated a positive increase (mean rise of 0.31 ± 0.467 g/dL). In contrast, both the UCM and ECC groups experienced declines (-1.39 ± 1.455 g/dL and -1.53 ± 0.692 g/dL, respectively). The statistical significance of these changes ($p<0.001$) highlights the superior ability of DCC to maintain or enhance hemoglobin levels during the early postnatal period. Notably, the difference in decline between UCM and ECC was not statistically significant ($p = 0.475$), suggesting a comparable downward trend between the two, which may reflect a relatively limited sustainability of UCM's hematological benefit compared to DCC. Despite this, it is important to acknowledge that UCM still demonstrated a substantial initial advantage over ECC at Day 0, aligning with the literature that supports UCM's short-term hematologic benefits. For instance, Jeevan A *et al.*, (2022) [17] reported that UCM significantly increased hemoglobin levels at 48-72 hours (mean difference: 0.36 g/dL; 95% CI: 0.19-0.53) in a meta-analysis of six studies involving 924 neonates. Furthermore, UCM was associated with higher hemoglobin levels even at 6 to 8 weeks of age. In another study, Kumar B *et al.*, (2015) [18] found significantly elevated hemoglobin in preterm neonates receiving UCM (12.1 ± 1.5 g/dL) versus ECC (10.4 ± 1.2 g/dL) at 6 weeks of age ($p<0.01$). Upadhyay A *et al.*, (2013) [19] also reported significantly higher hemoglobin in the UCM group at both 12 hours (15.1±2.5 vs. 13.5±2.1 g/dl; $p<0.05$) and 48 hours (11.9± 1.6 g/dl vs.10.8±0.9; $p<0.05$), findings that resonate with the Day 0 results in our study.

Our study reinforces the growing body of evidence supporting the implementation of DCC as an effective strategy for enhancing and sustaining early neonatal hemoglobin levels. While DCC demonstrated a superior and sustained hematological advantage, UCM also proved beneficial, particularly in the immediate postnatal period. These findings are not only consistent with existing literature but also emphasize the practical value of both techniques, especially in resource-limited settings or clinical scenarios where DCC may not be feasible.

At birth, neonates in the ECC group exhibited the highest mean serum bilirubin levels (1.27 ± 0.366 mg/dL), followed by the UCM group (0.90 ± 0.212 mg/dL) and the DCC group (0.82 ± 0.298 mg/dL). The difference was statistically significant between ECC and both UCM and DCC groups ($p<0.001$), suggesting that early clamping may be associated with higher bilirubin levels at birth. The lower levels observed in DCC and UCM groups could be attributed to more efficient placental transfusion and improved circulatory adaptation, resulting in a more stable hemodynamic profile and less hemolysis at birth. By Day 3, the trend persisted with ECC continuing to show the highest bilirubin levels (1.81 ± 0.425 mg/dL), followed by UCM (1.40 ± 0.458 mg/dL), and DCC (1.02 ± 0.229 mg/dL), with all pair wise comparisons reaching statistical significance ($p<0.001$). These findings reinforce the notion that DCC may reduce the risk of early hyperbilirubinemia, a benefit likely linked to gradual and controlled red blood cell transfusion, allowing for slower breakdown of fetal erythrocytes.

These findings contrast with those reported by Chawanpaiboon *et al.*, (2025) [20], who evaluated neonatal outcomes among term infants receiving ECC, DCC, or UCM. In their study, the mean microbilirubin levels within 48-72 hours were 8.3 ± 1.5 mg/dL for the ECC group, 8.7 ± 1.7 mg/dL for the UCM group, and 8.7 ± 2.2 mg/dL for the DCC group, with no statistically significant difference among the three groups ($p = 0.401$). Moreover, the need for phototherapy was observed in 3.9% of neonates in the ECC group, 13.2% in the UCM group, and 10.5% in the DCC group, although this difference did not reach statistical significance ($p = 0.129$). Despite the variation in absolute values and statistical significance, both studies reinforce that DCC and UCM do not increase the risk of hyperbilirubinemia and may provide hemodynamic and hematologic benefits over ECC. Our findings are also supported by Yaşartekin Y *et al.*, (2020) [21], who reported that early cord clamping was associated with increased bilirubin levels compared to delayed cord management (14.49 ± 3.39 vs. 10.34 ± 3.78; p-value<0.0001*) and a higher risk of clinically significant hyperbilirubinemia necessitating phototherapy. This may be attributed to the lower red cell mass transferred to the infant in ECC, which limits erythrocyte degradation initially but delays bilirubin metabolism due to lower hepatic perfusion, ultimately elevating serum bilirubin concentrations. Similarly, studies by Ranjit *et al.*, (2015) [22] and Shinohara E *et al.*, (2021) [23] reported that delayed cord clamping (DCC) did not significantly increase the risk of neonatal jaundice. On the contrary, both studies highlighted the beneficial effects of DCC on neonatal hematologic status and in the prevention of anemia. Specifically, Ranjit *et al.*, [22] found no statistically significant difference in mean bilirubin levels between the early and delayed cord clamping groups (12.4 ± 3.9 vs. 13.1 ± 3.2; $p > 0.05$), further supporting the safety and hematologic benefits of DCC in neonates.

Moreover, Shao H *et al.*, (2021) [15] also reported significantly higher hemoglobin levels in neonates undergoing DCC compared to those with ECC, without a corresponding rise in serum bilirubin levels supporting our observation that DCC may favor a more stable bilirubin profile over time. Interestingly, while Shao H *et al.*, (2021) [15] noted a marginal, non-significant increase in transcutaneous bilirubin levels on the day of birth in the DCC group (61-120 s), they emphasized that no significant differences were observed in bilirubin trends over the following five days. This aligns with our study's findings, where the mean increase in bilirubin over 72 hours was smallest in the DCC group (0.19 ± 0.231 mg/dL), significantly less than that in the UCM and ECC groups, reinforcing the notion that DCC may help attenuate the rise in bilirubin levels during the critical early neonatal period.

The concern that DCC may lead to an increased need for phototherapy is addressed in several studies, including those by Mercer J *et al.*, (2017) [24] and Qian Y *et al.*, (2020) [25] who concluded that although hyperbilirubinemia is theoretically considered a potential drawback of DCC, it has not been shown to translate into a significantly increased phototherapeutic burden in clinical practice. This clinical insignificance is further emphasized by the absence of exchange transfusions or statistically significant phototherapy requirements in their cohorts findings echoed in our study. Contrastingly, our study observed that UCM, while more favorable than ECC in terms of bilirubin levels at birth and Day 3, still demonstrated a significantly larger rise in bilirubin over 72 hours compared to DCC ($p<0.001$). This trend may support findings from Kumar B *et al.*, (2015) [18], who reported a higher incidence of phototherapy requirements in neonates undergoing UCM compared to DCC (33% vs. 9%; $P<0.01$). Though UCM enhances neonatal iron stores and hematologic outcomes, the rapid transfusion effect may increase red blood cell mass abruptly, leading to a proportionally higher bilirubin load from hemolysis, which could account for the observed trend toward elevated bilirubin levels.

The position of the American College of Obstetricians and Gynecologists (ACOG) further supports our findings, acknowledging a small increase in the incidence of jaundice requiring phototherapy in neonates undergoing DCC. However, they emphasize that the overall hematologic and developmental benefits of DCC including better iron reserves and improved oxygen delivery outweigh the marginal risk, especially when supported by vigilant monitoring and timely intervention. These findings collectively reinforce the clinical value of DCC as a safe and effective strategy in neonatal care, especially when integrated with structured jaundice surveillance protocols.

Limitations

- The study was conducted at a single tertiary care center, limiting generalizability to other populations and settings.
- Only term cesarean deliveries were included, excluding high-risk pregnancies and vaginal births, which restricts broader applicability.

- Follow-up was limited to Day 3 of life; long-term neonatal outcomes were not assessed.

Conclusion

The findings of this study demonstrated the clinical superiority of delayed cord clamping (DCC) over other cord management strategies, particularly in promoting favourable neonatal hematological and bilirubin profiles. With comparable baseline maternal and neonatal characteristics across groups, the observed benefits can be confidently attributed to the intervention itself rather than to confounding factors. DCC not only ensured higher hemoglobin levels at birth but also maintained and even improved these levels by Day 3, underscoring its role in enhancing and sustaining neonatal iron stores during the critical early postnatal period. In contrast, early cord clamping (ECC) was associated with the lowest hemoglobin levels and the highest rise in serum bilirubin, suggesting greater risk for anemia and hyperbilirubinemia. Umbilical cord milking (UCM), while beneficial compared to ECC, did not match the sustained outcomes observed with DCC. The consistently lower bilirubin levels and minimal rise over time in the DCC group further reinforce its safety and effectiveness. These findings support the recommendation of delayed cord clamping as a preferred and evidence-based practice in routine neonatal care to optimize early neonatal outcomes.

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Author's Contribution

Not available

Conflict of Interest

Not available

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Not available

Reference

1. Moshiri M, Zaidi SF, Robinson TJ, Bhargava P, Siebert JR, Dubinsky TJ, Katz DS. Comprehensive imaging review of abnormalities of the umbilical cord. Radiographics. 2014;34(1):179-196.
2. Rabe H, Diaz-Rossello JL, Duley L, Dowswell T. Effect of timing of umbilical cord clamping and other strategies to influence placental transfusion at preterm birth on maternal and infant outcomes. Cochrane Database Syst Rev. 2012;(8):CD003248.
3. Mwakawanga DL, Mselle LT. Early or delayed umbilical cord clamping? Experiences and perceptions of nurse-midwives and obstetricians at a regional referral hospital in Tanzania. PLoS One. 2020;15(6):e0234854.
4. Jain SN, Mehendale AM. A review on umbilical cord milking and its implications in neonatal health. Cureus. 2022;14(10):e30610.
5. Katheria A, Reister F, Essers J, Mendler M, Hummler H, Subramaniam A, et al. Association of umbilical cord milking vs delayed umbilical cord clamping with death or severe intraventricular hemorrhage among preterm infants. JAMA. 2019;322(19):1877-1886.
6. Fogarty M, Osborn DA, Askie L, Seidler AL, Hunter K, Lui K, et al. Delayed vs early umbilical cord clamping for preterm infants: a systematic review and meta-analysis. Am J Obstet Gynecol. 2018;218(1):1-8.
7. Bhutani VK, Stark AR, Lazzeroni LC, Poland R, Gourley GR, Kazmierczak S, et al. Predischarge screening for severe neonatal hyperbilirubinemia identifies infants who need phototherapy. J Pediatr. 2013;162(3):477-482.e1.
8. Rabe H, Diaz-Rossello JL, Duley L, Dowswell T. Effect of timing of umbilical cord clamping and other strategies to influence placental transfusion at preterm birth on maternal and infant outcomes. Cochrane Database Syst Rev. 2012;(8):CD003248.
9. Koo J, Kilicdag H, Katheria A. Umbilical cord milking - benefits and risks. Front Pediatr. 2023;11:1146057.
10. Welsh S, Elwell J, Manister NN, Gildersleeve RK. Implementing delayed umbilical cord clamping in cesarean birth using a novel method: a pilot study of feasibility and safety. J Midwifery Womens Health. 2020;65(1):109-118.
11. World Health Organization. Caesarean section rates continue to rise, amid growing inequalities in access. Geneva: World Health Organization; 2021.
12. Cleary-Goldman J, Malone FD, Vidaver J, Ball RH, Nyberg DA, Comstock CH, et al. Impact of maternal age on obstetric outcome. Obstet Gynecol. 2005;105(5 Pt 1):983-990.
13. Vandekerckhove M, Guignard M, Civadier MS, Benachi A, Bouyer J. Impact of maternal age on obstetric and neonatal morbidity: a retrospective cohort study. BMC Pregnancy Childbirth. 2021;21:1-7.
14. Ratiu D, Sauter F, Gilman E, Ludwig S, Ratiu J, Mallmann-Gottschalk N, et al. Impact of advanced maternal age on maternal and neonatal outcomes. In Vivo. 2023;37(4):1694-1702.
15. Shao H, Gao S, Lu Q, Zhao X, Hua Y, Wang X. Effects of delayed cord clamping on neonatal jaundice, phototherapy and early hematological status in term cesarean section. Ital J Pediatr. 2021;47(1):115.
16. Jafra BS, Mehendiratta SK, Jafra PR, Jafra A. Effect of timing of cord clamping (early vs delayed) on hemoglobin level among newborns: an Indian study. Int J Reprod Contracept Obstet Gynecol. 2023;12:1775-1779.
17. Jeevan A, Ananthan A, Bhuwan M, Balasubramanian H, Rao S, Kabra NS. Umbilical cord milking versus delayed cord clamping in term and late-preterm infants: a systematic review and meta-analysis. J Matern Fetal Neonatal Med. 2022;35(25):5478-5488.
18. Kumar B, Upadhyay A, Gothwal S, Jaiswal V, Joshi P, Dubey K. Umbilical cord milking and hematological parameters in moderate to late preterm neonates: a randomized controlled trial. Indian Pediatr. 2015;52:753-757.
19. Upadhyay A, Gothwal S, Parihar R, Garg A, Gupta A, Chawla D, et al. Effect of umbilical cord milking in term and near-term infants: randomized control trial. Am J Obstet Gynecol. 2013;208(2):120.e1-120.e7.
20. Chawanpaiboon S, Nuanjeen S, Wayuphak T, Oncharoen G, Phuengphaeng A, Pooliam J. Neonatal outcomes of umbilical cord milking, early cord clamping and delayed cord clamping in term infants: a randomised controlled trial. Cureus. 2025;17(2):e78922.
21. Yaşartekin Y, Sarıcı SÜ, Özcan M, Akpınar M, Altun D, Akın A, et al. Investigation of the relationship between cord clamping time and risk of hyperbilirubinemia. Turk J Pediatr. 2020;62(5):756-762.
22. Ranjit T, Nesargi S, Rao PN, Sahoo JP, Ashok C, Chandrakala BS, et al. Effect of early versus delayed cord

clamping on hematological status of preterm infants at 6 week of age. Indian J Pediatr. 2015;82(1):29-34.
23. Shinohara E, Kataoka Y. Prevalence and risk factors for hyperbilirubinemia among newborns from a low-risk birth setting using delayed cord clamping in Japan. Jpn J Nurs Sci. 2021;18(1):e12372.
24. Mercer JS, Erickson-Owens DA. Rethinking placental transfusion and cord clamping issues. J Perinat Neonatal Nurs. 2012;26(3):202-217.
25. Qian Y, Lu Q, Shao H, Ying X, Huang W, Hua Y. Timing of umbilical cord clamping and neonatal jaundice in singleton term pregnancy. Early Hum Dev. 2020;142:104948.

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