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A Systematic Review on Delayed Cord Clamp and Early Cord Clamp

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1. INTRODUCTION

The timing of umbilical cord clamping has been debated in obstetric care, impacting maternal and neonatal outcomes. Early cord clamping (ECC), performed within 15–30 seconds of birth, was historically the standard practice, partly based on the belief that it reduced the risk of postpartum hemorrhage and facilitated neonatal resuscitation (1). However, increasing evidence suggests that delaying cord clamping (DCC) — generally defined as waiting at least 30–60 seconds before clamping the umbilical cord — offers significant neonatal benefits without adversely affecting maternal outcomes (2, 3).

The World Health Organization (WHO), as well as other health bodies like the American College of Obstetricians and Gynecologists (ACOG), now recommend DCC for all births, especially in preterm infants (4, 5). DCC allows for continued placental transfusion, resulting in up to 30% more blood volume being transferred to the newborn, which increases iron stores and hemoglobin levels (6). In contrast, ECC interrupts this process, limiting blood volume and potentially leading to neonatal anemia, which can have long-term developmental consequences, particularly in low-resource settings (7).

The neonatal benefits of DCC, particularly in preterm infants, include improved cardiovascular stability, better blood pressure regulation, and reduced need for blood transfusions (8, 9). DCC has also been associated with lower incidences of intraventricular hemorrhage (IVH) and necrotizing enterocolitis (NEC) in preterm infants, both of which are major complications of prematurity (10). However, concerns about DCC leading to neonatal jaundice and hyperbilirubinemia due to the increased blood volume have been raised, although evidence suggests that this risk is manageable with appropriate monitoring and treatment (11, 12).

On the maternal side, concerns regarding postpartum hemorrhage (PPH) and placental retention with DCC have largely been disproven. Multiple studies indicate no significant difference in the rates of PPH or retained placenta between DCC and ECC (13). This has led to a paradigm shift in clinical practice, with DCC becoming the preferred approach in many settings, particularly as part of delayed newborn care practices like skin-to-skin contact (14).

Despite these findings, ECC is still practiced in certain situations, particularly in emergencies requiring immediate neonatal resuscitation, although evidence suggests that even in such cases, brief DCC may still be beneficial (15). This review aims to systematically compare the neonatal and maternal outcomes of DCC versus ECC based on the most recent evidence, offering insight into current best practices in obstetric and neonatal care.

METHODOLOGY

A systematic review was conducted using databases like PubMed, Cochrane Library, and Scopus. Studies were included based on the following criteria:

1. Randomized controlled trials (RCTs), cohort studies, and meta-analyses comparing DCC and ECC.
2. Studies reporting neonatal and maternal outcomes.

Studies published in English between 2008 and 2023. The primary outcomes assessed include neonatal hemoglobin levels, iron stores, and incidence of neonatal jaundice, while secondary

outcomes focus on maternal health, such as postpartum hemorrhage.

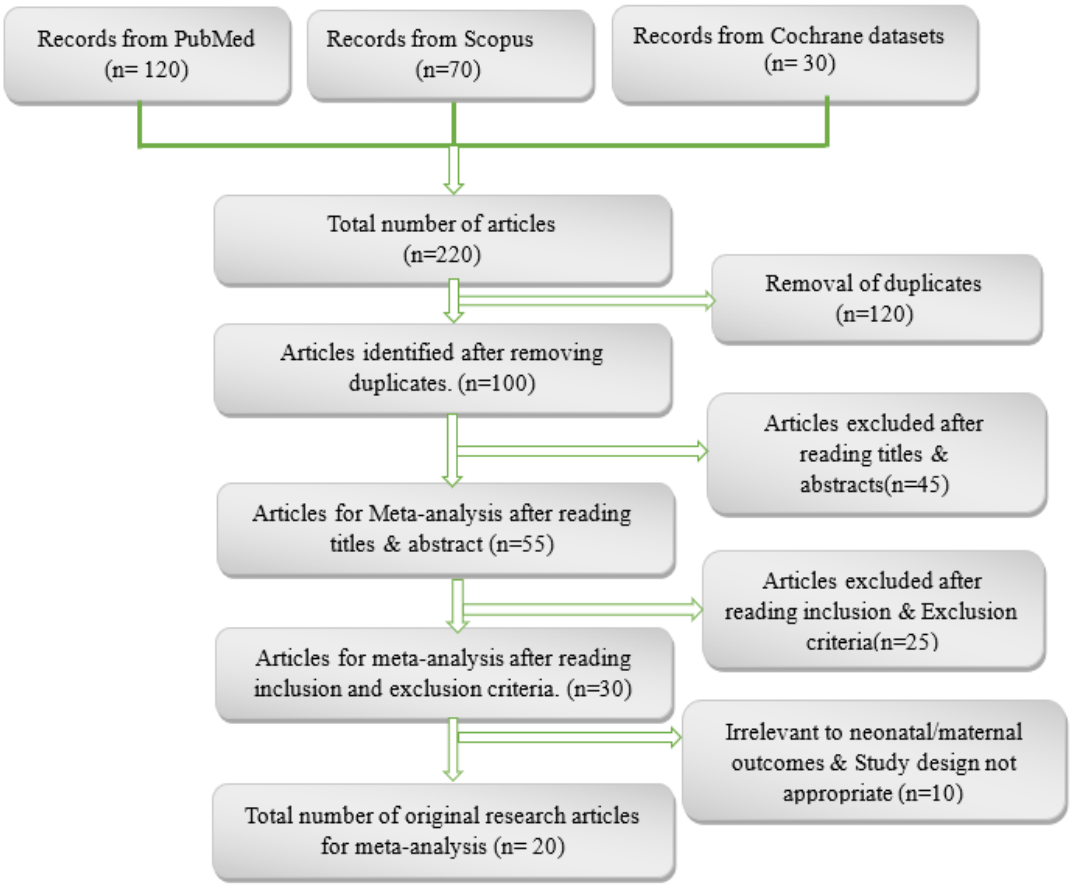

FIGURE 1: PRISMA flowchart showing the selection of included studies

2. RESULTS

Neonatal Outcomes

1. Hemoglobin and Iron Stores

Studies consistently show that DCC results in significantly higher neonatal hemoglobin and ferritin levels compared to ECC. This finding is particularly important in preventing anemia during infancy. A Cochrane review (1) involving over 3,000 neonates found that infants in the DCC group had higher hemoglobin concentrations and increased iron stores at 4–6 months of age, reducing the risk of iron deficiency anemia. This is attributed to the transfer of additional blood from the placenta to the neonate, which may account for up to 30% more blood volume in term infants.

2. Neonatal Jaundice

A common concern with DCC is the potential increase in jaundice due to the greater volume of blood and consequently higher bilirubin levels. However, systematic reviews suggest that while DCC slightly increases the risk of jaundice, the incidence of clinically significant hyperbilirubinemia requiring phototherapy is comparable between DCC and ECC groups. Andersson et al. (2) found no significant difference in the need for phototherapy between the two groups despite elevated

bilirubin levels in DCC infants.

3. Respiratory and cardiovascular adaptation

CC has been associated with improved respiratory and cardiovascular transition after birth, especially in preterm infants. Studies show that preterm infants benefit from continued placental transfusion during DCC, leading to more stable blood pressures and reduced need for transfusions. A randomized trial by Rabe et al. (3) highlighted that DCC reduced the risk of intraventricular hemorrhage and late-onset sepsis in preterm infants.

Maternal Outcomes

1. Postpartum Haemorrhage (PPH)

One of the historical reasons for ECC was the assumption that it would reduce the risk of postpartum hemorrhage (PPH). However, recent evidence challenges this belief. A large systematic review by McDonald et al. (1) found no significant difference in PPH rates between DCC and ECC, suggesting that DCC does not increase maternal bleeding risks.

2. Placental retention and uterotonic use

ECC has been traditionally linked to quicker delivery of the placenta, but DCC does not appear to significantly delay placental expulsion. A Cochrane review (5) concluded that DCC does not increase the need for uterotonics or the incidence of retained placenta, dispelling concerns about its impact on the third stage of labor.

3. DISCUSSION

Table 1 shows the observations noted by the researchers.

Authors	Sample Size	Parameters of the study	Observation	Conclusion
Mc Donalad SJ et al (2013)[1]	3911 Females & Infants	They included 15 trials involving a total of 3911 women and infant pairs.	Two review authors independently assessed trial eligibility and quality and extracted data.	A more liberal approach to delaying clamping of the umbilical cord in healthy term infants appears to be warranted, particularly in light of growing evidence that delayed cord clamping increases early hemoglobin concentrations and iron stores in infants.
Ola Andersson et al (2011)[2]	400 full-term infants born after a low-risk pregnancy.	Infants were randomized to delayed umbilical cord clamping (≥ 180 seconds after delivery) or early clamping (≤ 10 seconds after delivery).	Hemoglobin and iron status at 4 months of age with the power estimate based on serum ferritin levels. Secondary outcomes included neonatal anemia, early respiratory symptoms, polycythemia, and the need for phototherapy.	Delayed cord clamping, compared with early clamping, resulted in improved iron status and reduced prevalence of iron deficiency at 4 months of age, and reduced prevalence of neonatal anemia, without demonstrable adverse effects.
J S Mercer et al (2017)[6]	73 women with term (37 to 41 weeks) singleton fetuses were randomized to DCC (⩾5 min; n=37) or ICC (<20 s; n=36).	Measure the effects of a 5-min delay (DCC) versus immediate cord clamping (ICC) on residual placental blood volume (RPBV) at birth, and hemoglobin and serum bilirubin at 24 to 48 h of age.	Mean cord clamping time was 303±121 (DCC) versus 23±59 (ICC) s (P<0.001) with 10 protocol violations. Cord milking was the proxy for DCC (n=11) when the provider could not wait.	Term infants had early hematological advantage of DCC without increases in hyperbilirubinemia or symptomatic polycythemia.

Ashish KC et al (2017)[7]	540 late preterm and term infants born vaginally at a tertiary hospital	Infants were randomized to delayed umbilical cord clamping (≥180 seconds after delivery) or early clamping (≤60 seconds after delivery).	Main outcomes included hemoglobin and anemia levels at 8 months of age with the power estimate based on the prevalence of anemia. Secondary outcomes included hemoglobin and anemia levels at 12 months of age and ferritin level, iron deficiency, and iron deficiency anemia at 8 and 12 months of age.	Delayed cord clamping reduces anemia at 8 and 12 months of age in a high-risk population, which may have major positive effects on infants' health and development.
William Tarnow Mordi et al (2017)[8]	1634 fetuses that underwent randomization, 1566 were born alive before 30 weeks of gestation; of these, 782 were assigned to immediate cord clamping and 784 to delayed cord clamping.	They randomly assigned fetuses from women who were expected to deliver before 30 weeks of gestation to either immediate clamping of the umbilical cord (≤10 seconds after delivery) or delayed clamping (≥60 seconds after delivery).	The median time between delivery and cord clamping was 5 seconds and 60 seconds in the respective groups. Infants assigned to delayed clamping (37.0%) and those assigned to immediate clamping (37.2%). The mortality was 6.4% in the delayed-clamping group and 9.0% in the immediate-clamping group.	Among preterm infants, delayed cord clamping did not result in a lower incidence of the combined outcome of death or major morbidity at 36 weeks of gestation than immediate cord clamping.
S hosono et al (2008)[12]	40 singleton infants born between 24 and 28 weeks gestation	The effects of umbilical cord milking on the need for red blood cell (RBC) transfusion and morbidity in very preterm infants.	The milked group had a shorter duration of ventilation or supplemental oxygen than the control group.	Milking the umbilical cord is a safe procedure, reducing the need for RBC transfusions, and the need for circulatory and respiratory support in very preterm infants.
Ola Andersson et al (2015)[13]	382 as full-term infants born	The effects of delayed CC compared with early CC on neurodevelopment at 4 years of age.	Fewer children in the delayed-CC group had results below the cutoff in the ASQ fine-motor domain (11.0% vs 3.7%; P = .02) and the Movement ABC bicycle-trail task (12.9% vs 3.8%; P = .02).	Delayed CC compared with early CC improved scores in the fine-motor and social domains at 4 years of age, especially in boys, indicating that optimizing the time to CC may affect neurodevelopment in a low-risk population of children born in a high-income country.
Khitam Mohammad et al (2021)[16]	One hundred twenty-eight mothers expecting a full-term singleton baby were assigned to delayed cord clamping	To compare the effects of early versus delayed cord clamping of term births on maternal and neonatal outcomes.	Delayed cord clamping was associated with higher hemoglobin levels among newborns after 12 hours. On the other hand, early cord clamping was associated with an increased need for oxygen therapy	Term babies receiving delayed cord clamping had improved hemoglobin levels with no adverse effect on other maternal and neonatal variables. Creating evidence-based practice guidelines for umbilical cord clamping in Jordanian hospitals is

	(90 seconds) or early cord clamping (<30 seconds).		among newborns and the occurrence of postpartum hemorrhage among mothers.	essential to improve neonatal and maternal health.
Francesco Cavallin et al (2019)[17]	Eighty neonates were randomized to the DCC (n = 40) or the ECC (n = 40) arm.	To compare delayed cord clamping (DCC) with early cord clamping (ECC) with regard to postnatal adaptation in neonates born through elective CS.	The hematocrit at day 2 was significantly higher in the DCC arm than in the ECC arm (mean difference: 6%; 95% CI 3–8; p < 0.0001). The secondary outcome measures were not statistically different between the two arms. No infants needed phototherapy for hyperbilirubinemia during their hospital stay.	Delaying cord clamping beyond 60 s increases the hematocrit at day 2 in neonates born through elective CS, without affecting maternal blood losses. Our findings suggest that DCC should be recommended in elective CS, but further studies are warranted to assess long-term outcomes.
Dorlasi LM & Lilian TM (2020)[18]	A descriptive qualitative study design that adopted a purposeful sampling strategy to recruit 19 participants was used	This study describes the experiences and perceptions of nurse-midwives and obstetricians about the timing of umbilical cord clamping at a regional referral hospital in Tanzania.	Three main themes were generated from the data, each having 2 to 5 subthemes. 1. Experiences about the timing of umbilical cord clamping. 2. Perceptions about the umbilical cord clamping. 3. Factors influencing the practice of delayed umbilical cord clamping to improve newborn health outcomes.	Although the nurse-midwives and obstetricians commonly practiced clamping the umbilical cord immediately after delivery, they understood that delayed cord clamping has the potential benefit of oxygenation to the newborn in the event of the need for resuscitation. Delayed cord clamping should be practiced widely to improve the health outcomes of the newborn.
Devin Joan & Larkin Patricia (2018)[19]	One hundred and fifty-three valid responses were received.	A cross-sectional descriptive survey was distributed to three maternity hospitals and two Irish online midwifery groups.	One hundred and eleven midwives (72.4%) defined delayed cord clamping as “clamping after the cord ceases to pulsate.” One hundred and forty (91.5%) respondents practiced delayed cord clamping.	A variety of midwifery practices were identified with differing attitudes toward cord clamping practices. Diverse influences included the practice environment, awareness of research, and availability of adjunct resuscitation support.
Abd El-Moneim A. Fawzy et al (2015)[20]	100 primigravida full-term single pregnancy	To compare the potential benefits and harms of early versus late clamping in term infants in Shatby Maternity Hospital.	They were divided into two groups (each 50) where in the first group the umbilical cord was clamped immediately “early cord clamping” (ECC) and where the 2nd group the umbilical cord was clamped after pulsation had ceased”	Delayed cord clamping is likely to result in better neonatal outcomes.

			delayed cord clamping" (DCC) and then Apgar score, Hemoglobin level, random blood sugar, oxygen saturation, and bilirubin after 72 h of labor of newborn were compared and analyzed.	

Benefits of Delayed Cord Clamping

The advantages of delayed cord clamping (DCC) are well-supported by a growing body of evidence. The primary neonatal benefit of DCC is the significant increase in neonatal blood volume, which translates into improved hemoglobin levels and iron stores. Several studies, including randomized controlled trials and systematic reviews, have demonstrated that infants subjected to DCC have significantly higher hemoglobin concentrations at birth and improved iron stores at 4–6 months of age compared to those who underwent early cord clamping (ECC) (1, 6). These findings are critical, particularly in low-resource settings, where the prevalence of infant anemia is high, and access to healthcare interventions is limited (2).

DCC allows up to 30% of the infant's total blood volume to be transferred from the placenta, which increases the infant's hematocrit levels and provides a natural form of "autotransfusion" (9). This placental transfusion results in enhanced neonatal iron stores associated with improved developmental outcomes, especially in the first year of life (7). In a meta-analysis of DCC in term infants, Kc et al. (7) found that the infants who received DCC had significantly reduced risks of iron deficiency at 8 and 12 months of age, supporting its role in preventing anemia. The impact of this additional blood volume is particularly crucial in preterm infants, who are often at higher risk of requiring blood transfusions postnatally (8).

In addition to hematological benefits, DCC has been shown to improve cardiovascular transition at birth. Preterm infants who experience DCC demonstrate more stable blood pressure levels and better perfusion during the neonatal period (10). This benefit is closely linked to the prevention of intraventricular hemorrhage (IVH), one of the most severe complications in preterm infants. A systematic review by Tarnow-Mordi et al. (8) revealed that DCC significantly reduces the incidence of IVH in preterm infants by allowing a smoother cardiovascular transition. Similar findings were reported by Mercer et al. (11), who noted improved respiratory outcomes in preterm infants who underwent DCC, likely due to the increased blood volume and oxygen-carrying capacity.

Risks Associated with Delayed Cord Clamping

One of the primary concerns surrounding DCC is the potential for increased bilirubin levels and a higher incidence of neonatal jaundice. Since DCC results in the transfer of a larger blood volume to the neonate, it theoretically increases the risk of hyperbilirubinemia due to the breakdown of additional red blood cells (12). While elevated bilirubin levels have been observed in neonates subjected to DCC, the majority of studies have not reported a clinically significant increase in the need for phototherapy (8). For example, Andersson et al. (2) found that while bilirubin levels were higher in the DCC group, the incidence of hyperbilirubinemia requiring intervention did not significantly differ from the ECC group.

Similarly, Bhatt et al. (10) concluded that the increased risk of jaundice associated with DCC is manageable with regular monitoring and appropriate treatment, and it does not outweigh the hematological benefits. This finding has been confirmed by several other studies, including those by Hosono et al. (16) and McDonald et al. (1), both of which showed no significant increase in the need for phototherapy among DCC infants. Therefore, while jaundice remains a theoretical risk, current evidence suggests that it can be managed effectively without compromising the benefits of DCC.

Maternal Outcomes and Concerns

In terms of maternal outcomes, one of the primary concerns with DCC is the risk of postpartum hemorrhage (PPH), which was a major reason ECC was historically preferred. However, multiple studies have debunked the notion that DCC increases the risk of PPH. A comprehensive review by McDonald et al. (1) found no statistically significant difference in the rates of PPH between DCC and ECC groups. This is supported by the findings of Andersson et al. (2), who reported that the timing of cord clamping had no impact on maternal blood loss or the incidence of retained placenta.

Similarly, a large randomized controlled trial conducted by Rabe et al. (3) concluded that DCC does not adversely affect maternal outcomes, and the risk of uterine atony or the need for additional uterotonics is comparable between DCC and ECC.

Implications for Practice

The benefits of DCC have led to its recommendation by numerous health authorities, including the World Health Organization (WHO) and the American College of Obstetricians and Gynecologists (ACOG), which now advocate for DCC in both term and preterm deliveries (4, 5). The guidelines from these organizations emphasize that DCC should be the

standard practice in uncomplicated deliveries, as it significantly improves neonatal outcomes without increasing maternal risks.

In clinical settings, DCC has also been integrated into delayed newborn care practices, such as immediate skin-to-skin contact and delayed bathing, both of which are associated with improved breastfeeding rates and enhanced maternal bonding (15). These additional benefits further support the widespread adoption of DCC as the standard of care in modern obstetric practice.

Conclusion

The evidence overwhelmingly supports the benefits of delayed cord clamping for neonatal outcomes, particularly in enhancing iron stores and stabilizing cardiovascular function. While ECC has historically been practiced to reduce PPH and facilitate rapid delivery of the placenta, modern evidence suggests that DCC does not negatively impact maternal outcomes. Future research should focus on the long-term neurodevelopmental impact of improved iron stores in DCC infants. Based on current evidence, DCC should be adopted as the standard practice in both term and preterm deliveries, with monitoring for neonatal jaundice as needed.

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