COMPARINGDELAYEDANDEARLYCORDCLAMPING:ASYSTEMATIC REVIEW OF BENEFITS AND RISKS

ABSTRACT

Background: The timing ofumbilical cord clamping has long been debated in obstetric care, with implications for both maternal and neonatal outcomes. Early cord clamping (ECC), traditionally performed within 15–30 seconds after birth, was once believed to reduce postpartum hemorrhage and facilitate neonatal resuscitation.**Objective:**Thissystematicreviewaimstocomparetheneonatalandmaternaloutcomes of DCC versus ECC, evaluating recent evidence to determine best practices in obstetric and neonatal care.**Methods:** A comprehensive search of PubMed, Cochrane Library, and Scopus was conducted to identify randomized controlled trials (RCTs), cohort studies, and meta- analyses published in English between 2008 and 2023. Studies reporting neonatal hemoglobinlevels,ironstores,neonataljaundice,postpartumhemorrhage,andplacental retention were included.**Results:** The review found that DCC is associated with significantly higher neonatal hemoglobin levels and iron stores, reducing the risk of anemia in infancy. DCC also improves cardiovascular stability and reduces the need for blood transfusions, particularly in preterm infants. While DCC slightly increases bilirubin levels, the need for phototherapy remains comparable between DCC and ECC groups. On the maternal side, evidence indicates no significant difference in postpartum hemorrhage or placental retention between the two practices.**Conclusion:** DCC offers substantial neonatal benefits, including enhanced hematological status and improved cardiovascular adaptation, without increasing maternal risks. These findingssupportcurrent recommendations fromWHOandACOG advocatingforDCCinbothtermandpretermbirths.Furtherresearchisneededtoassess the long-term developmental impacts of DCC.

Keywords: Delayedcordclamping,Earlycordclamping,Neonataloutcomes,Maternal outcomes, Placental transfusion, Hemoglobin, Postpartum hemorrhage

INTRODUCTION

The optimal timing of umbilical cord clamping remains a subject of ongoing discussion

within obstetric practice, given its implications for both maternal and neonatal health outcomes. Traditionally, early cord clamping (ECC) defined as clamping the umbilical cord within 15 to 30 seconds post-delivery was the standard of care, based on assumptions that it might mitigate the risk of postpartum hemorrhage and facilitate prompt neonatal resuscitation [1]. However, a growing body of evidence now supports delayed cord clamping (DCC), typically defined as a delay of at least 30 to 60 seconds, as a practice that confers substantial benefits to neonates without increasing adverse outcomes for mothers [2,3].

Current guidelines from the World Health Organization (WHO) and other professional organizations, including the American College of Obstetricians and Gynecologists (ACOG), advocate for DCC in all deliveries, withparticular emphasis on its importance in preterm births [4,5]. DCC permits continued placental transfusion, thereby enhancing neonatal blood volume by up to 30%, which in turn improves hemoglobin concentrations and iron stores[6]. Conversely, ECC disrupts this physiological process, potentially resulting in reduced neonatal blood volume and a heightened risk of anemia an outcome that may have long-term developmental implications, especially inresource-limited settings [7].

Delayed cord clamping (DCC) offers several neonatal advantages, particularly for preterm infants. These include enhanced cardiovascular stability, improved regulationof blood pressure, and a decreased requirement for blood transfusions [8,9]. Moreover, DCC has been linked to a reduced incidence of serious complications associated with prematurity,suchasintraventricularhemorrhage(IVH)andnecrotizingenterocolitis

(NEC) [10]. Despite these benefits, some concerns have been raised regarding the potential for increased neonatal jaundice and hyperbilirubinemia due to the augmented blood volume following DCC. However, current evidence indicates that these risks are generallymanageablethrough vigilant monitoring and timelyclinical intervention [11,12]. On the maternal side, concerns regarding postpartum hemorrhage (PPH) and placental retention with DCC have largely been disproven. Multiple studies indicate nosignificant difference in the rates of PPH or retained placenta between DCC andECC[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 requiringimmediateneonatalresuscitation,althoughevidencesuggeststhat eveninsuchcases, brief DCC may still be beneficial [15].

AIM: Thisreviewaimstosystematicallycomparetheneonatalandmaternaloutcomesof 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. Randomizedcontrolledtrials(RCTs),cohortstudies,andmeta-analysescomparing DCC and ECC.
2. Studiesreportingneonatalandmaternaloutcomes.

StudiespublishedinEnglishbetween2008and2023.Theprimaryoutcomesassessed include neonatal hemoglobin levels, iron stores, and incidence of neonatal jaundice, whilesecondaryoutcomesfocusonmaternalhealth,suchaspostpartumhemorrhage.

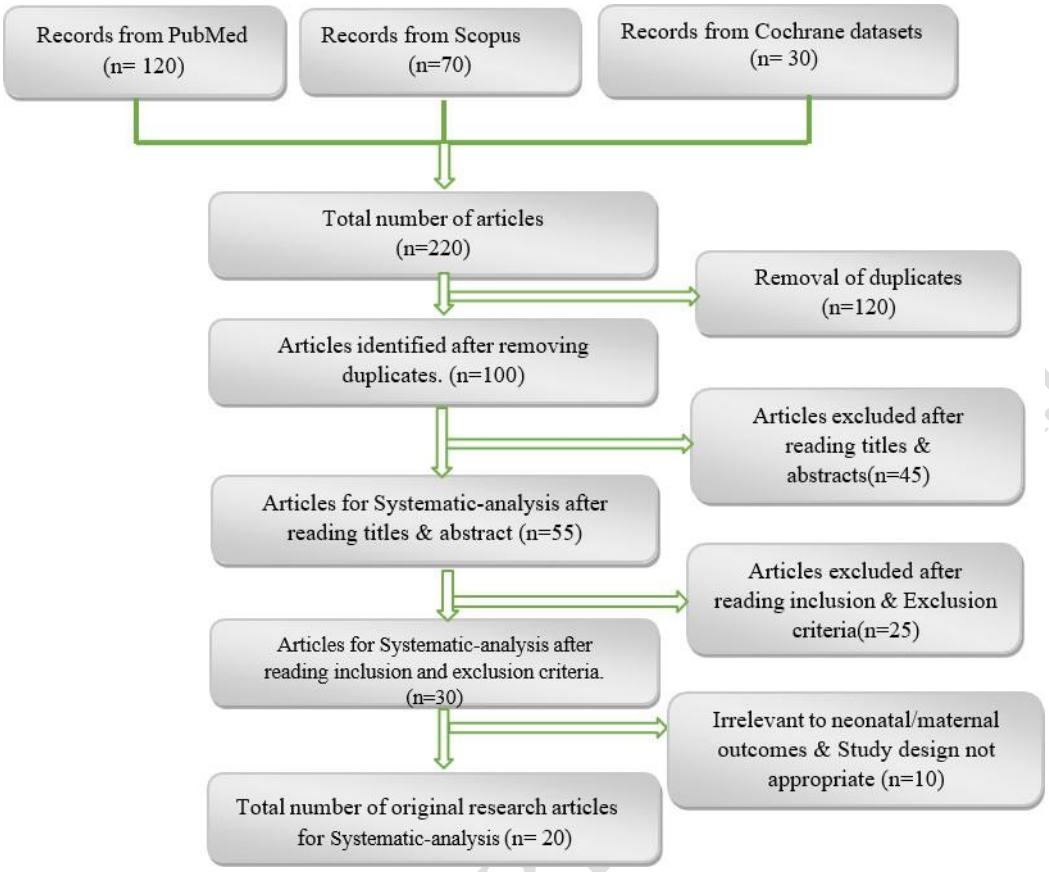

FIGURE1:PRISMAflowchartshowingtheselectionofincludedstudies

RESULTS

NeonatalOutcomes

1. **HemoglobinandIronStores**

Multiple studies have consistently demonstrated that delayed cord clamping (DCC)leads to significantly higher neonatal hemoglobin and ferritin levels when compared to early cord clamping (ECC), highlighting its critical role in the prevention of anemia during infancy. A Cochrane review [1] encompassing over 3,000 neonates reported that infants who underwent DCC exhibited higher hemoglobin concentrations and greater iron stores at 4 to 6 months of age, thereby lowering the incidence of iron deficiency anemia. These benefits are attributed to the continued placental transfusion enabled by DCC, which can contribute up to a 30% increase in blood volume in term infants.

2. **NeonatalJaundice**

A frequently cited concern regarding delayed cord clamping (DCC) is the potential for an increased incidence of neonatal jaundice, stemming from the larger transfused blood volume and the associated rise in bilirubin levels. Nonetheless, systematic reviews indicatethat although DCC mayresult in marginallyhigherbilirubin concentrations, the risk of clinically significant hyperbilirubinemia requiring phototherapy does not differ substantially between DCC and early cord clamping (ECC) groups. For instance, Andersson et al. [2] reported no significant difference in the frequency of phototherapy administration between infants in the DCC and ECC cohorts, despite the observed elevation in bilirubin among those who received DCC.

3. **Respiratoryandcardiovascularadaptation**

Cord clamping, particularly when delayed, has been associated with enhanced respiratory and cardiovascular adaptation immediately following birth, an effect especially pronounced in preterm infants. Evidence suggests that continued placental transfusion during delayed cord clamping (DCC) contributes to more stable systemic blood pressures and decreases the necessity for postnatal blood transfusions. In a randomized controlled trial, Rabe et al. [3] demonstrated that DCC significantly reduced the incidence of intraventricular hemorrhage and late-onset sepsis among preterm neonates, underscoring its protective benefits in this vulnerable population.

MaternalOutcomes

1. **PostpartumHaemorrhage(PPH)**

Historically, earlycord clamping(ECC) was widelypracticed under the assumption that it would mitigate the risk of postpartum hemorrhage (PPH). However, contemporary evidence has called this rationale into question. A comprehensive systematic review conducted byMcDonald et al.[1] found no significant difference in the incidence of PPH between delayed cord clamping (DCC) and ECC, indicating that DCC does not elevate the risk of maternal hemorrhage and can be safely implemented without compromising maternal outcomes.

2. **Placentalretentionanduterotonicuse**

ECC has been traditionallylinked to quicker deliveryof the placenta, but DCC does not appeartosignificantlydelayplacentalexpulsion.ACochranereview[5]concludedthat

DCCdoesnotincreasetheneedforuterotonicsortheincidenceofretainedplacenta, dispelling concerns about its impact on the third stage of labor.

DISCUSSION

Authors	Sample Size	StudyParameters	Observations	Conclusions
McDonaldSJ etal. (2013)[1]	3911women-infant pairs	Meta-analysisof15trials involving healthy term deliveries.	Independent reviewers assessedtrialeligibility and extracted data.	Delayedcordclamping(DCC) enhances early hemoglobin levels and iron stores, supportingamoreliberalDCC approach.
OlaAndersson et al. (2011)[2]	400 full-term infantsfromlow-risk pregnancies	Randomized to DCC (≥180 sec)vs.earlyclamping(≤10 sec).	Measuredhemoglobin and iron status at 4 months; secondary outcomes included anemia and phototherapyneeds.	DCC improved iron status, loweredneonatalanemiarates, with no observed adverse effects.
J.S.Merceret al. (2017)[6]	73termsingleton pregnancies	Compared 5-min DCC vs. immediate clamping (<20 sec);assessedplacentalblood volume and hemoglobin.	Meanclampingtime: 303s (DCC) vs. 23s (ICC);cordmilking used in some DCC cases.	DCCprovidedhematologic benefit without increasing hyperbilirubinemia or polycythemia.
AshishKCet al. (2017)[7]	540latepreterm andterminfants	RandomizedtoDCC(≥180 sec)orearlyclamping(≤60 sec).	Primaryoutcomes: anemia at 8 months; secondary:ironlevelsat 12 months.	DCC significantly reduced anemiaat8and12monthsin high-risk populations.
Tarnow-Mordi W et al. (2017)[8]	1566live births <30weeks gestation	Randomized to immediate clamping(≤10sec)vs.DCC (≥60 sec).	Median clamping time: 5svs.60s;mortalitywas 6.4% (DCC) vs. 9.0% (ICC).	DCC did not significantly reducedeathormajormorbidity compared to immediate clamping in very preterm infants.
S.Hosonoet al. (2008)[12]	40infants(24–28 weeks gestation)	Studied umbilical cord milkingvs.controlinvery preterminfants.	Milked group needed less respiratorysupport andfewer transfusions.	Cordmilkingissafeand reduces need for RBC transfusionandventilation.
OlaAndersson et al. (2015)[13]	382full-term infants	Assessedneurodevelopmental outcomes at 4 years comparingDCCvs.ECC.	Improved fine-motor scoresand movement tasksin DCCgroup.	DCC had long-term neurodevelopmentalbenefits, particularlyforboys.
Khitam Mohammadet al. (2021)[16]	128full-term singleton pregnancies	Compared DCC (90s) vs. ECC(<30s)onmaternaland neonatal outcomes.	Higher neonatal hemoglobinat12hours in DCC group; ECC group had higher oxygentherapyneeds.	DCC improved neonatal hemoglobinwithoutadverse maternaloutcomes;supports practice change in Jordan.
Francesco Cavallinetal. (2019)[17]	80neonatesfrom elective C-sections	RandomizedtoDCC(≥60s) vs.ECC;assessedpostnatal adaptation.	Higher hematocrit on day2 in DCC group;no increasein phototherapy needs.	DCC in elective C-sections improveshematocritwithout maternalrisks.Furtherstudy needed.
DorlasiLM& Lilian TM (2020)[18]	19healthcare professionals	Qualitativestudyexploring DCCpracticesinTanzania.	Themes:experiences, perceptions, and influencingfactorsof cordclamping.	DCCisunderstoodtobenefit newborn oxygenation;wider practice adoption recommended.
Devin Joan & LarkinPatricia (2018)[19]	153 midwife surveyresponses	Cross-sectionalsurveyof midwifery practices in Ireland.	91.5% practiced DCC; definitionsandpractices varied.	VariationinDCCpracticestems from clinical setting, research awareness, and resuscitation tools.
Abd El-MoneimA. Fawzyetal.	100 full-term primigravidas	ComparedDCC(post-pulsation) vs. ECC (immediate)on newborn	EvaluatedApgarscore, hemoglobin, bilirubin, bloodsugar,oxygen	DCCwasassociatedwithbetter overall neonatal outcomes.

(2015)[20]		outcomes.	levels.	

Table1showstheobservationsnotedbytheresearchers

BenefitsofDelayed CordClamping

The benefits of delayed cord clamping (DCC) are increasinglysubstantiated by a robust and expanding body of scientific literature. One of the most significant neonatal advantages of DCC is the marked increase in neonatal blood volume, which directly contributes to higher hemoglobin levels and improved iron stores. Numerous randomized controlled trials and systematicreviewshaveconsistentlydemonstratedthat infants who undergo DCC exhibit significantly elevated hemoglobin concentrations at birth, as well as enhanced iron reserves at 4 to 6 months of age, in comparison to those subjected to early cord clamping (ECC)[1,6]. These outcomes are especially vital in low-resource settings, where infant anemia is prevalent and healthcare resources are often constrained [2].

DCC facilitates the transfer of up to 30% of the neonate's total blood volume from the placenta, effectively serving as a physiological "autotransfusion" that elevates hematocrit levels [9]. This process of placental transfusion is associated with improved iron status and favorable neurodevelopmental outcomes during the critical first year of life [7]. Supporting this, a meta-analysis conducted by Kc et al. [7]) found that terminfants whoreceivedDCC had asignificantlylowerrisk ofirondeficiencyat both 8 and 12 months of age. These findings reinforce the role of DCC in the prevention of early childhood anemia. Moreover, the additional blood volume conferred by DCC is of particular importance in preterm infants, who are at heightened risk for anemia andoften require blood transfusions in the neonatal period [8].

Beyonditswell-documentedhematologicaladvantages,delayedcordclamping(DCC)

has also been shown to facilitate a more effective cardiovascular transition at birth, particularly in preterm infants. Infants who undergo DCC tend to exhibit more stable blood pressure levels and improved tissue perfusion during the immediate neonatal period [10]. These cardiovascular benefits are closely associated with a reduced risk of intraventricular hemorrhage (IVH), a serious and potentially life-threatening complication in preterm neonates. A systematic review by Tarnow-Mordi et al. [8] demonstrated that DCC significantly lowers the incidence of IVH by promoting a more gradual and physiologically stable transition from fetal to neonatal circulation. Complementary findings from Mercer et al. [11] further support these observations, reporting enhanced respiratory outcomes in preterm infants subjected to DCC an effect likely attributable to increased blood volume and improved oxygen-carrying capacity at birth.

RisksAssociatedwithDelayedCordClamping

One of the primary concerns surrounding DCC is the potential for increased bilirubin levels and ahigher incidenceofneonataljaundice. SinceDCCresults inthetransfer ofa larger blood volume to the neonate, it theoretically increases the risk of hyperbilirubinemia due to the breakdown of additional red blood cells [12]. While elevatedbilirubinlevelshavebeenobservedinneonatessubjectedto DCC,most 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,whilejaundiceremainsatheoreticalrisk,currentevidencesuggeststhatit

canbemanagedeffectivelywithout compromisingthebenefitsof DCC.

MaternalOutcomesandConcerns

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 trialconducted byRabe 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.

ImplicationsforPractice

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 thatDCC 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 breastfeedingrates 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 deliveryoftheplacenta, modern evidence suggests that DCC does not negativelyimpact maternal outcomes. Future research should focus on the long-term neurodevelopmental impact ofimproved 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.

References

1. McDonald SJ, Middleton P, Dowswell T, Morris PS. Effect of timing of umbilical cord clamping of term infants on maternal and neonatal outcomes. Cochrane Database Syst Rev. 2013;(7):CD004074.
2. AnderssonO,Hellström-WestasL,AnderssonD,DomellöfM.Effectofdelayed versus early umbilical cord clamping on neonatal outcomes and iron status at 4 months: a randomized controlled trial. BMJ. 2011;343:d7157.
3. 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.
4. World Health Organization. Delayed versus early umbilical cord clamping for improving maternal and infant health outcomes. Geneva: WHO; 2014.
5. American College of Obstetricians and Gynecologists. Delayed umbilical cord clamping after birth: Committee Opinion No. 684. Obstet Gynecol. 2017;129(1):e5–10.
6. Mercer JS, Erickson-Owens DA, Collins J, Barcelos MO, Parker AB, Padbury JF. Effects of delayed cord clamping on residual placental blood volume, hemoglobin, and bilirubin levels in term infants: a randomized controlled trial. J Perinatol. 2017;37(3):260–4.
7. Kc A, Rana N, Malqvist M, Ranneberg LJ, Subedi K. Effects of delayed umbilical cord clamping vs early clamping on anemia in infants at 8 and 12 months: a randomized clinical trial. JAMA Pediatr. 2017;171(3):264–70.

8. Tarnow-Mordi W, Morris J, KirbyA, Robledo K, Askie L, Brown R, Australian Placental Transfusion Study Collaborative Group. Delayed versus immediate cord clamping in preterm infants. N Engl J Med. 2017;377(25):2445–55.
9. YaoAC,LindJ.Placentaltransfusion.AmJDisChild.1974;127(1):128–41.
10. Bhatt S, Alison BJ, Wallace EM, Crossley KJ, Gill AW, Kluckow M, et al. Delayingcord clamping until ventilation onset improves cardiovascularfunction at birth in preterm lambs. J Physiol. 2013;591(8):2113–26.
11. Mercer JS, Vohr BR, Erickson-Owens DA, Padbury JF, Oh W. Seven-month developmental outcomes of very low birth weight infants enrolled in a randomized controlled trial of delayed versus immediate cord clamping. J Perinatol. 2010;30(1):11–6.
12. Hosono S, Mugishima H, Fujita H, Hosono A, Minato M, Okada T, et al. Umbilical cord milking reduces the need for red cell transfusions and improves neonataladaptationininfantsbornatlessthan29weeksgestation: arandomized controlled trial. Arch Dis Child Fetal Neonatal Ed. 2008;93(1):F14–9.
13. AnderssonO,DomellöfM,AnderssonD,Hellström-WestasL.Effectofdelayed cord clamping on neurodevelopment at 4 years of age: a randomized clinical trial. JAMA Pediatr. 2015;169(7):631–8. doi:10.1001/jamapediatrics.2015.0358.
14. McAdams RM, Backes CH, Hutchon DJ. Steps for implementing delayed cord clamping in a hospital setting. Matern Health Neonatol Perinatol. 2015;1:10.
15. Katheria AC, Lakshminrusimha S, Rabe H, McAdams R, Mercer JS. Placental transfusion: a review. J Perinatol. 2017;37(2):105–11. doi:10.1038/jp.2016.151.
16. Mohammad K, Tailakh S, Fram K, Creedy D. Effects of early umbilical cord clamping versus delayed clamping on maternal and neonatal outcomes: a Jordanian study. J Matern Fetal Neonatal Med. 2021;34(2):231–7.
17. Cavallin F, Baldo G, Loretelli V, Madella S, Pizzolato M, Visentin S, et al. Delayed cord clamping versus early cord clamping in elective cesarean section:a randomized controlled trial. Neonatology. 2019;116(3):252–9.
18. 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.
19. Joan D, Patricia L. Delayed cord clamping in term neonates: attitudes and practices of midwives in Irish hospitals. Int J Childbirth. 2018;8(1):1–17.
20. FawzyAbdEMA,MoustafaAA,El-KassarYS,SwelemMS,El-AgwanyAS,

DiabDA. EarlyversusdelayedcordclampingoftermbirthsinShatbyMaternity University Hospital. Progr Obstet Ginecol. 2015;58(9):389–92.