*Biological and Clinical Sciences Research Journal*
*eISSN: 2708-2261; pISSN: 2958-4728*
*www.bcsrj.com*
DOI: https://doi.org/10.54112/bcsrj.v2023i1.428
*Biol. Clin. Sci. Res. J., Volume, **2023**: 428*
***Original Research Article***

# EFFECT OF EARLY VS. DELAYED CORD CLAMPING IN NEONATE'S HEART RATE AND OXYGEN SATURATION IN THE FIRST 10 MINUTES OF LIFE

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*(Received, 16th May 2023, Revised 18th August 2023, Published 30th September 2023)*

**Abstract:** *The timing of umbilical cord clamping after birth can influence neonatal physiological parameters, which may affect immediate neonatal outcomes. This study sought to determine the effects of early cord clamping (ECC) and delayed cord clamping (DCC) on neonates' heart rate and oxygen saturation during the first ten minutes of life. The Obstetrics and Gynecology Department of Liaquat National Hospital, Karachi, carried out the randomized controlled trial with 200 participants. Two groups of newborns were assigned: ECC (cord clamped within 60 seconds of birth) and DCC (cord clamped after 60 seconds of birth). A pulse oximeter was used to monitor heart rate and oxygen saturation continuously from birth to 10 minutes of life. In most observed intervals, the heart rates of neonates in the DCC group fell within the range of 111 to 150 bpm. A significant proportion of ECC neonates had heart rates between 151 and 170 beats per minute at one minute. In addition, during the early postnatal period, DCC neonates consistently exhibited higher oxygen saturation levels, particularly within the 96-100% range, compared to ECC neonates. Delayed cord clamping appeared to promote stability in neonatal heart rate and enhance oxygen saturation in the immediate post-birth period. These findings highlighted the physiological advantages of DCC and its function in optimizing early neonatal outcomes.*

**Keywords:** Cord Clamping; Gestational Age; Immediate Postnatal Period; Neonatal Heart Rate; Neonatal Monitoring; Neonatal Outcomes; Oxygen Saturation.

## Introduction

The parturition process is a pivotal point in the lives of both the mother and the infant. Managing the umbilical cord, which connects the fetus to the placenta and the mother, is essential to this process (Al-Ninia et al., 2017). Historically, clamping the umbilical cord immediately after delivery is widespread and deeply rooted in the human birthing experience. In numerous nations, the immediate ligation of the umbilical cord is an integral part of the active management of the labor 3rd phase and is frequently institutionalized as standard practice (Houston et al., 2014; Ibrahim et al., 2017).

In recent years, however, there has been a growing debate among maternal health professionals regarding the optimal moment for clamping the umbilical cord during the 3rd phase. As part of actively managing the third stage of labor, the World Health Organization no longer recommends the early severing of the umbilical cord (Wenger et al., 2022). This transition has been influenced by gathering indications of the potential negative effects of ECC, for instance, higher risk of anemia in premature neonates, respiratory complications, and intraventricular hemorrhage (Downey and Bewley, 2012).

In contrast, DCC has validated promise. Numerous studies have demonstrated its significant advantages for neonates, including improved transitional circulation, enhanced establishment of erythrocytes volume, and a decreased need for blood transfusions. In addition, DCC appears to have a low risk of certain health complications, for instance, necrotizing enterocolitis and intraventricular hemorrhage (Henry et al., 2021; Mohammad et al., 2021).

A particularly intriguing international study recently concluded that delayed clamping, lasting more than a minute, led to earlier stabilization of oxygen saturation and heart rate in healthy term newborns in the preliminary delivery phase (McDonald et al., 2014; Padilla-Sánchez et al., 2020). Despite these proven benefits and known drawbacks, early cord severing remains a common practice among maternity staff 5.

In their meticulous research, Ashish KC et al. shed light on the tangible effects of early versus delayed cord severance. Their findings highlighted the differences in oxygen saturation and heart rate among neonates subjected to varying clamping times during the first 10 minutes of life (Brouwer et al., 2019; Kc et al., 2019).

With the evolution of medical practices and a deeper comprehension of neonatal physiology, the debate over early versus delayed cord severance has become more nuanced. Given the ongoing international debate and the potential implications for neonatal and maternal health, this study aims to delve deeper into this subject. We aim to compare neonate heart rate and oxygen saturation during the first 10 minutes of life under early and delayed cord clamping conditions. By contributing to this field, we expect to provide evidence that could influence clinical guidelines for umbilical cord clamping, enhancing neonatal and maternal outcomes.

## Methodology

This investigation was carried out in the Obstetrics and Gynecology Department of Liaquat National Hospital in

Karachi as a randomized controlled trial for six months in 2022-23, following CPSP's approval of the executive summary. The sample size, determined using the WHO software for calculating sample size, was 200 patients, with 100 patients allocated to each cohort. The sampling technique used was non-probability consecutive sampling. The inclusion requirements were male or female newborns of normal vaginal delivery, preterm and full-term neonates, infants with fetal pulse rates between 100-160 bpm, and women over 33 weeks gestational age. Exclusion standards included women who delivered stillborn babies, abnormal fetal pulse rates, patients who couldn't or refused to provide informed assent, neonatal patients who were stimulated, suctioned, or given bag-mask ventilation, cases involving congenital anomalies, Rh-incompatibility, multiple pregnancies, and infants who were not breathing.

After approval from the Ethical Review Committee and CPSP, patients visiting the Department of Gynecology and Obstetrics were included in the study after obtaining informed consent from their parents or caretakers. Pregnant women with audible fetal heart signals and no medical or obstetric complications were considered at admission. Using computer software, participants were categorized randomly into two groups:

Group A had the umbilical cord clamped within 60 seconds after birth (Early Cord Clamping- ECC).

Group B experienced delayed cord clamping, i.e., 60 seconds after birth (Delayed Cord Clamping- DCC).

The time between complete neonate delivery and the first umbilical cord clamp was measured using a stopwatch. Following clamping, oxytocin was administered to both groups. A pulse oximeter was utilized for continuous monitoring from birth to 10 minutes. The beginning and regularity of respiration were noted.

The fetal heart rate monitor was attached to the mother's abdomen during transfer and remained there until delivery. Exclusions were made if fetal heart rate abnormalities were detected. After delivery, the pulse oximeter was attached to the newborn's thumb or big toe to record heart rate and oxygen saturation for 10 minutes. Apgar scores were recorded in both groups at 1, 5, and 10-minute intervals.

On pre-designed proforma, all data were meticulously documented. Strict compliance with the inclusion criteria mitigated confounding variables and bias.

All data were processed and analyzed using version 21.0 of SPSS. For qualitative variables such as the gender and neonatal status of the infant, frequencies and percentages were computed. Mean + SD values were calculated for quantitative variables such as the mother's age, gestational age, birth weight, duration to clamp the umbilical cord, Apgar scores, heart rates, and oxygen saturation levels. To assess the impact of these modifiable factors on the outcome, stratification was performed based on the mother's age, baby's gender, birth weight, and neonatal status. As appropriate, the Chi-square test and student t-test were applied. A p-value <0.05 was regarded as significant.

Ethical standards were upheld during the research. Participants received informational and permission letters. Data was coded to protect confidentiality and was only available to the supervisor.

**Results**

The distribution of the mother's age in the sample of 200 participants indicated a clear skew toward the age range of 26 to 35 years ($p<0.05$). Specifically, 18% (36 participants) fell within the 18-25 years category, significant 59.5% (119 participants) were in the 26-35 years bracket, and 22.5% (45 participants) were above 35 years of age ($p<0.05$). 90.5% (181 participants) of the births occurred between 37 and 41 weeks of gestation, while only 9.5% (19 participants) occurred between 34 and 36 weeks ($p<0.05$). The preponderance of neonates, 64% (128 neonates), had birth weights ranging from 2.5 to 3.5 kilograms, as determined by an analysis of birth weight. In comparison, 8.5% (17 newborns) weighed less than 2.5 kg, and 27.5% (55 newborns) weighed more than 3.5 kg ($p<0.05$). 54.5 percent (109 neonates) of the sample were females, while 45.5 percent (91 neonates) were males. In terms of neonatal status, 90.5% (181 neonates) were full-term ($p<0.05$), whereas 9.5% (19 neonates) were premature (Table 1).

The study compared the heart rates of neonates between two procedures, ECC (Early Cord Clamping) and DCC (Delayed Cord Clamping), at three intervals post-birth: 1 minute, 5 minutes, and 10 minutes. At 1 minute post-birth, 5% of the ECC group and 12% of the DCC group had heart rates between 100-110 bpm, whereas 49% of the ECC group and 79% of the DCC group had heart rates between 111-150 bpm ($p<0.05$). 46% of ECC neonates and 9% of DCC neonates exhibited heart rates between 151-170 bpm ($p<0.05$). At the five-minute mark, there was a modest shift in the distribution, and at the ten-minute mark ($p<0.05$), the differences between the two groups grew more pronounced (Table 2).

Significant differences were observed in the comparison of oxygen saturation levels of neonates with ECC and DCC ($p<0.05$). At 1 minute after delivery, more DCC neonates than ECC neonates had 96-100% oxygen saturation ($p<0.05$). At the 5-minute mark, the DCC group again displayed a substantially greater proportion of individuals within the 96-100% saturation range. Both groups displayed 91-95% and 96-100% differences after 10 minutes ($p<0.05$). Statistical analysis revealed statistically significant differences in oxygen saturation levels between the ECC and DCC groups in the early postnatal period ($p<0.05$) (Table 3). Comparing ECC and DCC in neonates revealed that DCC infants typically had heart rates within the 111-150 bpm range and increased oxygen saturation levels, primarily 96-100%, across all time intervals examined (Figure 1).

**Table 1: Baseline characteristics of participants**

| Baseline Characteristics | Variables Range | No. of participants n=200 | Frequency (%) | p-value |
|---|---|---|---|---|
| Mother's Age (Mean±SD) Years | 18-25<br>26-35<br>>35 | 36 (18.0)<br>119 (59.5)<br>45 (22.5) | 18.0<br>59.5<br>22.5 | 0.00001* |

[Citation Anwar, A., Naqvi, Z. (2023). Effect of early vs. Delayed cord clamping in neonate's heart rate and oxygen saturation in the first 10 minutes of life. *Biol. Clin. Sci. Res. J.*, **2023***: 428*. doi: https://doi.org/10.54112/bcsrj.v2023i1.428]

| | | | | |
|---|---|---|---|---|
| Gestational Age (Mean±SD) Weeks | 34-36<br>37-41 | 19 (9.5)<br>181 (90.5) | 9.50<br>90.5 | 0.00001* |
| Birth Weight (Mean±SD) Kgs | <2.5<br>2.5-3.5<br>>3.5 | 17 (8.5)<br>128 (64.0)<br>55 (27.5) | 8.50<br>64.0<br>27.5 | 0.00001* |
| Gender (n) | Male<br>Female | 91 (45.5)<br>109 (54.5) | 45.5<br>54.5 | 0.00001* |
| Neonatal status | Preterm<br>Full term | 19 (9.5)<br>181 (90.5) | 9.50<br>90.5 | 0.00001* |
| ***Indicated the significant values*** | | | | |

**Table 2: Heart rate of fetuses in ECC and DCC**

| Heart rate | ECC n=100 | DCC n=100 | χ2 | p-value |
|---|---|---|---|---|
| At 1 minute | | | | |
| 100-110 bpm | 05 | 12 | 1.2091 | 0.2715 |
| 111-150 bpm | 49 | 79 | 4.2564 | 0.0391* |
| 151-170 bpm | 46 | 09 | 15.998 | 0.00006* |
| At 5 minutes | | | | |
| 100-110 bpm | 07 | 10 | 0.0885 | 0.7660 |
| 111-150 bpm | 51 | 76 | 0.9029 | 0.5290 |
| 151-170 bpm | 42 | 14 | 13.832 | 0.0005* |
| At 10 minutes | | | | |
| 100-110 bpm | 08 | 09 | 0.0726 | 0.1029 |
| 111-150 bpm | 53 | 74 | 2.0021 | 0.1570 |
| 151-170 bpm | 39 | 17 | 5.0903 | 0.0240* |
| ***indicated the significant values*** | | | | |

**Table 3: Oxygen saturation of fetuses in ECC and DCC**

| Oxygen saturation | ECC n=100 | DCC n=100 | χ2 | p-value |
|---|---|---|---|---|
| At 1 minute | | | | |
| ≥ 90 % | 11 | 05 | 0.0857 | 0.3545 |
| 91-95% | 53 | 13 | 15.609 | 0.00007* |
| 96-100% | 36 | 82 | 11.38 | 0.00074* |
| At 5 minutes | | | | |
| ≥ 90 % | 13 | 06 | 0.0912 | 0.2391 |
| 91-95% | 44 | 18 | 6.5829 | 0.0102* |
| 96-100% | 43 | 76 | 5.6067 | 0.0178 |
| At 10 minutes | | | | |
| ≥ 90 % | 10 | 03 | 1.6029 | 0.2054 |
| 91-95% | 50 | 22 | 6.6134 | 0.0101* |
| 96-100% | 40 | 75 | 6.5735 | 0.0103* |
| ***Indicated the significant values*** | | | | |

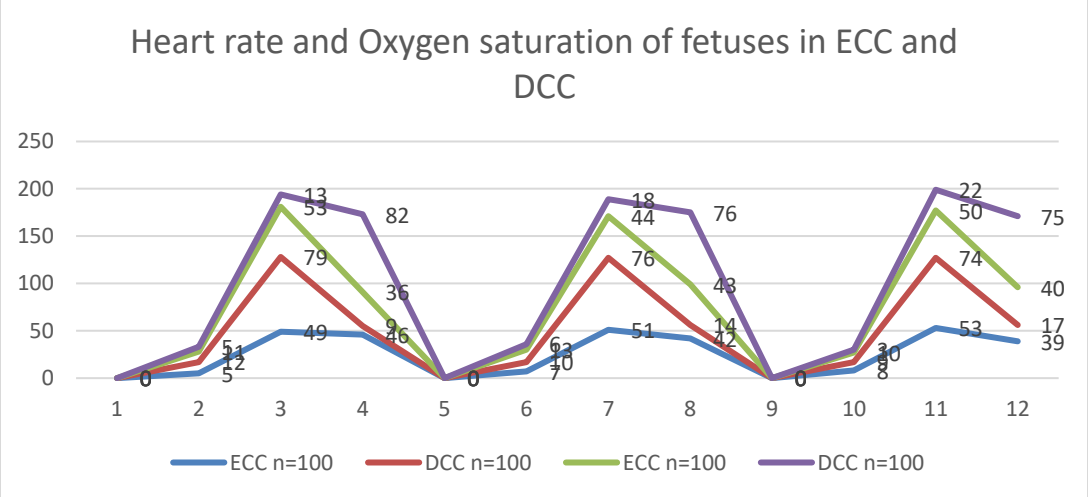


**Figure 1: Comparison of heart rate and oxygen saturation of fetuses in ECC and DCC**

## Discussion

As a newborn transition from an intrauterine to an extrauterine environment, the significance of the immediate postnatal period cannot be overstated. This limited opportunity window can profoundly affect neonatal health and long-term health outcomes. One such decision is when to clamp the umbilical cord. Our research sought to determine the immediate effects of early versus delayed cord clamping on neonates' heart rate and oxygen saturation levels during the first ten minutes of life.

Our findings revealed that the pulse rates of neonates in the DCC group tended to range between 111 and 150 bpm across all time intervals. In contrast, a substantial proportion of neonates in the ECC group exhibited heart rates between 151 and 170 bpm at 1 minute, progressively converging to patterns similar to the DCC group as time progressed (Fawzy et al., 2015; Mahli et al., 2015). Previous research indicates that delayed cord clamping permits a more gradual transition to extrauterine circulation, which may account for the more stable pulse rates observed (Bhatt et al., 2013; Mahli et al., 2015). In the first minute after the abrupt cessation of placental blood flow, the relatively elevated heart rates observed in the ECC group may have reflected a transient stress response (Remien and Majmundar, 2023).

During the early postnatal period, the DCC group had significantly higher oxygen saturation levels than the control group. Several physiological changes occur during the transition from fetal to neonatal circulation, including establishing pulmonary blood flow and cessation of placental blood flow (Kc et al., 2019). The higher oxygen saturation levels in the DCC group are attributable to the additional placental blood transfusion, which supplies the neonate with oxygen-rich blood. This additional blood can improve oxygenation, particularly in the postnatal period when the lungs are still expanding and establishing their function (Katheria et al., 2017).

Previous studies have highlighted the benefits of delayed cord clamping, including better iron stores, reduced risk of necrotizing enterocolitis, and enhanced transitional circulation in preterm neonates (Qian et al., 2019). In addition, the enhanced oxygen saturation and stable heart rate in the DCC group may reduce the need for immediate medical interventions, allowing for uninterrupted skin-to-skin contact and promoting early breastfeeding initiation (Huang et al., 2022). Conclusively, our findings are also corroborated with the research reporting that spontaneously breathing babies subjected to DCC have higher oxygen saturation up to 10 min after birth compared to those who have undergone ECC, have lower heart rates compared to ECC until 390 s and early establishment of breathing compared to ECC (Kc et al., 2019).

## Conclusion

This RCT compared the effects of early versus delayed cord clamping on neonatal heart rate and oxygen saturation in the first ten minutes after birth. Compared to their early cord clamping counterparts, neonates exposed to delayed cord clamping consistently exhibited heart rates within the 111-150 bpm range across all time intervals and higher oxygen saturation levels, particularly in the 96-100% range. These results highlighted the physiological benefits of DCC in stabilizing neonatal heart rate and optimizing oxygen saturation immediately after birth, possibly highlighting its function in improving early neonatal outcomes.

## Declarations

**Data Availability statement**
All data generated or analyzed during the study are included in the manuscript.
**Ethics approval and consent to participate.**
Approved by the department Concerned.
**Consent for publication**
Approved
**Funding**
Not applicable

## Conflict of interest

The authors declared an absence of conflict of interest.

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