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# Significance of Delayed Umbilical Cord Clamping to 90 Seconds Over 60 Seconds and Requirement of Phototherapy in Healthy Term Neonates Born by Elective Cesarean Section

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## ABSTRACT

Delayed cord clamping (DCC) has been associated with improved neonatal outcomes, especially hematologic parameters. This study evaluates the effects of umbilical cord clamping at 90 seconds versus 60 seconds on neonatal hemoglobin, hematocrit levels, and the requirement for phototherapy. A randomized study was conducted at tertiary care hospital, Visakhapatnam, involving 92 healthy term neonates born via elective cesarean section. Participants were randomly assigned to two groups: Group A (cord clamping at 60 seconds) and Group B (cord clamping at 90 seconds). Neonatal outcomes including hemoglobin, hematocrit, bilirubin levels, phototherapy requirement, $SpO_2$, heart rate, temperature, and glycemia were assessed at defined intervals post-delivery. Group B (90-second DCC) showed significantly higher hemoglobin levels on Day 0 (18.97 ± 2.46 g/dL vs. 16.16 ± 2.53 g/dL; p = 0.012) and Day 3 (21.95 ± 2.35 g/dL vs. 19.02 ± 2.23 g/dL; p = 0.029). Hematocrit levels were also significantly higher in Group B at both times. No significant differences were observed in bilirubin levels or phototherapy requirements between the groups (p = 0.500). Other parameters such as $SpO_2$, heart rate, temperature, and glycemia showed no statistically significant differences. Delayed cord clamping for 90 seconds significantly improves neonatal hemoglobin and hematocrit levels without elevating the risk for phototherapy, supporting its use in term infants born by elective cesarean section.

***Keywords:*** Delayed cord clamping, hemoglobin, hematocrit, phototherapy, hyperbilirubinemia, elective cesarean section, neonatal outcomes, umbilical cord clamping, neonatology

## INTRODUCTION

The most appropriate time for UCC (Umbilical cord clamping) has been a contentious issue in obstetric and neonatal care, with continuous study examining its effects on mother and newborn outcomes [1]. Early cord clamping (ECC), usually executed within the initial 30–60 seconds post-delivery, has conventionally been part of active management of 3rd stage of labor to decrease maternal blood loss and mitigate postpartum hemorrhage; however, delayed cord clamping (DCC) has gained recognition for its various advantages for

neonates [2-5]. These include improved hemoglobin and hematocrit levels, enhanced iron stores, reduced incidence of infant anemia, and potential long- term neurodevelopmental advantages [6]. In response to growing evidence, American College of Obstetricians and Gynecologists (ACOG) revised its recommendations to advocate DCC in both term & preterm infants, regardless of mode of delivery [7]. However, most data supporting these benefits stem from studies on vaginal births, with limited and inconsistent findings related to DCC in cesarean sections even though cesarean deliveries constitute a significant proportion of births globally [1]. Cesarean delivery is inherently linked with a elevated risk of maternal blood loss, which often leads to concerns among clinicians about the safety and feasibility of prolonged DCC during surgery [7]. Moreover, the physiology of placental transfusion may differ between cesarean and vaginal deliveries, potentially affecting the volume and benefits of placental blood transfer [1]. The effect of extending DCC from 60 to 90 seconds in cesarean deliveries remains underexplored, especially with respect to bilirubin metabolism and the potential requirement for phototherapy due to hyperbilirubinemia. Hyperbilirubinemia is a known physiological consequence of increased red cell volume following DCC and can necessitate phototherapy in some neonates [8-10]. However, recent evidence suggests that the incidence of clinically significant jaundice requiring treatment may not be substantially elevated with DCC, particularly within the 60–90 second window. As clinical practices evolve, it is essential to determine whether extending DCC beyond the 60-second mark to 90 seconds confers additional hematological benefits without increasing the risk of adverse neonatal outcomes such as hyperbilirubinemia requiring phototherapy. This study seeks to examine the importance of postponing UCC to 90 seconds compared to 60 seconds in healthy term infants born via elective cesarean section. The primary outcome is the requirement of phototherapy during the early neonatal period, while secondary outcomes include neonatal hemoglobin and hematocrit levels. This research seeks to provide evidence that can guide timing decisions in cesarean deliveries, balancing neonatal benefits with maternal safety.

## MATERIALS & METHODS

**Study Design:** The study design was Randomized controlled study.

**Study Settings:** The study was conducted in the department of Pediatrics, GITAM Institute of medical sciences and research, Visakhapatnam.

**Study Duration and study period:** The study was conducted for a period of 18 months from April 2023 to October 2024.

**Study population:** Healthy term neonates, born by elective cesarean section

Sample Size: The sample size was 92 neonates (No of cases under Group A - 46 No of cases under Group B – 46)

**Sampling technique:** Simple random sampling.

**Sampling procedure:** Randomly selected slip by examiner provided with a box containing numbered slips ranging from 1 to 92 given to participants. The participants with even-numbered slips were assigned to group A, while those who with odd-numbered slips were assigned to group B, ensuring that each participant had an equal chance of being allocated to either group. The allocation process was carried out by the examiner, who was aware of the timing of CC, but both patients & statistician remained blinded to the group assignments. To maintain confidentiality, each participant was assigned a unique code number that was known only to the investigator, and this code was disclosed only at the conclusion of the study. This random allocation process measured unbiased assignment to the groups while maintaining blinding for the outcome assessors.

**Inclusion Criteria:** All healthy terms neonates, appropriate for gestational age, born via elective cesarean section and

mothers who have given consent for DCC to 90 seconds

**Exclusion criteria:**

- Neonates delivered by normal vaginal delivery (NVD) or emergency lower segment cesarean section (LSCS).
- Neonates born from multiple pregnancies.
- Neonates born to Rh-negative mothers and those with ABO incompatibility.
- • Neonates born to mothers with hypertensive disorders, DM, intrahepatic cholestasis of pregnancy, polyhydramnios, oligohydramnios, placenta previa, or abruptio placenta.
- Neonates with birthweight less than 2500 grams or greater than 4 kilograms.
- Neonates who received CC in less than 30 seconds.
- Congenital malformations such as anal atresia, biliary atresia, heart diseases, cleft lip, cleft palate, or any other conditions influencing bilirubin levels.

**Measured Variables/Parameters Studied:**

**Socio-Demographics:** The age of the participants was recorded.

**Obstetric History:** GA was noted.

**Timing of cord clamping**

**Fetal Assessment:** Birth weight & Apgar at 1 & 5 minutes were documented.

**Neonatal Assessment:** Serum bilirubin levels, hemoglobin, hematocrit, and blood glucose levels on day 0 and day 3 were measured.

**Vitals:** Heart rate, SpO2, and temperature were recorded at 5 and 10 minutes.

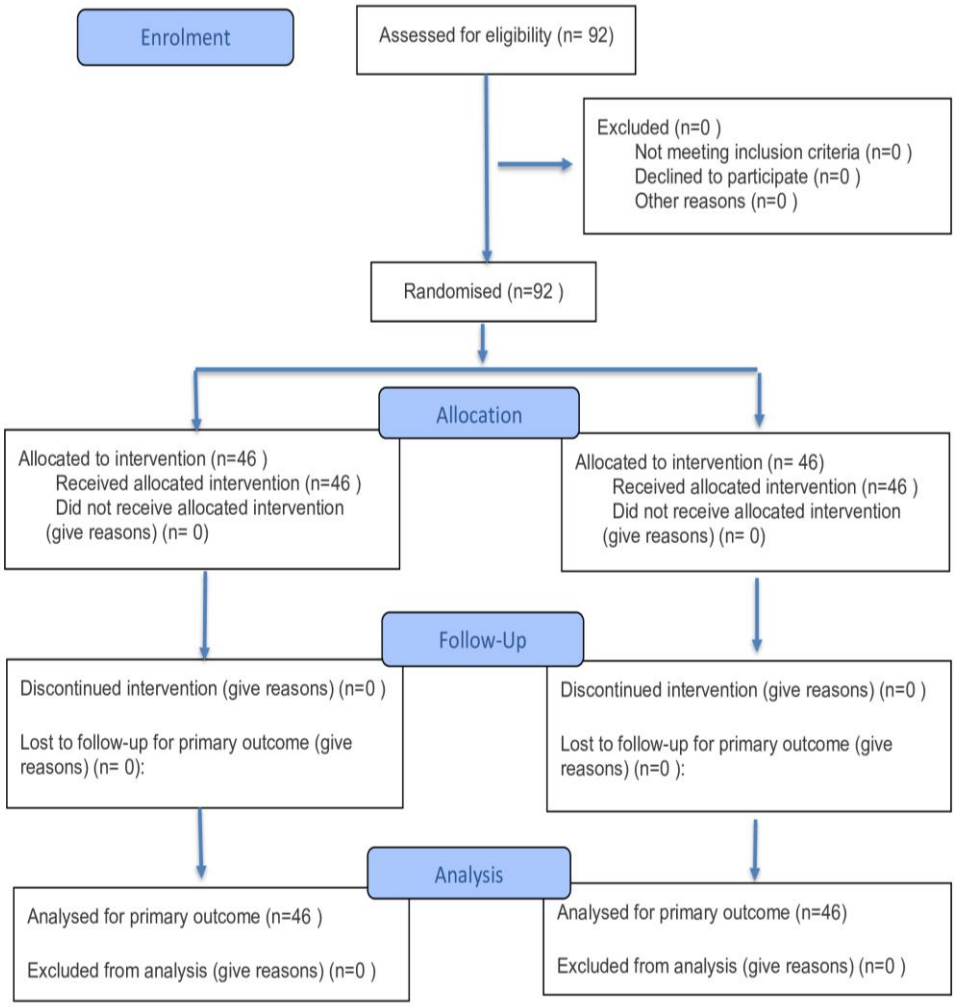
**Phototherapy Requirement:** The need for phototherapy was also assessed.

**Method of data collection:** A total of 92 neonates were randomly assigned to either the 60-second (Group A) or 90-second (Group B) cord clamping groups through a lottery method conducted by the examiner. Data collection included socio-demographic details (maternal age), obstetric history (gestational age), timing of cord clamping, and fetal parameters such as birth weight and Apgar scores at 1 & 5 minutes. Neonatal parameters, including serum bilirubin, hemoglobin, hematocrit, and blood glucose levels on day 0 and day 3, as well as vital signs (heart rate, $SpO_2$, and temperature at 5 and 10 minutes), were recorded. The requirement for phototherapy was also assessed.

## Statistical Analysis

The collected data was analyzed using SPSS V 28. Descriptive statistics were obtained as means and SD for continuous variables, frequency & percentage for categorical variables. Independent t test was performed for assessing continuous variables and chi-square for categorical variables. The significance level was stated as $p \leq 0.05$.

## RESULT




**Flow chart 1: CONSORT Flow Diagram of Participant Progress Through the Study**

All 92 participants assessed for eligibility were included and randomized into two equal groups of 46, each of which received the allocated intervention, with no exclusions, dropouts, or loss to follow-up, and all participants were ultimately included in the final analysis (Flow chart 1). 92 participants were randomly assigned to 60 seconds CC (Group A); 90 seconds CC (Group B). The mean age group of Group A was 28.78±5.318 and the mean age group of Group B was 28.23±3.683. Mean gestational age in Group A was 38.88 ± 0.822 weeks, while in Group B, it was 38.80 ± 0.648 weeks. Mean fetal weight in Group A was 3.13 ± 0.304 kgs, while in Group B, it was 3.20 ± 0.311 kgs. The mean APGAR scores at 1 & 5 minutes in both groups were 8 and 9 respectively with no observed variability. This indicates that neonatal outcomes in terms of immediate postnatal adaptation were comparable between the two groups. On Day 0, the mean bilirubin levels were 2.49 ± 0.745 mg/dL in Group A and 2.64 ± 0.653 mg/dL in Group B, with no significant difference ($p = 0.215$). On Day 3, the mean bilirubin levels increased to 13.3 ± 1.874 mg/dL in Group A and 13.8 ± 2.066 mg/dL in Group B, showing no statistically significant difference ($p = 0.389$) (Table 1). These findings suggest that bilirubin levels followed a similar trend in both groups without a significant impact of different UCC times. On Day 0, the mean hemoglobin levels were 16.16 ± 2.526 g/dL in Group A and 18.97 ±

2.455 g/dL in Group B, showing a statistically significant difference (p = 0.012). On Day 3, the mean hemoglobin levels increased to 19.02 ± 2.232 g/dL in Group A and 21.95 ± 2.348 g/dL in Group B, with a significant difference (p = 0.029) (Table 2). These findings indicate that delaying UCC to 90 seconds resulted in significantly higher hemoglobin levels compared to 60 seconds. On Day 0, the mean hematocrit levels were 60.63 ± 9.524% in Group A and 64.47 ± 9.035% in Group B, showing a statistically significant difference (p = 0.047). On Day 3, the mean hemoglobin levels were 57.52 ± 9.868% in Group A and 60.15 ± 7.122% in Group B, with a significant difference (p = 0.015) (Table 3). These findings suggest that DCC clamping to 90 seconds resulted in significantly higher hematocrit levels compared to 60 seconds at both time points. In Group A, 8 (17.4%) neonates required phototherapy, compared to 10 (21.7%) in Group B. The remaining 38 (82.6%) in Group A and 36 (78.3%) in Group B were not required. The difference was statistically insignificant (p = 0.500), suggesting that the duration of UCC did not have an influence on phototherapy (Table 4). At 5 minutes, the mean $SPO_2$ levels were 88.20 ± 6.696% in Group A and 89.55 ± 7.568% in Group B, with no statistically significant difference (p = 0.401). At 10 minutes, the mean SPO2 levels were 96.28 ± 2.689% in Group A and 95.43 ± 2.943% in Group B, also showing no significant difference (p = 0.181). These findings indicate that the timing of UCC did not significantly impact SPO2 levels at either time point (Table 5). At 5 minutes, the mean HR was 150.03 ± 16.470 bpm in Group A and 149.30 ± 12.867 bpm in Group B, with no statistically significant difference (p = 0.827). At 10 minutes, the mean HR was 144.05 ± 14.089 bpm in Group A and 143.15 ± 12.349 bpm in Group B, also showing no significant difference (p = 0.762). These results indicate that the timing of UCC did not significantly affect HR at either time point (Table 6). At 5 minutes, the mean body temperature was 36.65 ± 0.770°C in Group A and 36.75 ± 0.670°C in Group B, with no statistically significant difference (p = 0.537). At 10 minutes, the mean body temperature was 37.23 ± 1.097°C in Group A and 37.20 ± 0.723°C in Group B, also showing no significant difference (p = 0.905). These findings indicate that the timing of UCC did not significantly affect body temperature at either time point (Table 7). At 5 minutes, the mean glycaemia level in Group A (60-second DCC) was 78 ± 10 mg/dL, while in Group B (90-second DCC), it was 80 ± 9 mg/dL. The difference between the two groups was not statistically significant ($p$ = 0.153). Similarly, at 30 minutes, the mean glycaemia level increased to 82 ± 9 mg/dL in Group A and 84 ± 8 mg/dL in Group B. Again, this difference was not statistically significant ($p$ = 0.190) (Table 8).

**Table 1: Bilirubin levels among study participants**

| Bilirubin Levels | Group A | | Group B | | P-Value |
|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | |
| Day 0 | 2.49 | 0.745 | 2.64 | 0.653 | 0.215 |
| Day 3 | 13.3 | 1.874 | 13.8 | 2.066 | 0.389 |

**Table 2: Hemoglobin levels among study participants**

| Hemoglobin Levels | Group A | | Group B | | P-Value |
|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | |
| Day 0 | 16.16 | 2.526 | 18.97 | 2.455 | 0.012 |
| Day 3 | 19.02 | 2.232 | 21.95 | 2.348 | 0.029 |

**Table 3: Hematocrit levels among study participants**

| Hematocrit | Group A | | Group B | | P-Value |
|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | |
| Day 0 | 60.63 | 9.524 | 64.47 | 9.035 | 0.047 |
| Day 3 | 57.52 | 9.868 | 60.15 | 7.122 | 0.015 |

**Table 4: Phototherapy requirement among study participants**

| Phototherapy requirement | Group A | | Group B | | P-value |
|---|---|---|---|---|---|
| | N | % | N | % | |
| Neonates requiring Phototherapy | 8 | 17.4 | 10 | 21.7 | 0.500 |
| Neonates not requiring phototherapy | 38 | 82.6 | 36 | 78.3 | |

**Table 5: Oxygen saturation among study participants**

| Oxygen Saturation | Group A | | Group B | | P-Value |
|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | |
| 5 minutes | 88.20 | 6.696 | 89.55 | 7.568 | 0.401 |
| 10 minutes | 96.28 | 2.689 | 95.43 | 2.943 | 0.181 |

**Table 6: Heart rate among study participants**

| Variables | Group A | | Group B | | P-Value |
|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | |
| 5 Minutes | 150.03 | 16.470 | 149.30 | 12.867 | 0.827 |
| 10 Minutes | 144.05 | 14.089 | 143.15 | 12.349 | 0.762 |

**Table 7: Mean body temperature among study participants**

| Variables | Group A | | Group B | | P-Value |
|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | |
| 5 minutes | 36.65 | 0.770 | 36.75 | 0.670 | 0.537 |
| 10 minutes | 37.23 | 1.097 | 37.20 | 0.723 | 0.905 |

**Table 8: Glycaemia among study participants**

| Variables | Group A | | Group B | | P-value |
|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | |
| 5 minutes | 78 | 10 | 80 | 9 | 0.153 |
| 30 minutes | 82 | 9 | 84 | 8 | 0.190 |

## DISCUSSION

Historically, perinatal iron deficiency has not been a primary focus of clinical concern, largely due to the assumption that neonates are unlikely to experience iron deficiency unless maternal anemia is severe [11]. The newborn's iron stores at birth are largely dependent on the amount of iron transferred through the placenta during gestation and on the volume of placental blood received at delivery, both of which are significantly influenced by the timing of UCC [1]. One notable advantage of DCC is the increased transfer of hematopoietic stem cells to the infant, which may contribute to improved outcomes in various hematologic and immunologic conditions. Allowing the cord to remain unclamped until pulsations naturally cease reflects a physiological approach that facilitates optimal placental transfusion [12]. Importantly, this practice has not been linked to adverse outcomes in uncomplicated deliveries. While DCC has been shown to improve outcomes in term neonates compared to immediate clamping, the most effective timing in preterm neonates continues to be an area of ongoing research. DCC is defined as a delay of no less than 30 seconds, in accordance with the ACOG recommendation. This study examines the short-term effects of different lengths of DCC on infant jaundice, the frequency of phototherapy, and initial hematological parameters [13]. Maternal age and gestational age are important demographic and clinical variables that may influence neonatal outcomes. In the present study, maternal age in the 60- second DCC

group averaged 28.78 years, while in the 90-second group it was slightly lower at 28.23 years, consistent with those of Shao et al. [1] and Morales-Allard et al. [14] found nearly identical maternal ages between the 15-second (29.21 years) and 90-second (29.25 years) groups [14].

In the current study, the mean birth weight in the 60-second DCC group was 3.13 kg, while in the 90-second group it was slightly higher at 3.20 kg. Chidre et al. [6] specifically reported no difference in birth weight between ECC & DCC, reinforcing the notion that clamping time does not directly influence fetal weight at birth [6]. The mean Apgar at 1 & 5 minutes were 8 and 9, respectively, for both the 60-second and 90-second DCC groups, with no notable differences observed. These results suggest that extending the duration of CC does not compromise early neonatal adaptation. Chidre et al. [6] found no differences in Apgar between ECC and DCC groups. In the present study, mean total serum bilirubin levels on Day 0 were 2.49mg/dL in the 60-second group and 2.64mg/dL in the 90-second group. These results align with those presented by Chidre et al. [6] and Rashwan et al. [7] who also observed no significant difference in hyperbilirubinemia between ICC and DCC.

On Day 3, the mean hemoglobin levels increased to 19.02 g/dL in Group A and 21.95 g/dL in Group B, with a significant difference ($p = 0.029$). These findings indicate that delaying UCC to 90 seconds resulted in significantly higher hemoglobin levels compared to 60 seconds. Shao et al. [1] and reported elevated hemoglobin levels in the 61–90 second group on Day 1 (205.32g/L) compared to the 30–60 second group (198.94g/L). By Day 3, however, the hemoglobin level was significantly lower in the DCC, possibly reflecting early redistribution or physiological adjustments post-delivery [1]. Jaleel et al. [15] documented a higher mean hemoglobin level in the DCC than in the ECC. Rashwan et al. [7] found In Group A (60 seconds), 8 neonates (17.4%) required phototherapy, whereas in Group B (90 seconds), 10 neonates (21.7%) received phototherapy. The majority in both groups—38 (82.6%) in Group A and 36 (78.3%) in Group B—did not require phototherapy. This difference was not significant, suggesting that extending the duration of UCC to 90 seconds does not significantly impact the incidence of jaundice severe enough to require treatment. These findings are in alignment with Purisch et al. [2] which similarly reported no significant difference in phototherapy requirements between immediate and delayed clamping groups. Oxygen saturation levels were evaluated at two critical intervals—5 and 10 minutes post-birth. At 5 minutes, the average oxygen saturation was 88.20% in the 60-second CC group and 89.55% in the 90-second group, with no statistically significant difference seen. At 10 minutes, the mean SpO2 was 96.28% in Group A and 95.43% in Group B, suggesting that the timing of CC did not significantly affect oxygen saturation at these intervals. These results align with those of Mahmoud et al. who documented SpO2 levels of 97.5% for the 60-second group and 98.4 1.4% for the 90-second group, revealing no significant difference [11]. The mean heart rate at 5 minutes post-birth was 150.03 bpm in Group A (60 seconds) and 149.30 bpm in Group B (90 seconds). At 10-minute mark, the mean heart rate was 144.05 bpm in Group A and 143.15bpm in Group B. The results indicate that the length of UCC did not significantly influence infant heart rate during the immediate postnatal phase. Conversely, Mahmoud et al. [11] documented a markedly elevated heart rate on Day 1 in the 90-second group (159 bpm) compared to the 60-second group (148.3 bpm). The current investigation revealed that it means blood glucose levels of 78 mg/dL in the 60-second group (Group A) and 80mg/dL in the 90-second group (Group B). At 30 minutes, glycaemia marginally rose to 82 mg/dL in Group A and 84 mg/dL in Group B. The data suggest that extending UCC to 90 seconds did not significantly affect early

infant blood glucose levels. Conversely, Mahmoud et al. [11] saw markedly reduced glucose levels in the 90-second group relative to the 60-second group on both Day 1 and Day 3, indicating diversity in outcomes across diverse populations and approaches. The present study corroborates the increasing evidence that DCC, even for 90 seconds, does not increase the incidence of jaundice necessitating phototherapy in infants delivered by elective cesarean section.

## CONCLUSION

DCC to 90 seconds is a simple, reliable, and proficient intervention that significantly enhances early neonatal hematological parameters, such as hemoglobin and hematocrit levels, without increasing the risk of hyperbilirubinemia requiring phototherapy. These hematologic benefits may contribute to improved oxygen delivery and better neurodevelopmental outcomes in term neonates. When compared to clamping at 60 seconds, the 90-second delay offers measurable advantages with no associated adverse effects, supporting its implementation as a standard practice during elective cesarean deliveries.

### *Declaration by Authors*

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**Conflict of Interest:** The authors declare no conflict of interest.

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