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Neonatal and Maternal Outcomes of Immediately versus Delayed Umbilical Cord Clamping in Full Term Caesarean Delivery

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ABSTRACT

Background: Traditionally, early umbilical cord clamping (UCC) part of third-stage labor management, though its optimal timing remains debated. **Objective:** To evaluate maternal and neonatal outcomes of immediate versus delayed cord clamping (DCC) in term cesarean deliveries (CD). **Subjects and Methods:** This randomized clinical study involved 160 pregnant women undergoing elective caesarean delivery at Menoufia University Hospitals and Tala General Hospital. Participants were equally divided into four groups: Group A (immediate cord clamping), Group B (clamping after 30 seconds), Group C (after 60 seconds), and Group D (after 90 seconds).

Results: Fetal Hb, Hct and ferritin at 24 hrs. were significantly higher in group B, group C, and group D compared to group A ($P<0.05$). Fetal bilirubin at 48 hrs. was significantly higher in group B, group C, and group D compared to group A ($P<0.05$), with no significant difference between group C and group D. Fetal Hb, Hct, ferritin and bilirubin at birth were insignificantly different among the studied groups. There was an insignificant difference among the total groups regarding the need for NICU admission and oxygen therapy. **Conclusions:** DUCC is an efficient and safe procedure for full term CD with better neonatal outcomes and the optimal timing of cord clamping is at 60 seconds.

Keywords: Neonatal Outcomes, Maternal Outcomes, Immediately UCC, DUCC, Full Term CD.

INTRODUCTION

The circulatory system in a fetus operates differently from that of an adult. It is specially designed to enable the fetus to obtain oxygen-rich blood and essential nutrients directly from the placenta [(1)]. Following birth, umbilical blood flow persists briefly, facilitating placental transfusion—an increase in neonatal blood volume. Traditionally, early clamping of the umbilical cord is performed as part of active management in the 3rd stage of labor [(2)]. Prior to the mid-1950s, early cord clamping referred to clamping within 1-minute post-birth, while late clamping occurs after 5 minutes. Small studies on neonatal blood volume indicated that 80–100 mL of placental blood transferred within 3 minutes, with up to 90% occurring during the infant's initial breaths [(3)]. In both preterm and strong term infants, the American College of Obstetricians and Gynecologists and American Academy of pediatrics have recommended a DUCC for a minimum of 30 to 60 seconds [(4)]. For healthy term and preterm infants, the Royal College of Obstetricians and Gynecologists advises DUCC for a minimum of two minutes [(5)]. DCC in term infants enhances hemoglobin levels at birth and improves iron stores during early infancy, potentially supporting positive developmental outcomes [(6)].

A potential concern with DCC is the risk of excessive placental transfusion which may increase the risk of polycythemia or jaundice [(7)]. Regarding maternal outcome, DCC clamping was not linked to a heightened risk of postpartum hemorrhage, increased intrapartum blood loss, or significant changes in postpartum hemoglobin levels or need for blood transfusion [(8)].

We can safely delay the cord clamping in healthy new born infant [(9)]. DCC is contraindicated when placental circulation is compromised, including cases of abruption, previa, vasa previa, or cord avulsion. Its clinical importance lies in timing the intervention to optimize benefits for both mother and infant [(10)].

The aim of this work was evaluation of maternal and neonatal outcomes of immediate versus DCC and the optimal timing of clamping in term CD.

SUBJECTS AND METHODS

This prospective, randomized clinical trial included 160 pregnant women scheduled for elective caesarean delivery at the Department of Obstetrics and Gynecology, Menoufia University Hospitals, and Tala General Hospital.

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Inclusion criteria were pregnant females between ages of 20 and 40, full term pregnancy, singleton pregnancy and free of any medical disease.

Exclusion criteria were multiple pregnancies, pregnancy with medical complications, fetal distress, polyhydramnios, oligohydramnios, fetal anomalies, infant with growth retardation and bad Doppler studies, ante partum hemorrhage (placenta previa and abruption placenta), pre-term labor, fetal isoimmunization, chorioamnionitis stained amniotic fluid and hepatitis viruses.

160 patients were randomized into four equal groups at a ratio of 1:1:1:1. Opaque sealed envelopes containing sequential numbers were given to the study patients, according to which each patient was enrolled to one of the four groups: Group A (N=40): the cord was clamped immediately, group B (N=40): the cord was clamped after 30 seconds, group C (N=40): the cord was clamped after 60 seconds and group D (N=40): the cord was clamped after 90 seconds. Data collected included demographics (age, residence, BMI), prenatal care status, substance use, and medical history (e.g., GDM, hypertension, PROM, preeclampsia, macrosomia, IUGR). Assessments involved physical examination, obstetric ultrasound (LOGIC P5, Korea), and routine labs (CBC, liver/kidney function, HCV/HBV screening, ABO/Rh typing). At the participating hospitals, preoperative hemoglobin levels were evaluated using CBC performed prior to delivery. Participants received preoperative antibiotic unictam 1.5 gram.

Caesarean deliveries were performed. A designated research staff member was present in the operating room during each delivery to document intraoperative parameters, including the interval between neonatal delivery and umbilical cord clamping.

Outcomes:

In this study, neonatal and maternal outcomes were evaluated across four groups distinguished by the timing of umbilical cord clamping. Group A underwent immediate cord clamping post-delivery, followed by prompt neonatal bonding and standard stabilization measures, including drying, stimulation, and placement under warmers. Vital parameters were assessed via pulse oximetry and chest-mounted probes at 1, 5, and 10 minutes, with Apgar scores recorded at 1 and 5 minutes. Blood samples from the umbilical cord were collected at birth to measure hematocrit, hemoglobin, bilirubin, and ferritin levels, while neonatal suckling scores were evaluated at four hours using (LATCH) breastfeeding assessment tool. Groups B, C, and D employed delayed cord clamping at 30, 60, and 90 seconds respectively, with newborns placed at placental level on the maternal thigh prior to stimulation. All groups received standardized neonatal monitoring and maternal care. Maternal blood loss during caesarean section was quantitatively assessed by weighing absorbent surgical materials before and after use, applying a 1g ≈ 1mL conversion to enable precise intraoperative tracking [(11)].

Additionally, the volume of blood collected in the suction apparatus was calculated by subtracting the pre-measured amount of amniotic fluid—aspirated prior to placental delivery—from the total suctioned volume recorded following placental expulsion. Intravenous fluids were also administered as part of routine postpartum management. Maternal hemoglobin and hematocrit levels were evaluated on the first postpartum day, and neonatal bilirubin levels were measured 48 hours after birth to assess the potential effects of cord clamping duration. In addition, the requirement for oxygen therapy and admission to the neonatal intensive care unit (NICU) were evaluated.

Ethical approval:

The patients gave their signed, informed permission. The study was carried out with permission from Menoufia University's Faculty of Medicine Ethics Committee (IRB No. and date 1/2023 OBSGN 24). The study adhered to the Helsinki Declaration throughout its execution.

Statistical analysis

We used SPSS Version 28.0 to do the statistical analysis. The data distribution's normality was assessed using histograms and the Shapiro-Wilks test.

The mean and ± SD of quantitative parametric data were displayed, and the one-way ANOVA (F) test was used to analyze the data together with the post-hoc Tukey test. Using the X^2-test, qualitative variables were analyzed and shown as frequency and percentage (%). It was deemed statistically significant when the two-tailed P value was less than 0.05.

RESULTS

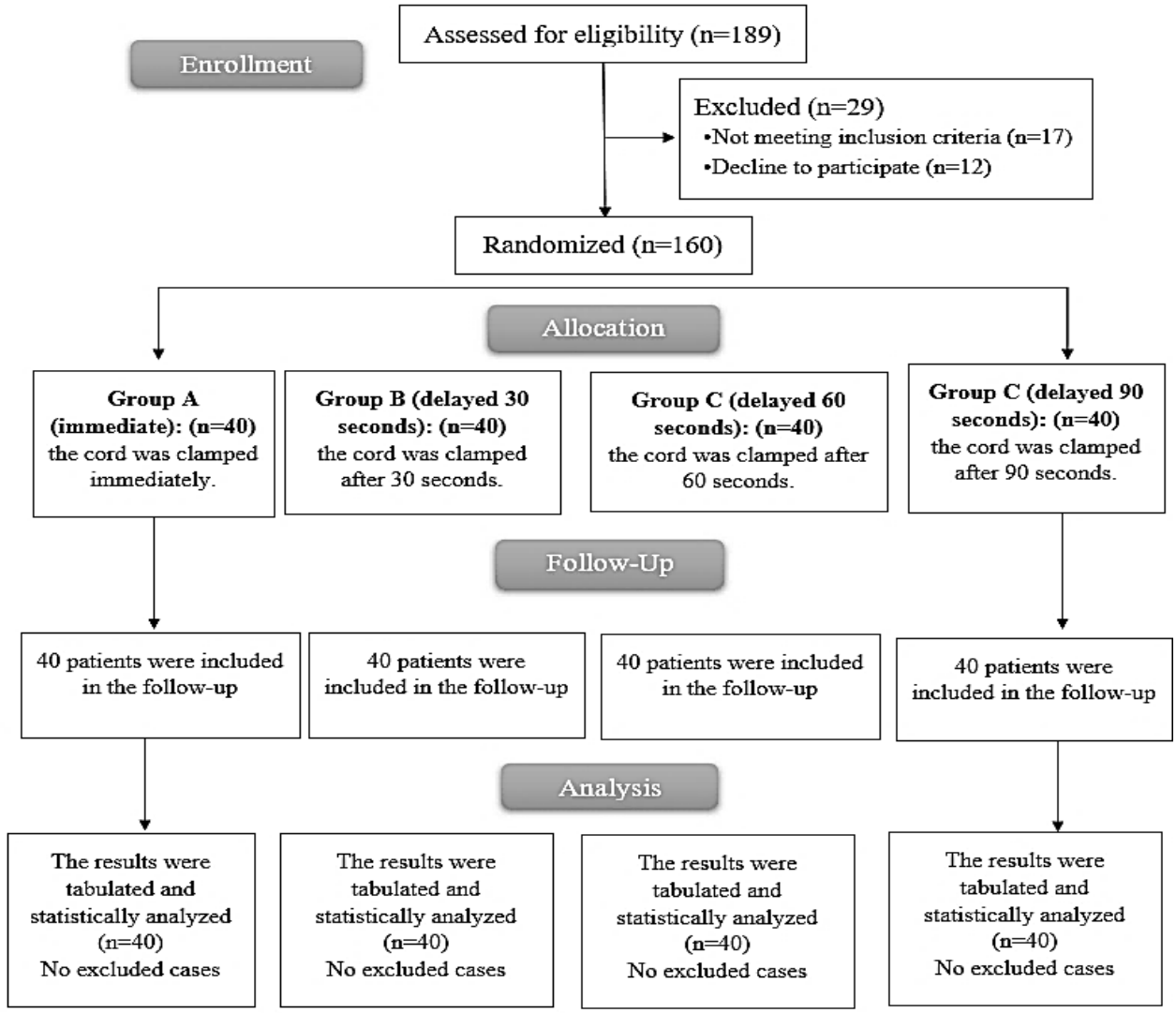

Figure (1): The distribution of the studied patients.

There was an insignificant difference among the studied groups regarding the maternal baseline characteristics (age, sex, weight, height, BMI, occupation, residence, parity). All the studied cases were delivered through CS and were free from any associated comorbidities (hypertension and DM). The neonatal baseline characteristics (gestational age (GA), sex and birth weight) were insignificantly different among the studied groups. There was an insignificant difference among the studied groups regarding the maternal preoperative and at day 1 laboratory examination (Hemoglobin (Hb), Hct), postpartum blood loss and number of patients had postpartum blood loss> 1000 ml.

At 24 hours post-delivery, fetal hemoglobin (Hb), hematocrit (Hct), and ferritin levels were significantly elevated in groups B (30-second delay), C (60-second delay), and D (90-second delay) compared to group A (immediate clamping) ($P<0.05$). Furthermore, groups C and D exhibited significantly higher values than group B ($P<0.05$), while no statistically significant difference was observed between groups C and D. At 48 hours post-delivery, bilirubin levels were significantly elevated in groups B (30-second delay), C (60-second delay), and D (90-second delay) compared to group A (immediate clamping). Furthermore, bilirubin levels were significantly higher in groups C and D relative to group B. No statistically significant difference was observed between groups C and D.

Fetal Hb, Hct, ferritin and bilirubin at birth were insignificantly different among the studied groups **(Table 1)**.

Table (1): Maternal and neonatal baseline characteristics and maternal and fetal laboratory examination and blood loss of the studied groups

		Group A (immediate) (n=40)	Group B (delayed 30 seconds) (n=40)	Group C (delayed 60 seconds) (n=40)	Group D (delayed 90 seconds) (n=40)	P value
Maternal baseline characteristics						
Maternal age (years)		29.3 ± 3.59	29.9 ± 3.86	29.7 ± 3.76	30.6 ± 1.76	0.364
Weight (Kg)		82.9 ± 5.13	80.5 ± 4.68	81.2 ± 3.8	82.7 ± 6.45	0.112
Height (m)		1.6 ± 0.03	1.6 ± 0.04	1.6 ± 0.03	1.7 ± 0.04	0.868
BMI (Kg/m^2)		30.6 ± 2.39	29.8 ± 2.28	30 ± 2.01	30.4 ± 2.82	0.474
Occupation	**Working**	21 (52.5%)	23 (57.5%)	27 (67.5%)	19 (47.5%)	0.314
Residence	**Urban**	24 (60%)	14 (35%)	21 (52.5%)	17 (42.5%)	0.121
	Rural	16 (40%)	26 (65%)	19 (47.5%)	23 (57.5%)	
Parity	**Nullipara**	13 (32.5%)	22 (55%)	19 (47.5%)	23 (57.5%)	0.108
	Multipara	27 (67.5%)	18 (45%)	21 (52.5%)	17 (42.5%)	
Neonatal baseline characteristics						
GA (weeks)		39.7 ± 1.22	39.7 ± 1.34	39.4 ± 1.34	39.6 ± 1.3	0.638
Sex	**Male**	27 (67.5%)	17 (42.5%)	22 (55%)	19 (47.5%)	0.127
	Female	13 (32.5%)	23 (57.5%)	18 (45%)	21 (52.5%)	
Birth weight (gm)		3113.3 ± 222.92	3141.8 ± 186.09	3075 ± 187.15	3137.3 ± 162.61	0.383
Maternal laboratory examination						
Preoperative Hb (g/dL)		11.8 ± 0.98	11.7 ± 0.37	11.8 ± 0.55	11.7 ± 0.64	0.688
Hb at day 1 (g/dL)		10.8 ± 0.92	10.7 ± 0.4	10.8 ± 0.55	10.7 ± 0.65	0.446
Decrease in Hb (g/dL)		0.98 ± 0.25	0.99 ± 0.09	1.03 ± 0.19	1.01 ± 0.1	0.508
Postpartum blood loss (ml)		837.5 ± 153.1	895 ± 125.98	845 ± 160.05	832.5 ± 159.14	0.225
Postpartum blood loss> 1000 ml		2 (5%)	3 (7.5%)	1 (2.5%)	1 (2.5%)	0.650
Preoperative Hct (%)		34.2 ± 1.69	34.4 ± 1.17	34.5 ± 0.72	34.2 ± 1.01	0.525
Hct at day 1 (%)		32.9 ± 1.33	32.8 ± 1.38	33.3 ± 0.6	32.9 ± 1.18	0.242
Fetal laboratory examination						
Fetal Hb (g/dL)	**Fetal Hb at birth (g/dL)**	18.8 ± 2.06	18.9 ± 1.66	19 ± 1.4	19.6 ± 1.59	0.144
	Fetal Hb at 24 hrs. (g/dL)	14.9 ± 2	16.1 ± 2.03	17.5 ± 1.86	18.1 ± 1.76	**<0.001***
	Post hoc	**P1=0.010*, P2<0.001*, P3<0.001*, P4<0.001*, P5<0.001*,** P6=0.145				--
Fetal Hct (%)	**Fetal Hct at birth (%)**	57.8 ± 6.85	58.7 ± 6.43	60.3 ± 6.11	61.04 ± 7.29	0.121
	Fetal Hct at 24 hrs. (%)	37.4 ± 8.66	41.6 ± 9.76	46 ± 8.98	46.9 ± 8.19	**<0.001***
	Post hoc	**P1=0.048*, P2<0.001*, P3<0.001*, P4=0.037*, P5=0.009*,** P6=0.638				--
Fetal ferritin (ng/mL)	**Fetal ferritin at birth (ng/mL)**	94.3 ± 8.48	106.5 ± 8.24	109.2 ± 6.43	110.7 ± 6.16	0.354
	Fetal ferritin at 24 hrs. (ng/mL)	94.8 ± 9.58	115.9 ± 7.33	117.7 ± 5.86	119.5 ± 4.61	**0.047***
	Post hoc	**P1=0.033*, P2=0.019*, P3=0.011*,** P4=0.856, P5=0.729, P6=0.859				--
Fetal bilirubin (mg/dL)	**Fetal bilirubin at birth (mg/dL)**	1.51 ± 0.4	1.28 ± 0.1	1.44 ± 0.1	1.42 ± 0.16	0.322
	Fetal bilirubin at 48 hrs. (mg/dL)	9.5 ± 0.64	10.9 ± 0.95	11.6 ± 1.24	11.7 ± 1.17	**<0.001***
	Post hoc	**P1<0.001*, P2<0.001*, P3<0.001*, P4=0.004*, P5=0.001*,** P6=0.732				

Data is presented as mean ±SD or frequency. BMI: body mass index. Hb: hemoglobin, Hct: hematocrit. *: significant as P value ≤ 0.05, P1: p value between groups A&B, P2: p value between groups A&C, P3: p value between groups A&C, P4: p value between groups B&C, P5: p value between groups B&D, P6: p value between groups C&D.

Apgar score at 1 and 5 min was insignificantly different among the studied groups. Oxygen saturation at 1, 5 and 10 min was significantly higher in group B (delayed 30 seconds), group C (delayed 60 seconds) and group D (delayed 90 seconds) compared to group A (immediate), was significantly higher in group C (delayed 60 seconds) and group D (delayed 90 seconds) compared to group B (delayed 30 seconds), with no significant difference between group C (delayed 60 seconds) and group D (delayed 90 seconds). LATCH score was significantly higher in group B (delayed 30 seconds), group C (delayed 60 seconds) and group D (delayed 90 seconds) compared to group A (immediate), was significantly higher in group C (delayed 60 seconds) and group D (delayed 90 seconds) compared to group B (delayed 30 seconds), with no significant difference between group C (delayed 60 seconds) and group D (delayed 90 seconds) (**Table 2).**

Table (2): Apgar score, neonatal oxygen saturation and LATCH score of the studied groups

		Group A (immediate) (n=40)	Group B (delayed 30 seconds) (n=40)	Group C (delayed 60 seconds) (n=40)	Group D (delayed 90 seconds) (n=40)	P value
Apgar score 1 min		5.1 ± 2.49	5.2 ± 2.57	5.4 ± 2.53	5.2 ± 2.19	0.956
Apgar score 5 min		8.4 ± 1.1	8.5 ± 0.68	8.5 ± 0.72	8.8 ± 0.66	0.129
Neonatal oxygen saturation						
Oxygen at 1 min	**Oxygen at 1 min**	60.1 ± 3.96	69.9 ± 4.77	74.4 ± 5.36	75.7 ± 5.83	**<0.001***
	Post hoc	**P1<0.001*, P2<0.001*, P3<0.001*, P4<0.001*, P5<0.001*,** P6=0.293				
Oxygen at 5 min	**Oxygen at 5 min**	72.2 ± 5.23	76.3 ± 6.93	80.9 ± 6.27	83.1 ± 7.4	**<0.001***
	Post hoc	**P1=0.004*, P2<0.001*, P3<0.001*, P4=0.002*, P5<0.001***, P6=0.170				
Oxygen at 10 min	**Oxygen at 10 min**	91.2 ± 2.65	94.2 ± 1.44	95.3 ± 1.73	95.2 ± 1.47	**<0.001***
	Post hoc	**P1<0.001*, P2<0.001*, P3<0.001*, P4=0.003*, P5=0.005***, P6=0.728				
LATCH score						
LATCH score		6.7 ± 0.72	7.3 ± 0.46	7.55 ± 0.5	7.58 ± 0.5	**<0.001***
Post hoc		**P1<0.001*, P2<0.001*, P3<0.001*, P4= 0.024*, P5=0.012*,** P6= 0.824				
Good 8:10		13 (32.5%)	19 (47.5%)	21 (52.5%)	26 (65%)	**0.002***
Moderate 4:7		21 (52.5%)	8 (20%)	10 (25%)	12 (30%)	
Poor 0:3		6 (15%)	13 (32.5%)	9 (22.5%)	2 (5%)	

Data is presented as mean ±SD or frequency. *: statistically significant as P value <0.05, P1: p value between groups A&B, P2: p value between groups A&C, P3: p value between groups A&C, P4: p value between groups B&C, P5: p value between groups B&D, P6: p value between groups C&D. LATCH: Latch, Audible Swallowing, Type of Nipple, Comfort, and Hold.

Regarding the neonatal outcomes, there were 2 (5%) neonates in group A, 3 (7.5%) neonates in group B, 2 (5%) neonates in group C and 1 (2.5%) neonate in group D, had need for NICU admission, and there were 6 (15%) neonates in group A, 4 (10%) neonates in group B, 3 (7.5%) neonates in group C and 1 (2.5%) neonate in group D, had need for oxygen therapy. Neonatal death was not observed in our study. There was an insignificant difference among the studied groups regarding the need for NICU admission and oxygen therapy **(Table 3).**

Table (3): Neonatal outcomes of the studied groups

	Group A (immediate) (n=40)	Group B (delayed 30 seconds) (n=40)	Group C (delayed 60 seconds) (n=40)	Group D (delayed 90 seconds) (n=40)	P value
Need for NICU admission	2 (5%)	3 (7.5%)	2 (5%)	1 (2.5%)	0.788
Need for oxygen therapy	6 (15%)	4 (10%)	3 (7.5%)	1 (2.5%)	0.254
Neonatal death	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1.000

DISCUSSION

The optimal timing of UCC in term newborns remains a subject of ongoing debate in obstetric practice. As a routine component of both active and passive management of the 3rd stage of labor, cord clamping raises important questions regarding its impact on neonatal outcomes. This warrants further investigation into how varying clamping intervals may influence short- and long-term neonatal health [12].

There was an insignificant difference among the studied groups regarding the maternal characteristics (maternal age, weight, height, BMI, occupation, residence, parity). All the studied cases were delivered through CS and were free from any associated comorbidities (gestational hypertension and DM).

In the same line, a randomized controlled trial of **Ofojebe *et al.*** [13] found that both groups' participants shared comparable sociodemographic and clinical traits; the mothers' mean age, mean parity, and mean GA were comparable (p>0.05).

The neonatal characteristics (GA, sex and birth weight) were insignificantly different among the studied groups.

In difference with our findings, **Mercer *et al.*** [14] included 15 trials and found that the late cord clamping resulted in a considerably greater mean birthweight than the early one.

There was an insignificant difference among the studied groups regarding the maternal preoperative and at day 1 laboratory examination (Hb, Hct), postpartum blood loss and number of patients had postpartum blood loss > 1000 ml.

Also, **Purisch *et al.*** [15] randomized clinical trial confirmed that when compared to instantaneous cord clamping, maternal blood loss was not enhanced by DCC for 60 seconds during planned term CD.

In coherence with the previous findings, a Jordanian study by **Mohammad *et al.*** [16] investigated the effects of early UCC versus delayed clamping on maternal and newborn outcomes, they discovered that the groups did not vary in terms of the women' hemoglobin levels 12 hours after giving delivery.

Fetal Hb, Hct and ferritin at 24 hrs were significantly higher in group B (delayed 30 seconds), group C (delayed 60 seconds), and group D (delayed 90 seconds) compared to group A (immediate) (P<0.05) Furthermore, groups C and D exhibited significantly higher values than group B (P < 0.05). Bilirubin at 48 hrs. was significantly higher in group B (delayed 30 seconds), group C (delayed 60 seconds), and group D (delayed 90 seconds) compared to group A (immediate), Furthermore, bilirubin levels were significantly higher in groups C and D relative to group B (P = 0.004 and P = 0.001, respectively) with no significant difference between group C (delayed 60 seconds) and group D (delayed 90 seconds).

In agreement, a randomized controlled trial of **Ofojebe *et al.*** [13] found that, at 48 hours of delivery, the delayed clamping group had a substantially higher mean hemoglobin concentration than the immediate clamping group (16.51±1.71 g/dl vs 15.16±2.27 g/dl; p<0.001). However, they discovered that overall mean bilirubin concentration was not substantially different (3.88±1.54 mg/dl vs 3.71±1.20 mg/dl; p=0.380), which contradicts our findings.

In difference, **Mohammad *et al.*** [16] found that after 12 hours and on day three of delivery, there were no changes in the groups' newborn bilirubin levels.

Oxygen saturation at 1, 5 and 10 min was significantly higher in group B (delayed 30 seconds), group C (delayed 60 seconds) and group D (delayed 90 seconds) compared to group A (immediate) (P<0.05). Oxygen saturation was significantly higher in group C (delayed 60 seconds) and group D (delayed 90 seconds) compared to group B (delayed 30 seconds) (P<0.05), with no significant difference between group C (delayed 60 seconds) and group D (delayed 90 seconds).

LATCH score was significantly higher in group B (delayed 30 seconds), group C (delayed 60 seconds) and group D (delayed 90 seconds) compared to group A (immediate), was significantly higher in group C (delayed 60 seconds) and group D (delayed 90 seconds) compared to group B (delayed 30 seconds) (P=0.024, 0.012), with no significant difference between group C (delayed 60 seconds) and group D (delayed 90 seconds).

LATCH score grades were significantly different among the studied groups, with higher prevalent of good scores in delayed clamping groups compared to group A, indicating that better LATCH score is significantly associated with DCC.

Regarding the neonatal outcomes, there were 2 (5%) neonates in group A, 3 (7.5%) neonates in group B, 2 (5%) neonates in group C and 1 (2.5%) neonate in group D, had need for NICU admission, and there were

6 (15%) neonates in group A, 4 (10%) neonates in group B, 3 (7.5%) neonates in group C and 1 (2.5%) neonate in group D, had need for oxygen therapy.

In our study, there was an insignificant difference among the studied groups regarding the need for NICU admission and oxygen therapy. Apgar score at 1 and 5 min was insignificantly different among the studied groups. Neonatal death was not observed.

In agreement, a Jordanian study by **Mohammad *et al.*** [16] found that Apgar scores at 1 and 5 minutes and NICU admission did not differ between early and DCC.

In disagreement with our findings, a study by **Fogarty *et al.*** [17] stated that delayed clamping did not lower the rate of intubation for mechanical ventilation or resuscitation, although it did lower the rate of poor Apgar scores at one minute but not at five.

However, a trial by **Mohammad *et al.*** [16] observed that early cord clamping was linked to a higher demand for oxygen treatment in neonates. This study was conducted in Jordan.

A previous study by **Herold *et al.*** [12] supported our study aim and hypothesis and confirmed that for term infants, DUCC should be carried out. To better understand the physiological timing of UCC in term infants, which has the similar benefits as DCC, more study is required.

This study possesses several notable strengths. Foremost, its prospective and randomized design contributes to a reduced risk of selection bias and enhances the reliability of the findings. The comparative nature of the research, including three distinct groups of DCC rather than a simple early versus delayed groups, adds further strength to the study design. Additionally, the targeted focus on neonates born via elective CS addresses an often-underrepresented population in the literature. The assessment of objective laboratory parameters strengthens the validity of the outcomes. Importantly, the practical relevance of the findings has already been reflected in the adaptation of local clinical protocols, where DCC is now implemented during planned caesarean deliveries.

The limitations of the study were that the relatively small sample size may limit the generalizability of the findings and reduce the statistical power to detect subtle effects, the investigation was confined to short-term outcomes, with no assessment of long-term parameters such as iron concentration or neurodevelopmental trajectories during childhood, and these long-term outcomes represent important areas for future research, given their potential implications for sustained child health and development.

CONCLUSION

DUCC is an efficient and safe procedure for full term CD with better neonatal outcomes and the optimal timing of cord clamping is at 60 seconds.

Therefore, we recommend utilizing DUCC for in term CD compared to immediate cord clamping, conducting same study aim and methodology on larger sample size and evaluating the variable for longer follow up periods.

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