ABENHA MEDICAL JOURNAL bmj
Print ISSN 1110-208X
Online ISSN 2357-0016

Original article

Influence of Cord Clamping Time on First Breath, Heart Rate and Oxygen Saturation throughout Neonatal Resuscitation

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Received: 20 November 2022

Accepted:1 April 2023

Abstract

Background: Prolonged cord clamping allows more time to transmission of fetal blood in the placenta to the baby during birth. **The study aimed to** define the influence of neonatal cord clamping time on first breath, oxygen saturation and heart rate throughout neonatal resuscitation as well as its relationship to clinical outcome. **Methods:** This study included 130 neonates, divided into 2 groups: Group I: the neonates were subjected to delayed cord clamping after 2 minutes (the intervention group). Group II they were subjected to immediate cord clamping (the control group). **Results:** Both groups differed significantly in the oxygen saturation ($p<0.001$), with group I higher values of 1st minute (89.51 ± 2.23 *vs.* 85.15 ± 3.33), 5th minute (93.75 ± 2.3 *vs.* 91.55 ± 2.78), and 10th minute (96.71 ± 2.22 *vs.* 95.03 ± 3.04) saturation, Both groups differed significantly in the heart rate ($p<0.001$), with group I lower values of 1st minute (118.29 ± 8.93 bpm *vs.* 132.88 ± 9.63 bpm), 5th minute (133.29 ± 6.81 bpm *vs.* 146.6 ± 9.33 bpm), the 10th minute (151.06 ± 8.66 bpm *vs.* 140.72 ± 7.6 bpm) heart rate. In respect of Apgar score or NICU admission, there wasn't any statistically significant difference in either of the 2 groups. **Conclusion:** In the first, fifth, and tenth minutes, DCC had highest oxygen saturation and lower heart rates.

Keywords: timing; cord; clamping; neonatal; resuscitation

Introduction

The transmission from fetal into neonatal circulation during birth is governed by two essential physiological processes: the start of breathing and the shift away from reliance on umbilical cord blood flow **(1).**

During the intrauterine life cardiac output from the fetus's right ventricle passes from the major pulmonary artery to a descending aorta through the ductus arteriosus, bypassing the lungs. As a result, blood bypasses the

pulmonary circulation and flows constantly into the systemic circulation via the ductus arteriosus as right-to-left shunting (**2**).

The disruption of the umbilical venous blood flow occurs during the umbilical cord clamping, as a result of which the preload is interrupted on the left ventricle and hence cardiac output. With the start of lung aeration, the cardiac output increases and pulmonary blood flow increases the venous return and left ventricular preload and possibly the right ventricle through the foramen oval (**1**). When the umbilical cord is clamped after an increase in pulmonary blood flow, the supplies of ventricular preload can transfer from umbilical to pulmonary venous returns with no reduction of supply (**2**).

The advantage of delaying cord clamping is that it allows enough time for such passage of fetal blood as from placenta towards the infant's circulation at the moment of birth. As a result, the newborn might receive an additional 40% greater blood volume. (**3**). The amount of blood passed to the newborn is mostly determined by when the cord was clamped and how the infant is handled before clamping, taking into account the height either above or below the placenta or the mother's heart (**4**).

With this increment of the placental transfusion, neonatal benefits take place including higher hemoglobin concentrations, rich iron stores and low risk of anemia in infancy and better cardiopulmonary adaptation (**5**). Furthermore, delayed cord clamping is linked to improved newborn developmental milestones till the age of four (**6**).

The purpose of this research was to determine whether timing cord clamping affected first breath, oxygen saturation, and heart rate in newborns during neonatal resuscitation, as well as their relevance to clinical results. The initial outcome was the time of initiation of normal breathing in both groups.

The secondary outcomes were the difference between both groups in the oxygen saturation, heart rate, respiratory rate, Apgar score, and the need for NICU admission.

Subjects and methods

This randomized controlled study was performed at the Benha University Hospital in the period from January2021 to December 2021. This study included 130 neonates selected from those attending the delivery unit of Benha University Hospital. The recruited neonates were divided in to 2 groups:

- **Group I** (DCC): subjected to delayed cord clamping after 2 minutes
- **Group II** (ECC): subjected to immediate cord clamping.

The research was carried out in conformity with ethical standards derived from the Helsinki Declaration. The investigation was carried out with the approval of the ethical committee of Faculty of medicine, Benha University (MS.17.10.2020). Before initiation of any study-related procedures, informed written consents were obtained from the neonates' mothers, after thorough explanation of the study design and aims. The mothers were promised that their involvement was entirely voluntary and that they might withdraw at any time.

The current study included full term and late preterm neonates. Both genders were

enrolled. Neonates with congenital anomalies, Rh-incompatibility, or where multiple gestations were excluded from the study. We also left out non-breathing neonates; as if the breathing did not occur within 30 seconds, the standard protocol for resuscitation will be provided. In addition, the neonates underwent stimulation or bag-and-mask ventilation, as well as neonates of a mother with chronic illness were also excluded.

Sample size:

Power and Sample size calculations software version 3.0 was used to compute sample size. A total sample size of 54 per group were enough to identify an 80% power and 5% level of significance. This number was increased to 65 subjects per group.

Randomization and blinding

The sequence generation for the participants' numbers was done by using computer software (Microsoft Excel). One hundred thirty numbers were produced and dispersed at random in a table on an Excel document, with a letter (C) for control and (I) for intervention put in front of each number. The random allocation sequence was done 10 minutes before the delivery and the sequence table was kept with a co-investigator. Each neonate was given a number from 1 to 130 after being confirmed eligible for the study. Based on this number the neonate was then allocated into intervention or control group after contacting the coinvestigator and asking about which group the number stands for. The blinding was not achieved because of the nature of the intervention.

The intervention

For the interventional group, DCC was accomplished by cord clamping 120 seconds after the child was delivered. Instantaneous cord clamping was performed as soon as feasible in the second group. During the waiting period, neonates who undergone DCC were kept on their mother's abdomen.

Neonatal characteristics

Data regarding the mode of delivery, gestational age, birth weight, fetal sex, and NICU admission were obtained. The time between the baby's entire birth and the first umbilical cord clamp was calculated using a stopwatch, and the following data were collected: The time of initiation of spontaneous breathing; A pulse oximetry sensor was placed on the newborn's right hand, and the oxygen saturation was recorded at 1, 5, and 10 minutes; we also assessed the heart rate continuously from birth to 10 minutes, then the measures at 1, 5 and 10 minutes were recorded; The respiratory rate; The Apgar score was taken at 1 and 5 min using the stop watch; Finally, follow up for all cases 2 hours after resuscitation, searching for any degree of respiratory distress and need neonatal intensive care unit admission or not.

Statistical analysis

The data obtained was reviewed, coded, tabulated, and transferred to a PC where it was analyzed with the IBM SPSS software program version 20.0. **(**Armonk, NY: IBM Corp**)**. The Chi-square test was used for categorical variables, to compare between different groups. If more > 20% of the cells had less than 5 predicted, Fisher's Exact was

employed to adjust the chi-square. For regularly distributed quantitative data, the student t-test was applied, to compare between two studied groups. To compare different groups with abnormally distributed quantitative data, the Mann Whitney test was utilized. The significance of the obtained results was judged at the 5% level.

Results

This study included 130 neonates who were selected from those attending the delivery unit of Benha University Hospital. They are separated into two groups, 65 in each: one for delayed cord clamping (group I) and one for immediate cord clamping (group II). In terms of demographic and clinical features, both groups were equivalent in baseline data **table 1**, which demonstrates no significant distinction among the 2 groups.

There wasn't a significant statistical difference between the two groups in the time of initiation of the first breath, with a mean of 2.03 ± 1.12 in group I and a mean of 2.03 ± 1.05 in group II (p=0.1). Both groups differed significantly in the oxygen saturation (p<0.001), with group I higher values of 1st minute (89.51 ± 2.23 *vs.* 85.15 ± 3.33), 5th minute (93.75 ± 2.3 *vs.* 91.55 ± 2.78), and 10th minute (96.71 ± 2.22 *vs.* 95.03 ± 3.04) saturation, **table 2**.

Both groups differed significantly in the heart rate (p<0.001), with group I lower values of 1st minute (118.29 ± 8.93 bpm *vs.* 132.88 ± 9.63 bpm), 5th minute (133.29 ± 6.81 bpm *vs.* 146.6 ± 9.33 bpm), and 10th minute (151.06 ± 8.66 bpm *vs.* 140.72 ± 7.6 bpm) heart rate, **table 3**.

The Apgar score is shown in Table 4, and There weren't any statistically significant findings between the two sets in the first minute score (with a median of 7 in both groups) and the fifth minute score (with a median of 9 in group I and 8 in group II) (p = 0.5 and 0.1, respectively), **table 4**

There wasn't a significant difference between the two groups in terms of NICU admission percentages, which were 7.7% in group I and 9.2% in group II (p = 0.8), as illustrated in **figure 1**.

Table (1): Comparison of study groups regarding general characters

		Delayed cord clamping (n=65)		**Immediate cord clamping (n=65)**		**Test of sig.**	**p-value**
		Mean	SD	Mean	SD		
Gestational age (weeks)		37.15	2.36	37.18	2.30	0.1	0.5
Birth weight (Kg)		2.94	.57	2.89	.62	0.5	0.3
Head circumference (cm)		32.88	1.31	32.85	1.57	0.1	0.5
		N	%	N	%		
Sex	female	36	55.4	34	52.3	0.1	0.7
	male	29	44.6	31	47.7		
Method of delivery	CS	53	81.5	56	86.2	0.5	0.5
	NVD	12	18.5	9	13.8		

Table (2): Comparison of study groups regarding first breath and Oxygen saturation

		Delayed cord clamping (n=65)		Immediate cord clamping (n=65)		Test of sig.	p-value
		Mean	S.D	Mean	S.D		
Time of initiation of the 1st breath		2.03	1.12	2.03	1.05	0.9	0.1
Oxygen saturation (%)	1st minute	89.51	2.23	85.15	3.33	8.8	<0.001*
	5th minute	93.75	2.30	91.55	2.78	4.9	<0.001*
	10th minute	96.71	2.22	95.03	3.04	3.6	<0.001*
Respiratory rate (breath/ min)		52.46	6.81	53.37	7.94	0.7	0.2

Table (3): Comparison of study groups regarding heart rate

	Delayed cord clamping (n=65)		Immediate cord clamping (n=65)		Test of sig.	p-value
	Mean	S.D	Mean	S.D		
1st minute	118.29	8.93	132.88	9.63	8.9	<0.001*
5th minute	133.29	6.81	146.60	9.33	9.3	<0.001*
10th minute	151.06	8.66	140.72	7.60	7.2	<0.001*

Table (4): Comparison of study groups regarding Apgar score

	Delayed cord clamping (n=65)		Immediate cord clamping (n=65)		Test of sig.	p-value
	Median	Range	Median	Range		
1st minute	7	5-8	7	5-8	0.7	0.5
5th minute	9	6-10	8	7-10	1.5	0.1

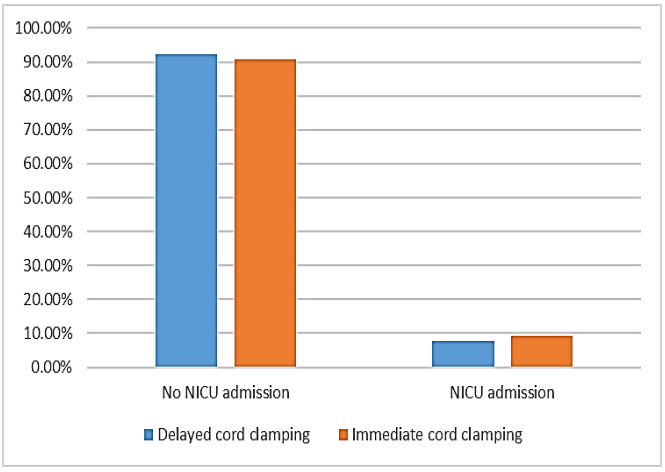

Figure 1: Comparison of study groups regarding the incidence of NICU admission

Discussion

The objectives of this research were to evaluate the influences of early vs delayed cord clamping in newborns, we noticed that newborns who had delayed cord clamping had considerably higher oxygen saturation and lower heart rates throughout the first, fifth, and tenth minutes. A probable explanation for this finding would be that delayed cord clamping improved blood volume, pulmonary circulation, and cardiac output, allowing for higher oxygen delivery to tissues and reducing the requirement for resuscitation treatments. The advantages with delayed cord clamping would be that the infant's hemodynamics would be stabilized (**7, 8**). In accordance with our findings, (**2**) assigned newborn children to cord clamping at 180 or 60 seconds after delivery. The primary results were changes in oxygen saturation and heart rate through the first ten minutes, as well as time for spontaneous breathing. Oxygen saturation was significantly higher at 1 minute (+18%), 5 minutes (+13%), and 10 minutes (+10%) in the group with delayed cord clamping. At 1, 5, and 10 minutes, the oxygen saturation ratios with in DCC group of (**2**) were 79.8%, 91.2%, and 98.0%, which were similar to the values reported in our study (89.51%, 93.75%, and 96.71%). Andersson (**8**) assigned children delivered vaginally to one of two cord clamping groups. HR was substantially higher in the early clamping group. Furthermore, (**9, 10**) confirmed our findings of enhanced oxygen saturation and decreased heart rate with in DCC group within the first ten minutes of birth.

Concerning the Apgar score assessment in the current work, there were no statistically significant differences between the 2 groups in either the 1st minute score (with a median of 7 in both groups), and the 5th minute (with a median of 9 in group I and 8 in group II) scores. Also, there was a comparable outcome of the 2 groups with NICU admission percentage of 7.7% in group I and 9.2% in group II. The lack of differences in Apgar scores and NICU admission among groups may, however, be related to excluding babies who needed immediate resuscitation from the study. Moreover, this result may also be due to excluding preterm babies.

In this context, (**11**) it was observed that DCC was accompanied with a trend toward lower 1-min Apgar scores but not 5-min Apgar scores. But most of the studies, in line with the current study, provided the evidence that there were no significant differences in Apgar scores and the frequency of events during delivery room resuscitation or the number of infants requiring resuscitation in infants between the groups that had their cords clamped early and those that had their cords fastened late **(12-17)**.

Finally, this study provided new evidence about the benefit effects of DCC. However, this study was limited as it was a single

center study, with a relatively small sample size which didn't allow for a better analysis, also due to lack of follow-up period. So, we recommend a larger sample size study with multicenter cooperation to validate our results, future studies should provide more follow up period.

Conclusion

DCC had greater oxygen saturation and lesser heart rates throughout the first, fifth, and tenth minutes. In the first and fifth minutes, Apgar values did not show any statistically significant difference between the two groups. Furthermore, the proportion of NICU admissions was comparable in both groups.

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To cite this article: Effat H. Assar, Tariq M. Khattab, Eman E. ElGammal, Shaimaa R. Abdelmaksoud. Influence of Cord Clamping Time on First Breath, Heart Rate and Oxygen Saturation throughout Neonatal Resuscitation. BMFJ 2024;41(pediatrics):51-58.