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Effects of early umbilical cord clamping versus delayed clamping on maternal and neonatal outcomes: a Jordanian study

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ABSTRACT

Objective: To compare the effects of early versus delayed cord clamping of term births on maternal and neonatal outcomes.

Method: A quasi-experimental study was conducted at the Jordan University Hospital in Amman. One hundred twenty-eight mothers expecting a full-term singleton baby were assigned to delayed cord clamping (90 seconds) or early cord clamping (<30 seconds).

Results: Delayed cord clamping was associated with higher hemoglobin levels among newborns after 12 hours. On the other hand, early cord clamping was associated with an increased need for oxygen therapy among newborns and occurrence of postpartum hemorrhage among mothers. There were no differences between the groups on any other variable (Apgar score at 1 and 5 minutes, admission to NICU, baby bilirubin levels after 12 hours and day 3 of birth, and mothers' Hb levels after 12 hours of childbirth).

Conclusion: Term babies receiving delayed cord clamping had improved hemoglobin levels with no adverse effect on other maternal and neonatal variables. Creating evidence-based practice guidelines for umbilical cord clamping in Jordanian hospitals is essential to improve neonatal and maternal health.

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Introduction

The ideal time for umbilical cord clamping has been debated amongst maternal health professional for decades [1,2]. In countries where birthing units have a policy of active management of the third stage of labor, immediate umbilical cord clamping is a routine practice [1–3]. Immediate clamping of the umbilical cord originally aimed to prevent respiratory depression in newborns through the transfusion of anesthesia drugs from a mother to her baby [1,2]. The World Health Organization (WHO) now no longer supports early cord clamping as part of the active management of the third stage of labor because evidence suggests no effect on the prevention of postpartum hemorrhage (PPH) [4]. In 2014, WHO recommended delayed cord clamping for all births while starting newborn care, with early clamping recommended if the newborn requires immediate and advanced resuscitation [5]. The National Institute for Health and Care Excellence [6] also recommends leaving the umbilical cord intact for at least 1 minute unless the heart rate

of the baby is less than 60 beats per minute. Similarly, the International Liaison Committee on Resuscitation, American Heart Association, and American Academy of Pediatrics all recommend delayed clamping from 30 to 60 seconds for both term and preterm newborns [7].

After childbirth, blood continues to flow in the umbilical arteries from the neonate to the placenta for around 20–25 seconds [2,8,9]. In the umbilical vein, blood continues to flow from the placenta to the infant for up to 3 minutes after childbirth [8,9]. If umbilical cord clamping is delayed, placental transfusion continues and represents 1/4–1/3 of newborn blood volume (83–110 ml or 24–32 ml/kg of birth weight) [8–10]. The potential disadvantage of early cord clamping relates to the increasing risk of fetomaternal transfusion [11]. This is because early cord clamping forces blood back to the placenta and increases the risk of a D-antigen (rhesus) negative mother being sensitized to her D-positive newborn [12].

Delayed cord clamping allows more time for placental transfusion which in turn protects the newborn from anemia without increased risk of jaundice [11,13–15]. Furthermore, infants gain protected time for adjustment because circulation from the placenta continues for a few minutes after birth and the newborn continues to obtain oxygen through the umbilical cord [11,15]. Delayed cord clamping also has positive effects on mothers such as decreasing the occurrence of red blood cell alloimmunization without any negative consequences such as PPH, manual removal of the placenta, and prolonging the third stage of labor [13]. Disadvantages of delayed cord clamping include increased risk of polycythemia and transient tachypnea of the newborn infant which may occur due to delayed absorption of lung fluid caused by an increase in blood volume [11].

Anemia has been recognized as a major public health problem affecting childbearing women in developing countries [16]. The most common type is iron-deficiency anemia which occurs worldwide [16]. Infants are also vulnerable to iron-deficiency anemia because of their increased iron requirements during times of rapid growth, particularly in the first 2 years of life. Infants with iron-deficiency anemia are more likely to have delayed psychomotor development. Iron supplementation incurs costs for the family and can contribute to food intolerances [5]. In Jordan, iron-deficiency anemia is high among infants aged 6–8 months (30.9%) and among those aged 9–11 months (34.6%) [17].

Delayed cord clamping is not universally accepted as around 2/3 of birthing units in developed and developing countries routinely practice early clamping [3,18]. This resistance to change practice requires further research to investigate the effects of delayed versus early clamping on mothers and neonates and provide local evidence to improve the knowledge of health care providers. The proposed study was the first in Jordan, to evaluate the effect of early versus delayed cord clamping on maternal and neonatal outcomes.

Materials and methods

Study design

A quasi-experimental design was used.

Study population

The target population was all birthing women who attended the birthing room in the Jordan University

Hospital, could speak and read Arabic, were aged between 18 and 45 years, primi or multigravida, had a normal pregnancy without complications, carrying a singleton full-term fetus, vertex presentation, expected a normal vaginal birth, had a fetus within normal weight ranges and no congenital abnormalities. Mothers were excluded from the study if they had Rh^{-ve} blood group, had a previous history of PPH, prolonged or complicated labor, a forceps or vacuum delivery, problems with the umbilical cord (node or cord around the neck), and a baby requiring immediate resuscitation or had a previous baby with hyperbilirubinemia.

Sample size

Using a power level of 0.8, medium effect size and significance level of 0.05, the required sample size was 128 women [19].

Instruments

Sociodemographic details

The sociodemographic form contained six items related to the mothers' age, level of education, occupation, blood group, gravidity (number of pregnancies), and parity (number of live births).

Maternal outcomes

Two items were assessed and included the occurrence of PPH (yes/no) and mother's Hb level after 12 hours of childbirth assessed by an electronic portable hemoglobinometer (Hemocue 201+).

Neonatal outcomes

Neonatal outcomes included Apgar scores at 1 and 5 minutes after birth, need for oxygen therapy (yes/no), Hb level at 12 hours of age measured by Hemocue 201+, bilirubin level at 12 hours of age measured by a noninvasive transcutaneous bilirubinometer (Bilichek), bilirubin level at Day 3 of life measured from a venous sample, and admission to the Neonatal Intensive Care Unit (NICU) (yes/no).

Procedure

The researcher met with the Medical Director of the participating hospital to explain the purpose of the study and data collection procedure. All doctors, nurses, and midwives working in the birthing unit and willing to be involved, were supported by the

workplace to attend training on randomization and data collection procedures.

Randomization of consenting women to the early or delayed cord clamping group was performed using sequentially numbered cards in sealed nontransparent envelopes. Both the woman and birthing room staff were informed of the allocation by the researcher and in writing on the mother's medical file, the labor record and on the newborn's medical record.

Intervention

Immediate care for the newborn. Immediately after childbirth, the obstetrician or resident placed the baby on a warm, covered movable table adjusted to the level of the woman's uterus. For the delayed group, the cord was left intact for 90 seconds (median = 90 seconds), then clamped and cut. Immediate infant care was conducted at the table. Apgar scores were assessed at 1 and 5 minutes. The time elapsed between childbirth and cord clamping was calculated using a stopwatch by one of the healthcare providers. For the early cord clamping group, the same immediate care for the newborn was provided except that the cord was clamped and cut within less than 30 seconds of childbirth (median = 14.50 seconds).

Immediate care for the mother. For both groups immediately after childbirth, the woman was injected with a mix of 10 IU oxytocin and 0.2 mg methylergonovine maleate (Methergine) intramuscular. After clamping of the cord, the healthcare provider waited until the placenta was expelled spontaneously. After the birth of the placenta, the uterus was assessed for uterine atony and the condition of the vagina and perineum was also assessed.

Postpartum procedures. After 12 hours of birth, the Hb level of both groups was measured by capillary finger-stick samples from mothers and heel-stick samples from newborns. These samples were assayed by Hemocue 201+. The bilirubin level of the newborn was measured using a Bilichek machine. These tests were conducted by trained nurses working in the nursery unit or postpartum units. For both groups, the occurrence of PPH (Yes/No) and admission of the newborn to the NICU (Yes/No) were collected from the mother's birth record.

Before discharge, healthcare providers advised the mother to attend the outpatient clinic on the 3rd postpartum day for a routine bilirubin test. The newborn venous sample was taken by a pediatric resident and sent to the laboratory in the Jordan University

Hospital. Based on the published data, bilirubin levels in the current study were divided into four diagnostic categories: normal-low risk below 40th percentile (≤ 13 mg/dl), low-intermediate risk ranging from the 40th to <75 th percentile (13.1–15.2 mg/dl), high-intermediate risk ranging from the 75th to <95 th percentile (15.3–17.2 mg/d), and high risk in the 95th percentile or more (17.3 mg/dl and more) [13,20].

Analysis

Data were analyzed using the Statistical Package of Social Science (SPSS) version 25 descriptive statistics were used to describe participant characteristics. *T*-test and chi-square were used to compare the mean differences between the groups. An alpha level of 0.05 was used for all statistical tests.

Ethical considerations

Ethical approval was obtained from the Institutional Review Board (IRB) at the Jordan University of Science and Technology and the hospital. At admission, information about the study was provided and written consent was obtained from the participants.

Results

Sociodemographic characteristics of participants

The sociodemographic characteristics of participants are shown in Table 1. The average age of participants was 28.9 years (± 5.5). Participants were well educated with nearly 50% having a degree-level education. Most participants were multiparous (76.6%).

Neonatal outcomes

As shown in Table 2, delayed cord clamping had a positive effect on newborns' Hb levels after 12 hours of birth. On the other hand, early cord clamping was significantly associated with the need for oxygen therapy. There were no other statistically significant differences in other newborn variables between the groups. Based on the bilirubin levels and group allocation, at 12 hours after birth, there were no significant interactions ($\chi^2(3) = 4.22$ $p > .05$), nor at 3 days postpartum ($\chi^2(3) = 0.35$ $p > .05$).

Maternal outcomes

As shown in Table 3, women who received early cord clamping were more likely to have PPH. There were

no statistically significant differences between the groups on maternal Hb level after 12 hours of childbirth.

Discussion

Recent recommendations by WHO [4] included delayed cord clamping to manage the third stage of labor and promote various maternal and neonatal benefits. Despite increasing evidence, delayed cord clamping is still not practiced in most Arab countries [3,13,21,22]. Relatively few studies have investigated the effects of early versus delayed cord clamping on maternal and neonatal outcomes in Arab countries, with the exception of studies conducted in Egypt and Saudi Arabia [3,9,13]. In the current study, the authors found that delayed cord clamping had a positive impact on newborns and mothers compared to those receiving early cord clamping. These results are

consistent with the results of most previous studies in developed and developing countries comparing cord clamping on maternal and neonatal outcomes [2,9,13,22,23].

The present study showed that delayed clamping was associated with higher hemoglobin levels among newborns after 12 hours of birth with no adverse effects on other variables (Apgar score at 1 and 5 minutes, increased need for oxygen therapy, admission to NICU, and baby bilirubin levels after 12 hours of birth, and day 3 of birth). Our finding of improved hemoglobin levels after 12 hours of childbirth adds to the growing evidence that delayed cord clamping is associated with increased hemoglobin levels of full-term babies [13,15,23–28]. Delayed cord clamping enables 80 ml of blood to be transfused from the placenta to the neonate at 1 minute and 100 ml at 3 minutes following childbirth [9]. In our study, we delayed the umbilical cord clamping to 90 seconds which meant that neonates received more than 80 ml of extra blood, but less than 100 ml compared to neonates in the early cord clamping group. Increasing hemoglobin levels is an important benefit of delayed cord clamping for newborns, especially in low and middle-income countries where the prevalence of iron-deficiency anemia is high [9,13,28].

The prevalence of iron-deficiency anemia in infants is particularly evident in Jordan [17]. Iron is essential for central nervous system development and function and has a vital effect on myelination of brain cells [9,13,28]. Iron deficiency is associated with cognitive

Table 1. Demographic characteristics of participants.

Demographic characteristics	<i>N</i> = 128	(%)
Mothers' age		
Less than 25 years	31	24.2
25–34 years	73	57
More than 34 years	24	18.8
Mothers' educational level		
High school or less	40	31.3
Diploma	25	19.5
Bachelor or more	63	49.2
Occupation		
Unemployed	81	63.3
Employed	47	36.7
Mothers' blood group		
A+	54	42.2
B+	25	19.5
AB+	6	4.7
O+	43	33.6
Gravidity		
1st pregnancy	30	23.4
2–3 pregnancies	55	43
4 pregnancies or more	43	33.6
Parity		
1 child	36	28.1
2–3 children	64	50
4 children or more	28	21.9
Sex of the baby		
Male	71	55.5
Female	57	44.5

Table 3. Effect of early versus delayed cord clamping on maternal outcomes.

Maternal variable	ECC		DCC		χ^2	df	<i>p</i>
	<i>n</i>	%	<i>n</i>	%			
PPH	7	10.9	1	1.6	4.80	1	.03*
Maternal variable	Mean	SD	Mean	SD	<i>t</i>	df	<i>p</i>
Hb level after 12 hours of birth	10.27	1.22	10.67	1.29	−1.79	124	.07

**p* < .05 is significant.

Table 2. Effect of early versus delayed cord clamping on neonatal outcomes.

Neonatal variable	ECC		DCC		χ^2	df	<i>p</i>
	<i>n</i>	%	<i>n</i>	%			
Need for O ₂ therapy	12	18.8	4	6.3	4.57	1	.03*
Admission to NICU	5	7.8	1	1.6	2.79	1	.09
Neonatal variable	Mean	SD	Mean	SD	<i>t</i>	df	<i>p</i>
Apgar score at 1 minute	7.97	0.18	8.00	0.00	−1.43	63	.16
Apgar score at 5 minutes	9.00	0.00	9.00	0.00	–	–	–
Hb level after 12 hours of birth	16.70	1.68	18.57	1.80	−6.04	126	.01*
Bilirubin level after 12 hours of birth	3.73	2.05	3.48	1.23	0.84	103.30	.40
Bilirubin level on day 3	8.42	3.91	8.85	3.85	−0.60	125	.54

**p* < .05 is significant.

problems, altered affective responding and impaired motor development [2,13,22]. Developing a practice guideline to promote delayed cord clamping in Jordanian hospitals would seem essential to decrease the risk of childhood anemia.

The current study found no significant differences between groups on Apgar scores at 1 and 5 minutes. This finding was also consistent with those of previous studies [13,28–30]. The lack of differences in Apgar scores between 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 relation to the need for oxygen therapy after birth, only one previous randomized controlled trial had compared the effect of early versus delayed cord clamping on this newborn outcome [13]. Like the current findings, these researchers also found a significant difference between groups with babies in the early cord clamping group being more likely to require oxygen therapy after birth [13]. This result may be related to the fact that delayed cord clamping facilitates the transfer of oxygenated blood from the placenta to the newborn, thereby enhancing the smooth transition of cardiopulmonary functioning from intrauterine to extrauterine life [31,32]. On the other hand, early cord clamping is known to restrict the newborn's ability to manage the transition from the fetal circulation to neonatal circulation [33]. Umbilical cord clamping should, therefore, be based on newborn physiologic status and after the first effective breath [8].

In the current study, no significant difference was observed regarding the rate of admission to NICU among groups. This result was consistent with the results of previous studies that investigated admission to NICU and cord clamping [13,28,34,35]. This result, however, may be attributed to excluding newborns who needed immediate resuscitation from the current study.

Finally, neonates' bilirubin levels were investigated at 12 hours and 3 days postpartum. The 12-hour time-frame was chosen because changes in bilirubin are more likely to be noticeable and less affected by nourishment and dehydration [36]. The authors found that bilirubin levels did not differ between groups and were not adversely affected by delayed clamping. This result was congruent with many previous studies [2,11,16,23,26,27,30]. Although some other studies have found that infants who experienced delayed cord clamping had higher bilirubin levels than infants who had early clamping, these results were not statistically or clinically significant and the babies did not

need intervention or phototherapy [13,28,37]. Although the weight of evidence suggests that delayed cord clamping does not adversely affect newborns' bilirubin levels, further research is needed [24].

In relation to maternal outcomes, the current study revealed no significant association between delayed cord clamping and the occurrence of PPH. This result was congruent with previous studies, which also found no association [13,28,38]. The risk of PPH may be associated with practices that involve immediate uterine massage and cord traction on a saturated placenta and exhausted uterine muscles. However, if cord clamping is delayed for 90 seconds, the amount of blood in the placenta is less and the uterine muscles have recovered sufficiently to expel all the products of conception. A recent systematic review conducted by McDonald et al. [28] revealed that compared with early clamping, delayed clamping decreased the occurrence of PPH. In line with this evidence, WHO [4] recommended delayed cord clamping in the active management of the third stage of labor.

Finally, this study found no significant differences in mothers' Hb levels after 12 hours of childbirth between groups. This finding is also in line with those of previous studies [28,34,38]. This result indicates that delayed cord clamping does not have a negative effect on maternal Hb levels.

Conclusion

The current study found that compared to early cord clamping, delayed clamping was associated with increased Hb levels and decreased need for oxygen therapy among newborns and decreased the occurrence of postpartum hemorrhage among mothers. Increasing Hb levels among infants is a critical outcome in a country where rates of infant anemia are high. Importantly, delayed cord clamping had no adverse effects on other maternal and neonatal outcomes. This local evidence can now inform a practice guideline to promote delayed cord clamping in Jordanian hospitals.

Limitations

The current study has several limitations that need to be acknowledged. The results can only be generalized to term singleton pregnancies, low-risk babies, low-risk pregnancies, low-risk births, and mothers with a positive blood group. Further research is required with populations that include low-birth weight and preterm babies, and multiple fetuses. Repeating the current

study in this same context with broader inclusion criteria would further establish the effectiveness of delayed cord clamping in this country. In addition, more research is needed with a larger sample size to generalize the results. The current study enlisted the cooperation of staff to recruit and obtain consent from women and conduct the cord clamping according to a woman's group allocation. It could be that staff interested in research and delayed cord clamping volunteered for training and participation and this approach affected recruitment and results. However, this effect is likely to be small, given that the sample was representative of the birthing population at the participating site and results were similar to those of previous studies.

Implications for practice

The findings of the present study confirm the safety of delayed cord clamping for both infants and mothers. Creating a practice guideline for delayed cord clamping in Jordanian hospitals is required to change hospital practices. A training program is essential to provide evidence-based information to staff and develop skills and confidence in performing delayed cord clamping. In Jordan, health care providers involved in labor and birth are still reluctant to adopt delayed cord clamping. Awareness of the benefits of this practice on neonates and mothers will enable obstetricians and midwives to review and change their practices toward delayed cord clamping. Obtaining research results from the local context, inclusion of staff in the study, and the provision of education and training may contribute to improving the quality of childbirth care and comply with international guidelines of prestigious bodies such as WHO. The findings of this study also have important implications for decreasing the high prevalence of anemia among infants. Staff needs to provide information to parents and encourage women to request delayed cord clamping by their care providers.

Disclosure statement

No potential conflict of interest was reported by the authors.

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