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Original Article

Obstetrics and Gynaecology Section

Residual Placental Blood Volume Estimation to Measure the Increase in Neonatal Blood Transfer by Delayed Cord Clamping: A Quasi-Experimental Study

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ABSTRACT

Introduction: Iron deficiency and iron deficiency anaemia are common in newborns and children in India. Iron is essential for the physical, mental and even emotional growth of the child. Breast milk is not rich in iron and is not enough to provide the requisite amount of iron to the baby. Though WHO recommends delayed clamping of the cord in all developing countries, this is rarely a routine practice.

Aim: To practically demonstrate the increase in neonatal blood transfer by adopting the practice of delayed cord clamping.

Materials and Methods: This was a quasi-experimental study conducted at a tertiary care centre in Bagalkot, Karnataka between July and September 2014. The study was conducted in two phases, with the first phase not attempting any change of existing practices. Halfway through the study, the birth attendants were asked to change the timing of clamping whenever possible, to after stoppage of cord pulsations. Maternal characteristics were recorded. Timings of the various events during labour were noted. Residual placental blood volume was estimated in all cases by allowing the cut end of the cord to bleed. The results were analysed using t-test.

Results: A total of 172 deliveries occurred during the period of observation, out of which 117 fulfilled the inclusion criteria. There were no significant differences in the maternal characteristics in the two groups (early cord clamping versus delayed cord clamping). There was an average difference of 44 mL in the residual placental blood volume (more in the early clamping group), which was statistically significant. The babies in the delayed clamping group had a higher average birth weight, which was also statistically significant. Unexpected complications interfering with a prior decision of delayed cord clamping were relatively few.

Conclusion: Delayed cord clamping significantly increases the volume of blood transferred to the baby. Adopting this practice routinely, as recommended, requires minimal extra efforts on the part of the birth attendants, and should be stressed on.

Keywords: Birth attendant, Cord pulsations, Iron, Neonatal anaemia, Practice, Recommendation

INTRODUCTION

Iron deficiency and iron deficiency anaemia are major health problems. According to a global study in 2011 [1], a fourth of pre-school children are iron deficient. About 80% of the pregnant women in India suffer from anaemia during pregnancy and this predisposes to neonatal iron deficiency [2]. Iron is of utmost importance as it helps in oxygen transport, enzymatic reactions and better development of neuromotor functions. The growth of the brain is maximal (almost 80%) within the first two years of life [3], with iron playing a vital role. Deficiency of iron at this critical period leads to delayed brain maturation; poor cognitive, motor, social and emotional function and may lead to altered temperament and even mental retardation [1]. Most of the manifestations of iron deficiency can be prolonged into infancy and childhood. These children are also prone to all the health hazards of a weak immune system and suffer from recurrent illnesses, contributing to further morbidity and possible mortality.

The sources of iron for neonates are limited and breast milk alone, supplying approximately 0.35 mg/litre, is not sufficient to meet the body requirement of iron [4]. Most babies are deprived of a very rich source of iron that nature actually intended for them. A simple change in the timing of cord clamping, delaying it by 1-3 minutes, has a great impact on the well-being of the baby and even later, in childhood [2].

The new-born's Red Blood Cell (RBC) production capacity slows down at birth when compared to that in fetal life and the fetal RBCs have a shorter lifespan [5]. These two factors necessitate the need for placental transfusion at birth. By term gestation, about one-third of the blood flows through the placenta and two-thirds flows through the fetus at any point in time. Immediate cord clamping results in about 30% of feto-placental blood volume remaining in the placenta, whereas delayed cord clamping reduces residual placental blood to 20% of the feto-placental blood volume by 60 seconds and to 13% by 3-5 minutes [6].

The WHO recommends delayed cord clamping as a routine in developing countries unless the baby is asphyxiated and needs resuscitation [7]. The blood thus transferred is to the extent of 80-100 ml [8,9] containing iron amounting to 40-50 mg/kg body weight, which when combined with body iron, prevents iron deficiency during the first year of life [9]. Various studies have documented improved hematologic parameters and better iron stores in infants when delayed cord clamping is practised [1,10-12].

Studies have mentioned other advantages of delayed cord clamping to be decreased incidence of late onset sepsis [13,14], decreased incidence of intraventricular haemorrhage and also protection against motor disability especially in very low birth weight male babies [13]. Delayed clamping facilitates increased transfer of stem cells which have the potential of transforming into a variety of different cells and are important for tissue repair and rebuilding [15].

The American College of Obstetricians and Gynaecologists (ACOG) lists the conditions in which the cord may have to be clamped immediately or in which care has to be individualised. The maternal conditions warranting such consideration are haemorrhage and/ or haemodynamic instability and abnormal placentation. The fetal/neonatal considerations are the need for

immediate resuscitation and placental circulation not being intact (placental abruption or previa/cord avulsion/IUGR with abnormal cord doppler evaluation) [16].

Though the practice of delayed cord clamping is very close to the natural birth process and dates back to ages in history, it is not widely practiced. This can perhaps be attributed to misconceptions on the part of the birth attendants or basic ignorance about the recommended practices. An observational study in Canada in 2006-2007 found that more than 50% of the babies had their cords clamped in less than 15 seconds [17].

Delayed clamping is associated with the potential increased risk of polycythemia and jaundice. According to a meta-analysis of controlled trials, there was an increase in polycythemia in the delayed cord clamped population. Nevertheless, this condition appeared to be benign [4].

Though the risk of jaundice does exist, it has not been found to require interventions beyond phototherapy. In a Cochrane review, of the babies with delayed cord clamping who developed hyperbilirubinemia, all recovered completely, and none had further complications like kernicterus. The review concluded that delayed clamping is likely to be beneficial as long as access to treatment for jaundice requiring phototherapy is available [18].

Delayed cord clamping requires no additional equipment or materials and no extra costs are incurred. When a simple intervention has the potential to drastically improve health of the newborn and thus the future population, it should be practiced as widely as possible. This study has been done to estimate the increase in the volume of blood transferred to the baby by delayed cord clamping by comparing the Residual Placental Blood Volume (RPBV) after early versus delayed clamping of the cord. The observations and results of this study will serve to bring home facts and increase awareness, hopefully leading to changes in practice.

MATERIALS AND METHODS

This quasi-experimental study was undertaken at a tertiary care centre at Bagalkot, Karnataka, India over duration of 45 days between July and September 2014. Women who delivered at the study hospital during the study period were assessed for eligibility for inclusion in the study. Women deemed eligible were approached and a written informed consent was obtained. Women were included in the study irrespective of the mode of delivery, whether by vaginal route or by Caesarean section.

This was a study sanctioned under the Short Term Studentship program by the Indian Council of Medical Research and was to be completed within two months as stipulated. All deliveries occurring within 45 days during the study period were included.

The power analysis was done using OpenEpi software version 3.2.1 by normal approximation method. The power of the study was estimated to be 100% (minimum is 80%), which was calculated using the residual placental blood in the two groups i.e., 32.99+17.85 mL and 76.70+18.47 mL in the delayed and early cord clamping groups, respectively.

Hence, the study sample size of 117 which has 99 percent confidence level and 100 percent power was adequate for the present study.

The inclusion criteria in this study were full term singleton deliveries with clinically estimated fetal weight between 2.5 kg and 3.5 kg. The exclusion criteria were pre-eclampsia/eclampsia, Rh negative blood type of the mother and immediate peripartum emergencies not allowing the study protocol to be followed. Babies which were found to weigh less than 2.5 kg and more than 3.5 kg after birth were also excluded. Though most of these criteria are not contraindications for the practice of delayed cord clamping, they are excluded from the study to maintain uniformity between the groups and prevent confounding.

All the doctors, postgraduate students and nursing staff were informed about the purpose and procedure of the study, which helped in efficient data collection. During vaginal delivery, the birth attendants were requested to clamp the cord about 5 cm from the perineum to maintain uniformity of the cord length available. During caesarean section also, the obstetricians were requested to clamp the cord about 5 cm from the maternal abdomen. Timings of events such as delivery of the baby, cord clamping and placental delivery were noted.

In the first half of the study, no attempt was made to change the existing practices of the birth attendants with regards to timing of cord clamping. However, after this period, the birth attendants were all requested to follow the practice of delayed cord clamping in the absence of any contraindicating circumstances. Delayed cord clamping has been described variously by different authors [19,20], and in our study, it was taken as the time at which the cord pulsations ceased.

The participants were divided into two groups depending on the timing of cord clamping:

Early Cord Clamping (ECC)

Delayed Cord Clamping (DCC)

In all the cases with delayed cord clamping, an assistant (usually an intern or a staff nurse), felt for the cord pulsations and informed when they stopped. This timing was noted. Events which interfered with a prior plan of delayed cord clamping such as tight loop/loops of cord around the neck or the baby requiring immediate resuscitation were made note of.

For estimating the volume of blood in the placenta, it was collected in a kidney tray immediately after delivery and the cord was cautiously unclamped. The unclamped cord was allowed to bleed into another kidney tray. The placenta was held a little higher than the kidney tray to facilitate flow of blood and the cord was milked. Efforts were directed towards minimising blood clotting and blood loss in all ways possible. The volume of blood collected was measured with the help of 20 mL syringes and the blood was then discarded safely. After draining out the retained blood, the placenta was weighed.

The birth weight and gender of the baby was also recorded. Some of the participants were found to be ineligible at this time because the birth weight of the baby was not between 2500 to 3500 grams. These women were later excluded.

Data were recorded on a predesigned format which included the socio-demographic details of the woman; the height, weight, blood pressure, and blood group; and also information regarding the pregnancy including gravidity and gestational age. After delivery, the mode of delivery, time of delivery of the baby, cord clamping, cessation of cord pulsations (in delayed cord clamping) and placental delivery were recorded. Volume of residual placental blood, weight of the placenta, weight and gender of the baby and conditions interfering with the timing of cord clamping were documented. The data were entered in Microsoft Excel, and statistical analysis was done with SPSS software version 19 using proportions and application of t-tests, $p<0.05$ was taken as significant.

This study was sanctioned by the Indian Council of Medical Research as a short-term studentship project for the year 2014. Ethical clearance was taken from the Institutional Ethics Committee at S. Nijalingappa Medical College, Bagalkot (SNMC/IECHSR/2014-15/STS-06/1.1).

RESULTS

A total of 172 deliveries occurred during the study, of which 55 were excluded. Eigth women who were initially included had babies with birth weights which did not fall between 2500 to 3500 grams and these women were excluded later. Finally, a total

of 117 women were included in the analysis. [Table/Fig-1] shows the reasons for exclusion.

[Table/Fig-2] shows the mode of delivery and the number in each group.

Reasons for exclusion	Number
Preterm deliveries	6
Post term deliveries	4
Pre-eclampsia/eclampsia	12
Rh negative maternal blood type	5
Large for gestational age babies	2
Small for gestational age babies	6
Tight loops of cord around neck	9
Birth asphyxiated babies requiring resuscitation	5
Physical absence of the researcher	5
Non-consenting mother	1

[Table/Fig-1]: Reasons for exclusion from the study.

Mode of delivery	Number	Group	Number
LSCS	69	ECC	39
		DCC	30
Vaginal	48	ECC	28
		DCC	20

[Table/Fig-2]: Mode of delivery versus timing of cord clamping.
ECC: Early cord clamping; DCC: Delayed cord clamping

DCC and ECC

Early cord clamping was done in 67 (58%) cases, and delayed cord clamping was done in the remaining 50 (42%) cases.

There were no significant differences in the baseline maternal characteristics in the two groups and the groups were comparable [Table/Fig-3].

In the ECC group, the majority were nulliparous (29, 43.3%) and in the DCC group, most were para 1 (23, 46%) as seen in [Table/Fig-4].

Characteristic	Group		t value	p-value
	ECC n=67	DCC n=50		
Maternal age in years	24.27±3.92	24.24±3.60	0.04	0.96
Maternal weight in kg	55.29±9.03	57.13±10.42	1.02	0.30
Maternal height in cm	153.43±5.59	152.99±4.79	0.45	0.65

[Table/Fig-3]: Baseline maternal characteristics in the two groups.
ECC: Early cord clamping; DCC: Delayed cord clamping

Parity	ECC (n=67)		DCC (n=50)	
	Number	Percentage	Number	Percentage
0	29	43.3%	18	36%
1	26	38.8%	23	46%
2	10	14.9%	6	12%
3	2	3.0%	3	6%
Total	67	100%	50	100%

[Table/Fig-4]: Maternal parity in early and delayed cord clamping groups.
ECC: Early cord clamping; DCC: Delayed cord clamping

The mean timing of cord clamping was 0.15 minute in the ECC group, ranging from 0.02 minute to 0.28 minute and this timing was approximately 1.12 minute in the DCC group, ranging from 0.67 minute to 1.57 minute. The average time required for the cord to stop pulsating was 1.12 minute (approximately 67.2 seconds).

[Table/Fig-5] shows the placental weight after letting out the residual blood, amount of residual blood in the placenta and the baby weight in the two groups. The placental weights were similar in the two groups.

Characteristic	Group		t value	p-value
	ECC n=67	DCC n=50		
Placental weight (in gram)	446.17±74.13	449.70±71.92	0.25	0.79
Residual placental blood volume (in mL)	76.73±18.47	32.99±17.85	12.85	0.0001
Baby weight (in Kg)	2.84±0.31	2.96±0.34	1.99	0.04

[Table/Fig-5]: Placental characteristics and baby weight in the two groups.
ECC: Early cord clamping; DCC: Delayed cord clamping

The average amount of residual blood volume in the placenta in ECC group was approximately 77 mL, ranging from 59 mL to 95 mL and that in DCC group was approximately 33 mL, ranging from 15 mL to 51 mL. This difference was significant with a p-value of 0.0001.

The average weight of the babies in the ECC group was 2.84 kg, ranging from 2.53 to 3.15 kg and that in the DCC group was 2.96 kg, ranging from 2.62 to 3.3 kg. This weight difference was statistically significant with a p-value of 0.04.

Factors that interfered with the prior decision of delayed cord clamping were tight loops of cord around the neck and birth asphyxia. There were five cases of birth asphyxia requiring immediate resuscitation, accounting for 4.27% of the study population. Tight loops of cord around the neck that prevented delayed clamping were found in nine cases which were 7.6% of the study population.

DISCUSSION

This study found that the majority of birth attendants at our institution followed the practice of early cord clamping. Even after instructing them to perform delayed cord clamping wherever possible in the latter half of the study, 58% of the babies had early cord clamping. This shows that delayed cord clamping is not in widespread use. This observation is similar to that observed by Hutton EK et al., where more than 50% of the babies had their cord clamped in less than 15 seconds [17]. Ibrahim NO et al., reported that most institutions in Saudi Arabia do not have set guidelines for cord clamping timings [21]. Tonse NKR et al., also reported that in most deliveries, cord clamping is performed soon after birth, often within 10-15 seconds after birth [22].

Ersdal HL et al., reported that healthy self-breathing neonates in a low-resource setting are more likely to die if cord clamping occurs before or immediately after onset of spontaneous respirations. The risk of death/admission decreases by 20% for every 10-second delay in clamping after breathing [23]. Also, a significant reduction in the incidence of intraventricular haemorrhages and need for blood transfusions with delayed umbilical cord clamping were reported in a systematic review by Rabe H et al., [24].

One of the reasons as to why many birth attendants may not be practicing this highly simple and effective intervention despite so many advantages may be due to perceived contraindications.

A total of 172 deliveries occurred during the present study, of which 55 were excluded. The exclusion criteria in this study are not contraindications for delayed clamping and were enforced so as to maintain uniformity amongst the groups and to prevent the interference of these factors with the results.

The incidence of a loop of cord around the neck at delivery is as high as 10-29% [25]. Many birth attendants clamp the cord immediately on seeing loops of cord around the neck. However, in most cases, the cord loops are loose and can easily be slipped off. Infact, in these babies with a nuchal cord, the baby may be left hypovolemic if the cord is clamped early [26].

In the earlier teachings, it was proposed that preterm infants are already fragile and will not be able to handle the circulatory overload caused by the transfer of this excess blood. However, it is now proven that preterm babies benefit maximally by delaying the cord clamping with the advantages being as in term infants but even more pronounced [16,27]. Though preterm births was one of the exclusion criteria in the present study, it is definitely not a contradiction to the practice of delayed cord clamping.

Delayed cord clamping can also be easily practised during caesarean sections without any increase in maternal blood loss. After the birth of the baby, the obstetrician has to secure the edges and the angles of the uterine incision amongst other procedures, and clamping can be delayed up to then. Thus, not much of the routine procedure is changed. The ACOG also recommends delayed cord clamping during caesarean section [16]. Other authors too have reported the feasibility of delayed cord clamping during caesarean births [28,29]. In the present study too, delayed cord clamping was practised during caesarean sections without any difficulties.

Our study found an average of 44 mL less residual blood in the placenta after delayed cord clamping. This is an indirect method of assessing the increase in neonatal blood volume by delaying the cord clamping. It is reported that by delaying cord clamping by one minute in term neonates, 80 mL of blood is transferred to the baby and by delaying it up to three minutes, 100 mL blood is transferred [22]. Mercer JS et al., reported a study in which the RPBV was 30.8 mL/kg birth weight and 20 mL/kg birth weight after early and delayed cord clamping respectively. However, delayed cord clamping was at five minutes in their study and the method of estimating the RPBV was by puncture of the umbilical vein with drainage into a blood collection bag [30].

Increased placental blood transfer can increase the birth weight of the baby. In a review article by McDonald SJ et al., 12 trials suggested that the mean birth weight was significantly higher in the delayed cord clamping group than in the early cord clamping group amounting to an increase of almost 101 grams [18]. In this study also, we noted a statistically significant increase in birth weight in the delayed clamping group (121 grams). However, this does not correlate directly with the increased volume of blood transferred by delayed cord clamping as assessed by RPBV measurement as this is an indirect means of estimation.

Delayed clamping is associated with an increased risk of polycythemia and jaundice which are usually benign and have rarely been found to require advanced treatment [4,18]. In the present study, babies were not followed-up in the postnatal period to evaluate the haematocrit/haemoglobin or the occurrence of jaundice and polycythemia requiring treatment and hence this cannot be commented about.

CONCLUSION

Iron is an essential component for the growth and neuromotor development of infants and children and its deficiency at birth can prolong the negative effects later into childhood. An efficient, no-cost intervention to tackle this is by delayed cord clamping which gives the baby its rightful blood and thus increases the iron stores for the initial few months of life. The results of our study show that a significant amount of blood remains in the placenta if the cord is clamped early. Increasing awareness about the benefits and limited contraindications of delayed cord clamping among the birth attendants will hopefully result in a favourable change in practice. Delayed cord clamping should be included in the institutional labour room protocols and should be insisted on.

LIMITATION

Follow-up of the babies to evaluate complications needing NICU admission and treatment, was not done.

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