Understanding the Importance of the Umbilical Cord

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Abstract

The umbilical cord represents the physical as well as emotional bond that occurs between mother and child. This design enables oxygen and nutrients to flow from the maternal circulation to the fetal circulation, as well as waste products to be removed from the fetal circulation and returned to the mother. Despite our awareness of abnormalities and associated pathology, there is "no evidence that early cord clamping is desirable, and neither immediate nor delayed cord clamping causes long-term harm. Instead of messing with the delicate, nuanced, and only partially understood design of the physiologic infant transition, it is wiser to emulate nature until we have sufficient evidence to indicate otherwise".

Keywords: Umbilical Cord, Abnormalities**,** Associated Pathology, Cord Clamping**.**

INTRODUCTION

"The umbilical cord is a representation of the physical as well as emotional connection that exists between mother and child. This structure permits oxygen and nutrients from the maternal circulation to be transferred to the fetal circulation while simultaneously eliminating waste materials from the fetal circulation for removal by the mother".[1] "The cord, which is a component of the placenta, is still linked to the mother at the time of birth. The cord is often constricted with two clamps to separate the infant from the placenta". "The umbilical cord is severed between two clamps, the first of which is placed around the infant's navel and the second of which is placed farther up the cord". The third stage of labor occurs between the birth of the infant and the delivery of the placenta, and this task takes place throughout that time.[2]

Furthermore, in recent years, a growing body of research has suggested that delaying the clamping of the umbilical cord can have positive effects on both premature and full-term newborns.[3,4] Despite extensive research, there remains a lack of consensus regarding the optimal approach to umbilical cord management in neonates who exhibit instability or require resuscitation as determined by the attending healthcare professionals. "The practice of delaying the clamping of the umbilical cord for a period of at least 30–60 seconds is commonly referred to as delayed cord clamping (DCC)".[5,6] Due to temporal constraints, certain critically ill or premature neonates may not receive the advantageous therapy. Numerous randomized controlled trials in which as many as 25% of the subjects do not receive delayed cord clamping (DCC) support this claim. "Umbilical cord milking (UCM) is an additional technique that involves the application of gentle pressure to the placenta and the repeated squeezing of the umbilical cord towards the infant prior to its severance. In contrast to the practice of delayed cord clamping, which results in a delay of placental transfusion and subsequently resuscitation, milking of the umbilical cord can be performed with similar expediency as immediate cord clamping while still facilitating placental transfusion".[7]

CORD DEVELOPMENT

"The umbilical cord forms when the connecting stalk develops blood vessels and meets the omphalomesenteric duct around 7-8 weeks. At 12–16 weeks of gestation, the allantois or urachus grows into the connecting stalk, and its blood vessels become umbilical cord vessels.

The pelvic iliac arteries and umbilical arteries are lateral to the bladder. After birth, the umbilical vein enters the left portal vein, forming the ligamentum venosus fissure. Two umbilical arteries and veins appear at 6 weeks. By 8 weeks of gestation, the umbilical cord has just one vein, the left. The normal umbilical cord has two arteries and one vein. The umbilical vein transports oxygenated blood from the placenta to the fetal liver through the left portal vein. Umbilical arteries carry deoxygenated fetal blood to the placenta. Normal umbilical cord length is less than 2 cm. The umbilical cord has grown to 50–60 cm in

length and 40 helical twists by the second trimester. On the left, the umbilical cord twists. Helical muscle fiber distribution in umbilical cord vessels is thought to induce this. Coiling is thought to preserve the cord by strengthening the vessels and reducing compression. Fetal tensile forces dictate cord length and twists. For normal cord length and coiling, there must be enough fluid space and fetal activity. Wharton jelly shields the umbilical cords".[8]

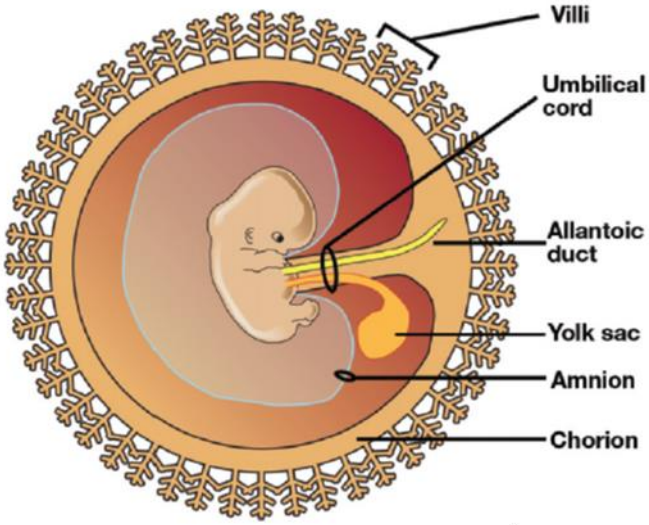

FIG 1: UMBILICAL CORD DEVELOPMENT.[8]

NORMAL APPEARANCE

"The umbilical cord may be seen on ultrasound by 42 days of gestation and is completely developed by 8–9 weeks. The midgut has normally reverted to normal by the end of the 11th week of pregnancy, with no protrusion or bowel loop remaining at the cord attachment site into the fetal abdomen".[8]

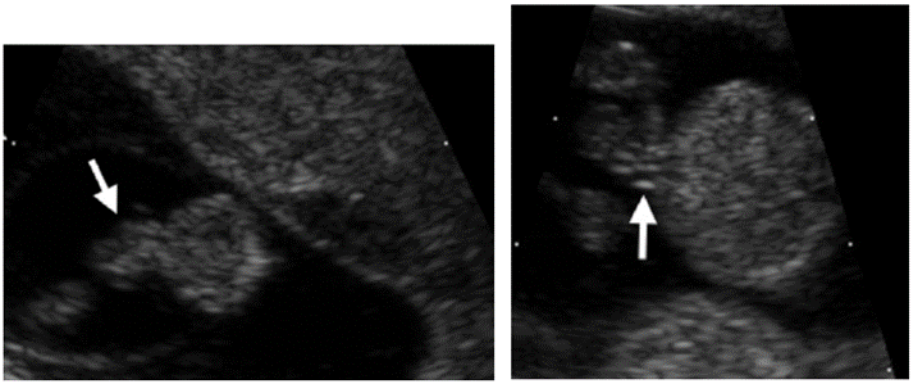

FIG 2: NORMAL PHYSIOLOGY OF UMBILICAL CORD IN ULTRASOUND[8]

A= 10 Weeks Of Gestation Shows Normal Physiologic Bowel.

B= 2 Weeks Of Gestation Shows Normal Cord Insertion Into The Fetal Abdominal Wall.

A physiologic cord herniation occurs at the base of the cord between weeks 7 and 12 of gestation. The umbilical cord links the fetus to the placenta at the umbilicus and shows in an ultrasound as a twisted, ropelike, echogenic structure.[8]

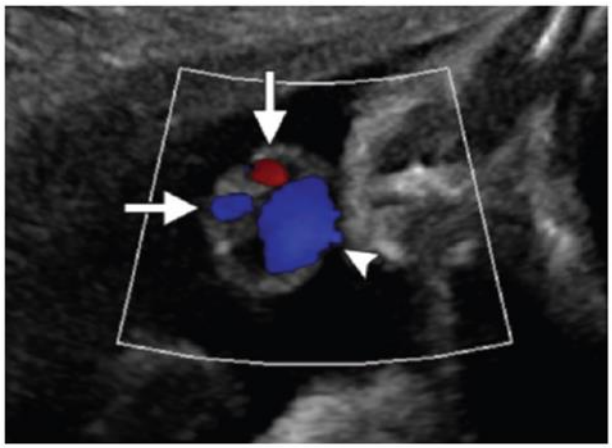

FIG 3: NORMAL UMBILICAL CORD.[8]

During the second trimester of pregnancy, a full evaluation of the umbilical cord is performed, which includes the use of gray-scale and color Doppler ultrasound to determine the number of vessels in the cord, cord thickness, and degree of coiling. Doppler evaluation of the blood flow pattern in the umbilical cord becomes crucial when fetal or cord abnormalities are found.[8]

Clinical Indication	Structures Assessed at Doppler US
Fetal and placental anatomy	Umbilical cord and placenta
Fetal growth restriction	Fetal MCA, UA, fetal ductus venosus
Fetal congenital anomalies	UA, fetal ductus venosus Depending on the location of the anomaly: fetal heart, fetal aorta, fetal kidneys, fetal liver, fetal pelvis
Preeclampsia	UA, maternal uterine artery, fetal MCA
Multiple gestation	Fetal MCA, UA, placenta
Maternal vascular diseases	Fetal MCA, UA, placenta
Fetal anemia	Fetal MCA peak systolic flow velocity

TABLE 2: DOPPLER ULTRASONIC FOR ASSESSMENT OF FETAL AND MATERNAL DISEASE PROCESSES.[8]

Intrauterine growth restriction (IUGR) is defined as fetal weight less than the 10th percentile for gestational age. A fetus is deemed small for gestational age (SGA) if its measures fall below the projected range for its gestational age, although its growth has been normal during pregnancy. IUGR may arise as a result of maternal, fetal, or placental causes. The majority of IUGR causes diminished fetal perfusion. Due to the obliteration of the placenta villus, these hemodynamic changes are seen during Doppler ultrasound examination as an increase in umbilical artery end diastolic flow resistance.When villous obliteration affects more than half of the placenta, end diastolic flow in the umbilical artery may be absent or reversed. As a result of these changes, the fetal myocardium and brain get more blood than other organs in the body as seen by Doppler US as decreased end diastolic flow resistance in the fetal Middle cerebal artery (MCA). When diastolic flow in the umbilical artery is absent or reversed, an increased risk of fetal morbidity and mortality is seen.[8]

ABNORMALITY OF UMBILICAL CORD

"Abnormalities of the umbilical cord, such as knots and velamentous insertion, entanglement, cord prolapse, and abnormal cord length or coiling, can lead to decreased blood flow in the umbilical vessels and result in a poor perinatal outcome and fetal demise.Flow through the umbilical cord can be diminished either by disruption or compression of the umbilical vessels. Damage to the umbilical cord can also occur due to longstanding meconium discharge associated with vascular myonecrosis. Thus, there are multiple etiologies for both umbilical vessel disruption and compression".[9] "Umbilical cord compression may lead to physical obstruction of blood flow between the fetus and the placenta.Compression may occur due to anatomical abnormalities of the umbilical cord, such as knots, improper coiling, or abnormal cord length, as well as direct compression on the cord by the fetus, as in cases of cord entanglement. Frequently, fetal growth restriction is associated with chronic conditions such as these".

Nonetheless, “even in the setting of chronic cord obstruction, there may be an acute aggravation or progression at the time of birth when the quantity of cushioning available to the cord is reduced due to infant movement, fetal descent into the pelvis, and the absence of amniotic fluid. While total obstruction can lead to fetal mortality, incomplete obstruction may result in neurological dam age.In general, compression of the umbilical vein occurs earlier and to a greater degree than compression of the umbilical arteries, which may lead to decreased venous return from the placenta and vascular congestion. Extreme compression may lead to hypovolemia and anemia in the fetus”. Doppler examinations have confirmed the diminished venous return in this setting.”Chronic compression or obstruction may also lead to venous stasis and venous thrombosis in the venous vessels of the placenta and the fetus itself.Thrombi most frequently occur in the vessels of the chorionic plate, but they may occasionally be seen on a superficial examination even when they are located at a greater distance. Due to calcification, older thrombi appear as white streaks in the vessels, while recent thrombi appear as black masses inside the vessel lumen. Thrombi are frequently mural thrombi with fibrin and platelets adhered to the vascular wall, but they may also be occlusive”.[9]

OTHER ABNORMALITY WITH ASSOCIATED PATHOLOGICAL CONDITIONS

Type of Abnormality	Associated Pathologic Conditions
Morphologic	Coiling, increased thickness, thinning
Insertion	Marginal, furcate, and velamentous insertions
Presentation	Vasa previa
In utero distortion	Cord knot, cord torsion, entanglement, nuchal cord
Vascular	SUA, PRUV, cord thrombosis and hematoma, varix, arterial aneurysm
Cord tumor	Hemangioma, teratoma

Note.—PRUV = persistent right umbilical vein, SUA = single umbilical artery.

TABLE 3: ABNORMALITIES & ASSOCIATE PATHOLOGY OF UMBILICAL CORD.[8]

“Research indicates that, barring the most recent half century to a century, there exists significant proof that the umbilical cord of a neonate pulsated until its natural closure. Despite significant advancements in obstetrics and neonatology, the routine implementation of fast cord clamping in numerous medical facilities has occurred without sufficient investigation into its potential immediate and prolonged effects. The delay of cord clamping has been linked to various adverse outcomes in the existing literature”. The notion that polycythemia is a consequence of delayed cord clamping has gained significant traction in recent times, to the extent that it is frequently cited in scholarly works as an established truth without necessitating empirical evidence. Based on the results of 16 randomized controlled trials and 5 controlled trials conducted within the past 20 years, it can be concluded that there is insufficient evidence to suggest that delayed cord clamping poses any harm to both term and preterm infants.[10]

PRACTICAL IMPLICATION

Delayed cord clamping is a viable option during both gentle and medically assisted childbirth. In cases where there is a delay of three minutes or more (specifically, between minutes 23 and 35), it is possible to safely place the infant on the mother's abdomen. “The trials have indicated that a rise in blood volume takes place when the neonate is positioned on the maternal abdomen and the clamping of the umbilical cord is postponed for a duration of three minutes or longer”. An additional discovery is noteworthy and warrants emphasis. “A study was conducted by researchers in Israel to determine the optimal conditions for collecting cord blood at term. According to the author's findings, 80 mL of cord blood could be obtained if the infant was positioned on the abdomen and the cord was clamped within a period of 30 seconds”. Upon clamping the cord at the 30-second mark and subsequently placing the infant on the obstetrician's lap in a lowered position, a total of 30 mL was retrieved. The authors' deduction is that no negative effects were observed, as there was no noticeable alteration in hemoglobin levels within a 24-hour timeframe. As mentioned earlier in the article, the levels of hemoglobin and hematocrit are inadequate indicators for determining the advantages or disadvantages of delayed cord clamping. In order to

optimize transfusion and ensure the necessity of early cord clamping, it is recommended that the Certified Nurse Midwife or Certified Midwife maintain a position where the infant is situated below the level of the placenta for a brief duration. The results of this research are relevant to the administration of care for neonates experiencing distress, who may require an increased blood volume as a consequence. In cases where an infant is at risk of hypovolemia, characterized by a very pale or mottled appearance, it may be advisable to lower the infant for a period of 30 seconds to 1 minute prior to placing them on the abdomen or clamping the cord.[10]

FUTURE PROSPECTIVE

Further research is required to investigate the "impact of delayed cord clamping on breastfeeding duration and other behavioral outcomes" and to replicate the findings. The act of breastfeeding confers multiple advantages to both maternal and neonatal health. It is imperative to exert all possible measures during the birthing process to prevent any complications related to breastfeeding.[10] The research conducted by Grajeda and colleagues (2020), which established a correlation between early clamping and anemia during infancy, necessitates further replication and extension until conclusive results are obtained.[11] The research conducted by Lozoff et al. (1986–1989), which demonstrated the presence of behavioral and developmental complications in older children who were subjected to anemia during the course of the study, underscores the necessity of replicating and expanding upon this investigation to encompass an assessment of neurobehavioral development.[12,13,14,15] The identification of cytokines during the neonatal period, specifically at birth, 3 hours post-birth, and subsequent time points in infants subjected to immediate and delayed cord clamping, will provide insight into the potential harm to human subjects and whether this sensitivity is exclusive to rats. Due to the limited number of subjects in preterm infant studies, it is necessary to replicate and assess them using larger samples of infants. The majority of individuals do not continue with a given activity or program beyond the initial 4-6 week period. The present evidence suggests that further investigation is necessary to examine the development and outcomes of preterm infants during their stay in the neonatal intensive care unit, as well as during the post-infancy follow-up period.[10]

CONCLUSION

The quick clamping of the umbilical cord is an intervention that has emerged in the United States over the last century as birth has moved into the hospital setting, and it represents the polar opposite of the noninterventionist philosophy typical of midwifery care. Prior to 1980, no studies suggested rapid cord clamping; even for preterm infants, the "most conservative recommendations were to delay 1 to 112 minutes". "However, in our well-intended rush to transfer an infant to the pediatric team, we may be depriving him or her of a considerable proportion of his or her vital blood supply, putting him or her in danger of hypovolemia and the harm that may result. Furthermore, no evidence suggests that early cord clamping is better, and neither immediate nor delayed cord clamping causes long-term harm. Unless we have compelling evidence to the contrary, it is preferable to mimic nature rather than interfere with the delicate, sophisticated, and only partly understood design of the physiologic infant transition".

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