Clinical Analysis of Eleven Cases of Spontaneous Umbilical Cord Vascular Rupture During Pregnancy

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Research Article

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Abstract

Background: Spontaneous umbilical cord vascular rupture is a rare but catastrophic event during pregnancy, and the perinatal mortality rate is extremely high. Live neonates may have severe asphyxia and require admission to the neonatal intensive care unit for many days.

Methods: A retrospective review of the clinical data of eleven patients with spontaneous umbilical cord vascular rupture from 2012 to 2020, was undertaken at our hospital.

Results: All patients were diagnosed by postpartum placental examination and pathological examination. The Obstetric Rapid Response Team performed emergency cesarean sections in fetal distress patients, and the time between detection of fetal heart abnormality and delivery was 5 to 13 minutes. Eight patients had bloodstained amniotic fluid and one had III° foul amniotic fluid. Six patients had the umbilical cord around their necks. Furthermore, pathological examination of postpartum placentas found four cases of intrauterine infection. Among the eight live neonates, one neonate died two days after birth due to severe complications and one had neonatal hyperbilirubinemia. No neurological sequelae, or other severe complications were found in the remaining seven neonates after three months of follow-up, and all of them had a positive prognosis.

Conclusion: Spontaneous umbilical cord vascular rupture is a serious risk for perinatal birth life and obstetric complications. For this reason, obstetricians should be familiar with and pay attention to its risk factors.

Background

Spontaneous umbilical cord vascular rupture (UCVR) is a rare but catastrophic event and there is insufficient data on its incidence^[1]. It is defined as the disruption of one or more of the umbilical cord vessels at any point between the fetus and the placenta^[2]. Before or during the process of labor and delivery, UCVR may lead to fetal blood loss and severe perinatal morbidity and mortality. Several cases of spontaneous umbilical cord vascular rupture were reported in the obstetric literature of the early 20th - century, most with fetal death as the outcome^[3]. Douglas^[4] concluded, by gross pathologic assessment, that the fetus died secondary to hemorrhage. Although prenatal color ultrasound has been continuously developed in recent years, umbilical cord vascular rupture remains difficult to diagnose.

This study retrospectively analyzed the clinical data of eleven patients who had UCVR during pregnancy from 2012 to 2020 in Fujian Provincial Maternity and Child Hospital. By summarizing the clinical manifestations, treatments, and outcomes, we aimed to improve the understanding of the pathophysiology of umbilical cord vascular rupture, achieve early detection, intervention and treatment, and improve prognosis.

Methods

A retrospective analysis was conducted on eleven UCVR during pregnancy in the Department of Obstetrics of Fujian Provincial Maternity and Child Hospital from 2012 to 2020. All patients were diagnosed by postpartum examination and pathological examination and were between 23 and 38 years old, with an average age of 28.72 years. Among these patients, only six were considered to be at high risk of developing umbilical cord vascular rupture before labor. The average gestational age at which rupture occurred was 36 weeks. Furthermore, seven of the eleven patients were primipara mothers and all patients denied having an adverse birth history.

The most common locations of umbilical cord rupture were umbilical veins (67%) and umbilical arteries (13%)^[4]. According to the degree of rupture, umbilical cord rupture can be either partial or complete. Partial rupture happens when blood enters the Wharton's jelly and forms a hematoma, with the outer amniotic membrane of the umbilical cord remaining intact. Complete umbilical cord rupture occurs when the umbilical cord is completely broken, i.e., when both the blood vessels and the outer amniotic membrane of the umbilical cord are broken, blood enters the amniotic fluid, and bloodstained amniotic fluid appears.

Data regarding patient history, clinical presentation, prenatal ultrasound tests, fetal heart rate monitoring tests, placenta pathological examination results, treatment, and prognosis were collected. All patients who were diagnosed with umbilical cord vascular rupture were followed up for more than 3 months after delivery. Follow-up information included neonatal weight, length, and general growth (physical growth and mental development).

Statistical analysis was not undertaken in this study.

Results

There were eleven cases of umbilical cord vascular rupture in this study, three cases (cases 6, 8 and 10) of stillbirth occurred, all of them were detected by prenatal ultrasound at 39 weeks and umbilical cord vascular rupture were confirmed by postpartum placenta pathology examination. The insertion of umbilical cord was normal in 2 cases and normal in 1 case. although there were eight live neonates, four (cases 3, 4, 9, and 10) had severe neonatal asphyxia, and all were admitted to the neonatal intensive care unit for 1 to 63 days. None of the mothers had a history of chronic disease, immune disease, or other relevant conditions. Additionally, no patients presented with a history of birth complications or other unusual family conditions. Down syndrome prenatal screening tests predicted that all patients were at low risk. Prenatal tests also found six patients of premature rupture of the membranes or nuchal cords, five patients of anemia, four patients of cord velamentous insertion, two patients of gestational diabetes mellitus, two patients of racket placenta, and two patients of uterine fibroids. All six patients of abnormal placental insertion, including the four patients of cord velamentous insertion and two patients of racket placenta, had fetal distress or stillbirth (Table 1).

Prenatal color ultrasound was performed in all patients, of which six (cases 1,2,4,5,9, and 11) presented with an abnormality. For example, case 2 showed a repeatedly abnormal fetal cerebral blood flow spectrum and floccus floating in the amniotic fluid. Furthermore, three patients (cases 6,8, and 11) presented with decreased fetal movements and a vanishing fetal heart. Other patients showed an abnormal placental insertion. Before labor, the fetal heart rate monitoring of three patients (cases 6,8, and 11) showed fetal distress through the nonstress test, while three patients (cases 6,8, and 11) showed a similar result during labor (Table 2).

There were three cases of stillbirth who underwent ethacridine lactate intra-amniotic injection and vaginal delivery, and eight livebirths who underwent cesarean section. The Obstetric Rapid Response Team (RRT) performed emergency cesarean sections in fetal distress cases, and the time between detection of fetal heart abnormality and delivery was 5 to 13 minutes. Postpartum examination discovered that eight patients had blood stained amniotic fluid, two patients had clear amniotic fluid and one patient had III° foul amniotic fluid. Although all the umbilical cord lengths were within the normal range (37–65 cm), six had the umbilical cord around their necks (cases 3,4,6,8,9, and 10). Furthermore, pathological examination of postpartum placentas revealed that four patients had intrauterine infection (Table 2).

Among the eight live neonates, one neonate (case 9) died two days after birth due to severe complications, and one (case 1) had neonatal hyperbilirubinemia. No neurological sequelae, or other severe complications, were found in the remaining seven neonates after three months of follow-up, and all of them had a positive prognosis (Table 2).

Discussion

Spontaneous UCVR in pregnancy is a rare but catastrophic event which may lead to fetal death. Many patients do not present with characteristic manifestations and cannot get immediate treatment. Therefore, understanding the etiology and clinical manifestation of umbilical cord vascular rupture is of great importance for its diagnosis, treatment, and prognosis.

Clinical features of umbilical cord vascular rupture

The umbilical cord is a band that connects the umbilical chakra of the fetus at one end and the placenta at the other. There are three channels within the umbilical cord: two umbilical arteries and one umbilical vein. The umbilical cord is coated with a water-rich colloid connective tissue called Wharton's jelly, which plays a role in protecting the umbilical cord blood vessels. It is also covered by the amniotic membrane, which is free in the amniotic fluid. The umbilical cord is an important channel for nutrient supply, gas exchange, and metabolite excretion for the fetus^[6]. Spontaneous umbilical cord vascular rupture has no specific clinical symptoms and is often secondary to velamentous insertion^[7], shortness, and damage of the umbilical cord, and rupture of the membranes^[8]. It is therefore difficult to distinguish between placental abruption and other conditions that can cause fetal distress.

Prenatal color ultrasound may be the best way to screen for prenatal risk factors such as abnormal umbilical cord insertion and amniotic fluid. In this study, six patients had cord insertion abnormalities, of which four had velamentous insertion and two had ratchet placenta. The detection rate of the umbilical cord attachment site is closely related to gestational age, with about 67% being diagnosed at 15–20 weeks of gestation and 30% at 36–40 weeks of gestation^[9]. Therefore, screening in the middle of pregnancy is particularly important^[10–12]. One patient in our study had a repeatedly abnormal fetal cerebral blood flow spectrum and floccus floating in the amniotic fluid. Fetal movement and fetal heart rate monitoring were also important. Six patients were diagnosed with fetal stress by fetal heart rate monitoring^[13].

Causes of umbilical cord vascular rupture.

The umbilical cord is the main pathway of material exchange between the fetus and mother, and the blood flow through the umbilical cord at term is 125 mL/kg/min and may affect fetal growth and development if abnormal. Umbilical cord vascular rupture occurs predominantly during labor and is more common in late pregnancy. Vascular rupture can include artery rupture, vein rupture and arteriovenous rupture. The majority of patients had umbilical cord vein rupture (67%)^[5]. Arteriovenous rupture is a serious condition, and can easily lead to acute fetal blood loss, resulting in stillbirth. In this study, six (54.55%) patients (cases 2, 3, 4, 5, 9, and 10) had vein rupture, three (27.27%) patients (cases 6, 7, and 11) had artery and vein rupture which led to two stillbirths, and two (18.18%) patients (cases 1 and 8) had artery rupture. Most umbilical cord vascular rupture is associated with uterine contraction. When uterine contraction occurs, the fetus drops, leading to a relatively short umbilical cord which is weakly attached to the placenta edge. This results in umbilical cord vascular rupture and bleeding, followed by vaginal bleeding, fetal blood loss, and finally, death. Furthermore, umbilical cord vascular rupture is always caused by velamentous and marginal cord insertion^[14]. The rate of velamentous cord insertion (VCI) was approximately 0.5–1.8%^[14]. VCI caused a five-fold increase in the risk of manual removal of the placenta (birth at term: OR = 5.38; preterm birth: OR = 2.66); whilst curettage caused a three-fold increase and postpartum hemorrhage caused a two-fold increase^[14].

Treatment of umbilical cord vascular rupture

Early identification, enhanced monitoring

Umbilical cord vascular rupture is easily misdiagnosed as placental abruption due to its non-specific symptoms. Therefore, the key to early diagnosis is to recognize the disease and increase vigilance. Clinically, fetal distress found by fetal heart monitoring with or without bleeding may be the first sign. It has been reported that VCI is associated with abnormal intrapartum fetal heart rate (FHR) patterns e.g., variable decelerations with no accelerations (VDNA)^[15], low Apgar scores at 1 and 5 min, and neonatal death. It is thought that the variable decelerations occur as a result of cord compression. Usually, cord compression first obstructs the umbilical vein, which reduces fetal blood return and acceleration via

baroreceptors. Thereafter, both umbilical arteries and vein are completely obstructed, which induces fetal systemic hypertension and results in the deceleration of the FHR. VDNA should be considered a potential warning sign for VCI. If a branch of an umbilical cord blood vessel is broken, it may manifest as bloodstained amniotic fluid or bloodstained secretions, while rupture of large blood vessels may manifest as vaginal bleeding accompanied by a slow or absent fetal heart rate. Therefore, close attention should be paid to the amniotic fluid character after membrane rupture. Bloodstained amniotic fluid would be sufficient for a diagnosis before the rupture of great vessels.

RRT and shortened DDI

Since UCVR can lead to serious adverse neonatal outcomes, a rapid response team should be established to perform emergency cesarean sections. The decision to delivery interval (DDI) is one of the major evaluation indices of emergency cesarean section, and the recommendation is that it should be performed in under 30 min, by both the Royal College of Obstetricians and Gynecologists and the American College of Obstetricians and Gynecologists (ACOG)^[16]. Shortening the DDI can significantly improve neonatal prognosis and survival. However, ACOG has made a careful statement to highlight that not all DDI's of emergency cesarean section should be within 30 minutes. DDI of more than 30 minutes will not lead to adverse neonatal complications in all cases. Nonetheless, all delivery facilities should be able to perform emergency cesarean sections to ensure the safety, and achieve the fastest delivery, of newborns. Achieving this goal is dependent on the facility, the team, the fetal situation and the timing of the surgery^[17]. In this study, we found that in fetal distress patients, RRT was activated to perform emergency cesarean section, and the DDI was 5 to 13 minutes. Furthermore, all patients had good results, which supports the ACOG recommendations. A study of 39 291 neonates in Germany showed that low Apgar scores were less common in children when emergency cesarean sections were performed within 10 or 20 minutes. It seems reasonable to expect care-delivery structures to perform emergency cesarean sections within 20 minutes of the decision being made^[18]. Introduction of a management protocol to shorten DDI in emergent cesarean section for non responsive fetal heart monitoring as associated with improved early neonatal outcomes without changes in maternal complications^[19]. However, some studies have shown different results. Delivery was not achieved within the recommended time interval in the majority of category-1 emergency caesarean sections. The average decision to delivery time interval was longer than the recommended time but it did not affect feto-maternal outcomes^[20–21]. Factors associated with prolonged DDI included: moving the patient to an operation theater, anesthesia, lack of resources or manpower, time taken to collect surgical materials, time taken from decision and arrival to the operation theater, and time taken from arrival at the operation theater to skin incision. Improving communication skills between staff members and performing simulation drills to assess and improve obstetric team performance may shorten DDI. Furthermore, according to international recommendations, space optimization should be performed to decrease the time taken to move from the delivery room to the operating room, thereby shortening DDI to less than 30 or even 15 minutes.

Prognosis of umbilical cord vascular rupture

UCVR causes little damage to the mother. However, when vascular preposition occurs at the same time, there is a risk of prenatal and postpartum bleeding. Furthermore, during vascular crawl, due to insufficient blood supply, umbilical cord vascular rupture may be related to a variety of adverse pregnancy outcomes, such as fetal growth restriction, premature birth, premature rupture of membranes, abnormal fetal heart rate during delivery, low Apgar score, and even newborn death. Specifically, a low Apgar score may be the most common complication. When blood vessel rupture and massive bleeding occur, the fetus can die within 3 minutes and the mortality rate can be as high as 58%~73%^[22]. In this study, six patients with abnormal placental insertion had fetal distress or stillbirth before labor. Furthermore, although delivery was performed in 20 minutes, four of the eight live neonates still experienced severe asphyxia and one neonate died two days later.

Conclusions

Spontaneous UCVR is a rare and serious threat to perinatal birth life. Once vascular rupture occurs, the perinatal mortality rate is extremely high. For this reason, obstetricians should be familiar with and pay attention to its risk factors. Prenatal diagnosis and decisive management of umbilical cord vascular rupture are necessary to reduce perinatal mortality. The limitations of this study are as follows: the patients were from one hospital, belonging to a single center study, which may have selection bias, and the small- cased study with only eleven cases, requiring further study with a larger sample size in multiple centers.

Abbreviations

ACOG: American College of Obstetricians and Gynecologists; DDI: decision to delivery interval; FHR: fetal heart rate; RRT: rapid response team; UCVR:umbilical cord vascular rupture;VCI: velamentous cord insertion; VDNA: variable decelerations with no accelerations.

Declarations

Acknowledgments

Not applicable. All contributors meet the criteria for authorship.

Submission

The work described here has not been published and is not under consideration for publication by another journal.

Authors' contributions

Protocol/project development: JYL, JFZ, KHH, LYL, JYY. Data collection or management: JYL, JFZ, KHH. Data analysis: JYL, JFZ. Manuscript writing/editing: JYL, JFZ. All authors read and approved the final manuscript.

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Availability of data and materials

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

Approval was obtained from the ethics committee of the Fujian Provincial Maternity and Children's Hospital (Approval number 2020KY117). Administrative permissions and/or licenses were acquired by our team to access the data used in our research. The investigation was performed in accordance with the Declaration of Helsinki.

Participants were assured of anonymity and confidentiality. All study participants provided an informed written consent included the records of hospital after the aim of the study had been explained to them. All women were offered the right to refuse, or withdraw consent at any time during the study.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Tables

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