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CASE SERIES

# Umbilical Vessel Rupture Leading to Adverse Pregnancy Outcomes: Two Cases

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**Objective:** This study aims to alert authors and readers to the possibility of spontaneous umbilical vessel rupture in cases of sudden changes in fetal heart rate or bloody amniotic fluid.

**Methods:** We analyzed cases of spontaneous rupture of umbilical cord vessels at our hospital over the past three years. Two cases of patients who delivered at our hospital were analyzed, both of whom exhibited sudden changes in fetal heart rate during the prenatal period and subsequently underwent emergency cesarean sections. Intraoperatively, both cases revealed a succenturiate placenta with ruptured umbilical vessels and bleeding.

**Results:** Both cases resulted in adverse pregnancy outcomes due to succenturiate placenta and bleeding from ruptured umbilical vessels, with pathological examination of the placenta confirming the clinical diagnosis.

**Conclusion:** Enhancing the detection rate of prenatal ultrasound for placental membranacea and umbilical cord vessel abnormalities, coupled with timely intervention, is crucial for reducing perinatal mortality.

**Keywords:** umbilical vessel abnormalities, succenturiate placenta, pregnancy outcomes

## Introduction

The umbilical cord is a vital connection between the fetus and placenta, serving as the main pathway for nutrient acquisition and waste excretion for the fetus, as well as maintaining fetal life. Any factors affecting the smooth blood flow in the umbilical cord or causing bleeding can lead to fetal distress and even perinatal death. Spontaneous rupture of umbilical cord vessels is a rare obstetric complication that, when it occurs, can lead to acute fetal hemorrhage within a short period of time. The rupture may result in the formation of a hematoma, which can compress the vessels and cause obstruction, leading to impaired blood flow between the mother and fetus. This can result in acute intrauterine ischemia and hypoxia in the fetus, potentially leading to fetal demise and poor prognosis.Spontaneous rupture of the umbilical cord may be associated with cord abnormalities. Literature has reported that a bifid umbilical cord insertion, which is a different abnormal insertion method compared to membranous (velamentous) insertion, may increase the risk of adverse perinatal outcomes.[1] However, other studies have indicated that the majority of cases with bifid umbilical cord insertion have favorable outcomes; nonetheless, approximately 1.02% of cases may result in intrauterine fetal demise.[2] This article presents a retrospective analysis of cases of spontaneous umbilical cord vessel rupture at our institution over the past three years. The aim is to explore key diagnostic and therapeutic strategies to reduce adverse pregnancy outcomes and to minimize the incidence of poor maternal and fetal outcomes.

## General Information

We extracted data from the medical record system. This study received approval from the Ethics Committee of the Second Nanning People's Hospital. This clinical study adheres to the provisions of the Declaration of Helsinki, the

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Ethical Review Measures for Research Involving Human Life Sciences and Medical Research, the Administrative Measures for Investigator-Initiated Clinical Research in Medical and Health Institutions (Trial), and the Regulations on the Management of Human Genetic Resources of the People's Republic of China, as well as other relevant laws and regulations.

The Ethics Committee has agreed to waive the requirement for informed consent from the participants, as the study involves minimal risk and does not compromise the rights and welfare of the participants.

The project researchers will collectively bear the responsibility for maintaining the confidentiality of the participants' relevant information and commit to not disclosing any content related to the participants. Any public report of the results of this study will not reveal the personal identities of the participants. We will make every effort, within the bounds of the law, to protect the privacy of the participants' personal medical data and personal information.

# Case Report

## Case 1

A 28-year-old female patient presented to the obstetrics department on December 24, 2021, at 09:58, due to "irregular abdominal distension and pain for over 3 hours" at $38^{+4}$ weeks of gestation. She had regular prenatal check-ups with no significant abnormalities. A pregnant woman presented to our hospital on December 23rd at approximately 10 PM, reporting an increase in fetal movements without any apparent trigger. The frequency and amplitude of the movements had nearly doubled compared to her previous baseline. At that time, she did not experience any abdominal pain, vaginal bleeding, or fluid leakage. On December 24th at around 6 AM, she began to experience intermittent, irregular lower abdominal pain, which was mild and tolerable. There were no accompanying symptoms of vaginal bleeding or fluid leakage, and she reported that fetal movements felt normal. Consequently, she sought medical attention at our outpatient department, where a non-stress test (NST) was performed, indicating normal fetal monitoring results. Given her presentation, she was assessed as being in "threatened labor" and was subsequently admitted to the hospital. Upon admission, a specialized examination revealed that her abdomen was distended consistent with gestational age, with no tenderness or rebound tenderness noted. Upon admission, examination revealed a fundal height of 33 cm, abdominal circumference of 97 cm, vertex presentation, and fetal heart rate of 145bpm with irregular contractions. There was no vaginal bleeding or fluid. Vaginal examination showed a closed cervix with intact membranes (S-2). Auxiliary examination via ultrasound indicated an intrauterine pregnancy with a single viable fetus in the vertex position, with biparietal diameter of 89mm, head circumference of 330mm, abdominal circumference of 344mm, humeral length of 59mm, and femoral length of 66mm. The amniotic fluid index was approximately 174mm, with good acoustic transparency, and the placental maturity was graded as level II, with no significant abnormalities noted in umbilical blood flow. Fetal monitoring indicated normal non-stress test (NST) results. Admission diagnosis included: 1. Primigravida, $38^{+4}$ weeks, vertex presentation, pre-labor. After admission, a trial of labor was initiated. On December 25 at 02:00, the midwife noted a fetal heart rate fluctuation of 160–170bpm without fetal movement. Following physician orders, fetal heart monitoring was performed, revealing tachycardia with a baseline of 160–170bpm and moderate variability. Interventions included oxygen supplementation, intravenous fluids, and position changes, with continuous fetal monitoring. At 02:52, it was observed that the fetal heart rate rapidly dropped from 160bpm to approximately 60bpm. Despite stimulation, the fetal heart rate did not recover, and the patient exhibited no vaginal bleeding or fluid, with weak and irregular contractions. Immediate communication with the patient and family was conducted, suggesting fetal distress possibly due to placental abruption or ruptured umbilical vessel abnormalities, and recommending emergency cesarean section. The patient and family consented to the procedure, and preparations for neonatal resuscitation were made. An emergency cesarean section was performed under local and general anesthesia from 03:05 to 04:10 on December 25, 2021. A stillborn infant was delivered at 03:06, with approximately 400 mL of bloody amniotic fluid noted, alongside collapsed umbilical vessels. Intraoperative examination revealed an intact placenta and membranes, with the umbilical cord insertion point located on the membranes, approximately 5 cm from the placental insertion point, where a branch of the umbilical vessel was found to be ruptured with active bleeding (Figure 1). All placental and membrane specimens were sent for pathological examination, with intraoperative blood loss amounting to 300mL. Postoperative diagnosis

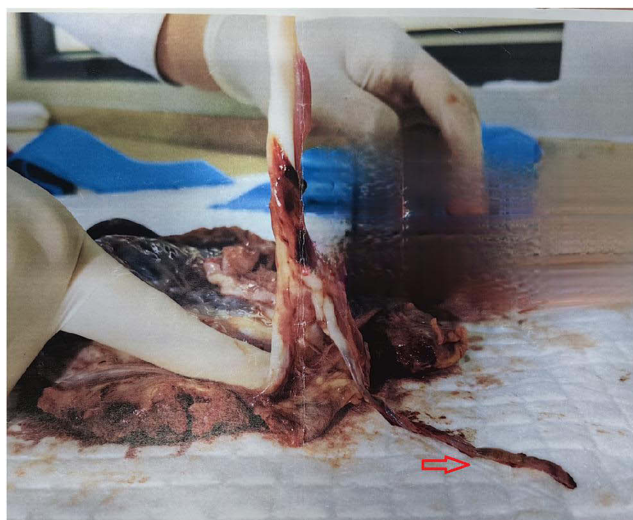

**Figure 1** Umbilical cord and placenta gross specimen image (red arrow indicates the ruptured umbilical cord blood vessels observed during surgery).

included: 1. Spontaneous rupture of umbilical vessels with bleeding; 2. Fetal distress; 3. Succenturiate placenta; 4. Primigravida, $38^{+5}$weeks, cesarean section; 5. Stillbirth. Pathological results confirmed succenturiate placenta with ruptured umbilical vessels. Macroscopic examination showed a succenturiate insertion of the umbilical cord with exposed vessels, located between the amniotic and chorionic membranes, with multiple dilated branches. A rupture site was observed approximately 5 cm from the placental insertion point. Microscopic examination confirmed significant vessel dilation and an increased number of vessels; mature late-stage placental tissue; no inflammatory cell infiltration in the chorionic membrane; three umbilical vessels. Findings supported the clinical diagnosis. The patient recovered well and was discharged on December 31, 2021.

## Case 2

A 33-year-old female patient presented to the emergency department on July 14, 2024, at 21:30, due to "vaginal fluid leakage for over 1 hour" at $35^{+5}$ weeks of gestation. She had regular prenatal check-ups, and a four-dimensional ultrasound indicated an intrauterine pregnancy with a single viable fetus, corresponding to approximately 22 weeks of gestation, with no significant abnormalities noted in umbilical blood flow. The umbilical cord insertion point was located at the lower edge of the placenta, indicating marginal insertion. Further relevant examinations showed no abnormalities. On July 14th at approximately 8 PM, the patient experienced vaginal fluid leakage without any apparent trigger, with an estimated volume of about 10 mL and clear in color. At that time, she did not report any abdominal distension or pain, nor any vaginal bleeding, and she felt that fetal movements were normal. She then presented to our hospital for evaluation, where a non-stress test (NST) indicated normal fetal monitoring results. Upon examination, clear fluid was observed at the vaginal opening, and the pH test strip turned blue. The emergency assessment suggested "premature rupture of membranes", and she was admitted to the hospital. Upon admission, a specialized examination revealed that her abdomen was distended consistent with gestational age, with no tenderness or rebound tenderness noted. Examination revealed a fundal height of 33 cm, abdominal circumference of 98 cm, vertex presentation, shallow engagement, and a fetal heart rate of 142bpm, with irregular contractions and a small amount of clear vaginal fluid. Vaginal examination showed a closed cervix with ruptured membranes and positive pH test (S-3). Auxiliary examination via ultrasound indicated an intrauterine pregnancy with a single viable fetus in the vertex position, with biparietal diameter of 86mm, head circumference of 330mm, abdominal circumference of 313mm, humeral length of 59mm, and femoral length of 69mm. The amniotic fluid index was approximately 56mm, with a maximum depth of 26mm, and the fetal umbilical cord was noted to be wrapped around the neck twice. Placental maturity was graded as level II, with no significant abnormalities noted in umbilical blood flow. Fetal monitoring indicated normal NST results. Admission diagnosis included: 1. Premature rupture of membranes; 2. Multiparous, $35^{+5}$weeks, vertex presentation, preterm labor; 3. Fetal

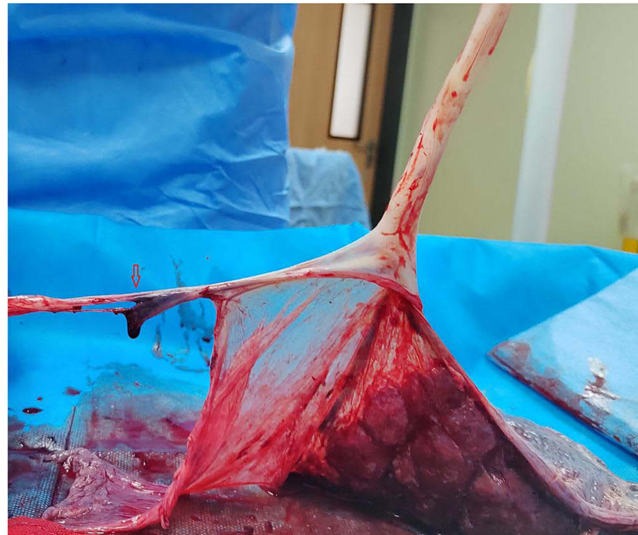

**Figure 2** Umbilical cord and placenta gross specimen image (red arrow indicates ruptured umbilical cord vessels).

umbilical cord wrapped around the neck twice; 4. In vitro fertilization. After admission, a trial of labor was initiated, and due to premature rupture of membranes and irregular contractions, intravenous oxytocin induction was administered on July 15 at 07:00. OCT results were negative. At 08:46, fetal monitoring indicated prolonged deceleration, and a vaginal examination revealed approximately 100mL of bloody amniotic fluid with a closed cervix. Immediate communication with the patient and family was conducted, suggesting possible fetal distress, placental abruption, or ruptured vessels, necessitating emergency cesarean section. An emergency cesarean section was performed under local and general anesthesia at 08:58, resulting in the delivery of a live infant with the umbilical cord wrapped around the neck once. Intraoperative blood loss was 500mL, and the newborn's Apgar scores were 3 at 1 minute, 5 at 5 minutes, 7 at 10 minutes, and 9 at 15 minutes. Intraoperative examination of the placenta revealed umbilical cord insertion on the membranes, with several vessels traversing the membranes, one of which was ruptured with visible bleeding (Figure 2). All placental and membrane specimens were sent for pathological examination. The newborn was transferred to the neonatal department for treatment due to "severe neonatal asphyxia." Postoperative diagnosis included: 1. Ruptured vasa previa; 2. Fetal distress; 3. Premature rupture of membranes; 4. Multiparous, $35^{+6}$ weeks, cesarean section; 5. Fetal umbilical cord wrapped around the neck twice; 6. In vitro fertilization; 7. Succenturiate placenta; 8. Preterm birth. Pathological examination results indicated: 1. Succenturiate placenta; 2. Mature late-stage placental tissue; placental villi were mature with no significant infarction; normal number of umbilical vessels with no significant abnormalities. Special stains (Ag, PAS) supported the diagnosis. The patient recovered well and was discharged on July 19, 2024.

## Discussion

The umbilical cord is an essential connection between the fetus and placenta, serving as a critical pathway for gas exchange, nutrient supply, and waste excretion between the mother and fetus. It is the lifeline for fetal growth and survival. Umbilical cord abnormalities are a type of pathological placental disease, encompassing issues related to the site of cord attachment, length, diameter, twisting, number of vessels, and integrity of the cord.[3] A related study indicates that approximately 19% of fetal deaths are associated with umbilical cord abnormalities.[4] Currently, cord factors are considered the primary cause of intrauterine fetal demise in late pregnancy, followed by placental and fetal factors, as well as infections.[5] Therefore, any factors that impair blood flow in the umbilical cord can jeopardize fetal health, leading to various adverse outcomes, such as fetal growth restriction (FGR), fetal distress, neonatal asphyxia, or death. Spontaneous rupture of umbilical cord vessels is a rare umbilical cord abnormality that is often difficult to identify and diagnose early; however, it is usually fatal for the fetus.

The umbilical cord comprises two umbilical arteries and one umbilical vein, surrounded by a gelatinous substance known as Wharton's jelly.[6] This anatomical structure helps transport oxygen and essential nutrients from the maternal blood supply to the fetal circulatory system while also removing waste products from the fetal circulation. A study by Valentino Remorgida et al noted that abnormalities in the number of umbilical cord vessels are associated with adverse pregnancy outcomes, with a single umbilical artery being the most common abnormality. It occurs in approximately 1% of singleton pregnancies and up to 5% of twin pregnancies. The presence of a single umbilical artery may result from primary developmental deficiencies of the umbilical artery or thrombotic atrophy, and it is closely associated with risks of perinatal mortality, stillbirth, and fetal malformations, particularly in the cardiovascular, gastrointestinal, and urinary reproductive systems.[7] Normally, the umbilical vessels distribute in a fan-like manner at the placenta, where Wharton's jelly provides support and protection, making them less prone to rupture or bleeding. However, when the umbilical cord attaches abnormally to the placenta, the vessels may lack the protective support of Wharton's jelly, making them more susceptible to rupture. This can lead to acute fetal hemorrhage and hypoxia, resulting in rapid fetal demise. Even with timely diagnosis and treatment, there can still be varying degrees of neonatal asphyxia.[8] There are two types of abnormal umbilical cord attachment: one is when the umbilical cord attaches to the placenta within 2 cm of the placental margin, known as a "battledore placenta", with an incidence of 1.9% to 15%.[9] The other is when the umbilical cord attaches to the membranes, with the vessels traversing through the amniotic membrane to the placenta, termed "succenturiate placenta", which has an incidence of 0.1% to 13.6%.[10] The incidence is about 1% in singleton pregnancies and more common in multiple pregnancies (with reports indicating that 45% of monozygotic twins may have a succenturiate placenta).[11] If the umbilical vessels cross the lower uterine segment or the cervical os, it is diagnosed as vasa previa, which occurs in 14% of cases.[12] In cases of battledore placenta, the umbilical vessels are still protected by Wharton's jelly, making them less likely to rupture or be compressed during delivery, thus having minimal effects on the mother and fetus. These cases are often discovered during prenatal ultrasounds or post-delivery examinations of the placenta. In contrast, succenturiate placenta exposes the vessels, which can become compressed during labor, leading to fetal hypoxia. After the rupture of membranes, exposed vessels are at a high risk of bleeding, and the fetus has poor tolerance to blood loss, which can lead to fetal distress and even fetal death.[13–16] Vasa previa associated with a succenturiate placenta is an absolute indication for cesarean delivery. The umbilical vessels are unprotected beneath the presenting part of the fetus, and factors such as membrane rupture, uterine contractions, and cervical dilation during labor can lead to traction and compression of the umbilical vessels. This can result in severe ischemia and hypoxia, and in severe cases, it may lead to vessel rupture, causing significant hemorrhage. This situation can directly result in intrauterine fetal demise within a short period, significantly increasing the rates of fetal mortality and neonatal asphyxia.[17]

Spontaneous rupture of umbilical vessels is extremely rare and usually occurs due to vascular dilation, vessel wall injury, or separation of the elastic layer of the vessel wall, indicating structural abnormalities of the umbilical cord. This type of bleeding does not constitute maternal hemorrhage but rather fetal blood loss, as fetal blood enters the amniotic fluid, resulting in bloody amniotic fluid. Once this occurs, the fetus may experience acute blood loss in a short time, leading to perinatal asphyxia and death, making it one of the significant causes of perinatal mortality.[18] Therefore, early diagnosis and timely intervention are crucial in reducing perinatal mortality rates.Fetal movements may lead to injuries to the umbilical vessels, particularly when oxytocin is used to induce labor. If there is a sudden decrease in fetal heart rate for no apparent reason, the possibility of umbilical cord injury should be considered, and cesarean delivery should be performed as soon as possible.[19] Ultrasound examination has been confirmed as the most commonly used and reliable method for diagnosing umbilical vessel abnormalities.[20] Velamentous insertion of the umbilical cord can reliably be detected prenatally by gray-scale and color Doppler ultrasound.[21] In the two cases presented in this article, prenatal ultrasound examinations did not reveal any succenturiate placenta or vasa previa, and both patients had normal prenatal check-ups without any vaginal bleeding. However, during labor, fetal heart monitoring showed sudden decelerations in fetal heart rate, which can easily confuse obstetricians. They may not readily consider that the changes in fetal heart rate could be due to umbilical cord vessel rupture and bleeding, as this presentation is very similar to that of concealed placental abruption, making it difficult to differentiate during prenatal assessment. In the two cases presented in this article, prenatal ultrasound did not reveal any succenturiate placenta, and neither patient exhibited vaginal bleeding before delivery; however, both displayed sudden decelerations in fetal heart

rate, which are clinically similar to concealed placental abruption, making it challenging to differentiate prenatally. During cesarean sections for both cases, a succenturiate placenta with ruptured umbilical vessels was discovered, and pathological results supported the clinical diagnosis. Therefore, in cases of slight vaginal bleeding or no vaginal bleeding but significant changes in fetal heart rate, the possibility of ruptured umbilical vessels must be considered. The only effective management for this condition is early detection, diagnosis, and intervention; otherwise, the perinatal mortality rate remains high.

To improve the diagnostic rate of vasa previa and succenturiate placenta during prenatal examinations, it is essential to archive images of the insertion site of the umbilical vessels into the placenta during mid-pregnancy fetal structural anomaly screening via ultrasound. For cases with abnormal insertion of the umbilical vessels, it is advisable to conduct thorough multi-plane scans of the insertion site in subsequent ultrasound examinations to check for a succenturiate attachment to the placenta. Since diagnosing late-stage succenturiate placenta with vasa previa can be challenging due to the influence of the fetal head, it may be necessary to advise the pregnant woman to have a moderately full bladder and to use a combination of transabdominal and transvaginal ultrasound for examination. The reasons for missed and mis-diagnoses are primarily related to the ultrasound physician's awareness of succenturiate placenta, the thoroughness of the examination, the techniques used, and a lack of experience. Research by Rao KP[22] and others has indicated that a certain proportion of cases of intrauterine fetal demise and fetal distress are associated with vasa previa and succenturiate placenta. Utilizing three-dimensional imaging technology can significantly enhance the diagnosis of succenturiate placenta and vasa previa.

The two cases presented in this article serve as a warning to the authors: obstetric practitioners must not only have sufficient knowledge of this condition but also maintain a high level of sensitivity to the symptoms it presents or changes in fetal heart rate. Additionally, the technical skills of ultrasound physicians should be improved to effectively increase the detection rate of succenturiate placenta and umbilical vessel abnormalities, providing essential reference for clinical diagnosis and treatment.

In summary, umbilical cord abnormalities are a primary factor contributing to intrauterine fetal demise in late pregnancy. Therefore, if prenatal ultrasound examinations identify abnormal umbilical cord insertion and appropriate management is implemented, the risk of intrauterine fetal death or neonatal asphyxia may be significantly reduced. We hope that future research will focus on standardizing detection methods for abnormal umbilical cord insertion or umbilical vessel anomalies.

## Data Sharing Statement

All data are available in the manuscript.

## Ethics Approval and Consent to Participate

This study received approval from the Ethics Committee of the Second Nanning People's Hospital [Y2025015].

## Consent for Publication

Informed consent was obtained from both patients for the publication of this case report and any clinical images.

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MeiRong He and KaiSun Zhao are co-first authors for this work. We would like to thank all patients who have made genuine contributions to the article and who endorse the data and conclusions.

## Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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## Disclosure

The authors have no conflicts of interest to declare in this work.

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