Article published online: 2024-10-01

Original Article

Spontaneous Umbilical Cord Vascular Rupture during Labor: A Retrospective Analysis of 12 Cases

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Abstract

Objective Umbilical cord vascular rupture is a rare and severe condition that can occur during labor, leading to adverse outcomes for the fetus before as well as after delivery. Prompt diagnosis and intervention are crucial for improving the chances of a successful outcome. We aimed to analyze cases of umbilical cord vascular rupture during labor to provide insights into this challenging condition.

Study Design This retrospective study evaluated the medical records of patients diagnosed with umbilical cord vessel rupture or umbilical cord hematoma at Fujian Maternity and Child Health Hospital from January 1, 2015, to May 31, 2023. The inclusion criteria included gestational age of $\geq$28 weeks, occurrence during labor, and availability of complete delivery data. Data on fetal heart rate (FHR) changes, delivery intervals, intraoperative findings, placental pathology, and neonatal outcomes were collected and analyzed.

Results A total of 12 cases were analyzed. The incidence of umbilical cord vascular rupture during childbirth was 0.08%. The FHR patterns in umbilical cord rupture during delivery included baseline tachycardia, minimal or absent variability, variable or late deceleration, prolonged deceleration, and undetectable heart rate. The bradycardia-to-delivery interval (BDI) ranged from 6 to 26 minutes. Among the 12 neonates, 9 were discharged well, 2 were stillbirths, and there was 1 neonatal death. Hemorrhagic shock was common in live births.

Conclusion Our study highlights the significance of continuous FHR monitoring during labor and the urgent need for medical teams to respond quickly in cases of umbilical cord vascular rupture. Despite advancements in neonatal resuscitation techniques, managing cases with undetectable fetal heart activity remains clinically challenging, and even with immediate pregnancy termination, poor neonatal outcomes may still occur.

Keywords

- umbilical cord vascular rupture
- labor
- velamentous cord insertion
- fetal heart rate monitoring
- emergency response

received
August 21, 2024
accepted after revision
September 6, 2024

DOI https://doi.org/10.1055/a-2412-3169.
ISSN 0735-1631.

Thieme Medical Publishers, Inc., 333 Seventh Avenue, 18th Floor, New York, NY 10001, USA

Key Points

- Umbilical cord vascular rupture during labor is a rare event.
- Its clinical management presents significant challenges.
- Advances in neonatal resuscitation have improved rescue success rates.
- In such cases, hemorrhagic shock is common in live births.

Umbilical cord vascular rupture is a rare but potentially life-threatening condition characterized by the development of a localized hematoma within the umbilical cord or leakage of blood into the amniotic cavity due to a ruptured vessel. Although it can occur during pregnancy, it is more commonly observed during labor.[1,2] Prompt extraction of the fetus is crucial as the condition can be life-threatening. Dipple[3] reported an incidence rate of 1 in 5,505 and a perinatal mortality rate of 50%. Diagnosis is typically made postnatally, although prenatal ultrasonography may detect it incidentally.[4] However, the prediction or prevention of stillbirths remains challenging. During labor, this condition presents as a catastrophic event requiring swift health care team intervention because of the narrow intervention window.[5,6] Considering that the existing literature on umbilical cord vascular rupture primarily comprises case reports, this study aimed to provide a comprehensive understanding of this condition through retrospective analysis to offer insights into its characteristics and management.

Materials and Methods

In this retrospective study, the medical records of patients diagnosed with umbilical cord vessel rupture or umbilical cord hematoma at Fujian Maternity and Child Health Hospital, China, were reviewed. The inclusion criteria comprised gestational age of ≥28 weeks, occurrence during labor, and availability of complete delivery data. Cases demonstrating evidence of umbilical cord vascular rupture or umbilical cord hematoma resulting from traction during placental delivery or cord blood sampling were excluded.

From January 1, 2015, to May 31, 2023, data were collected using the Clinical Electronic Medical Record System. The collected information included the characteristics of fetal heart rate (FHR) changes during labor, fetal bradycardia-to-delivery interval (BDI), intraoperative findings, placental pathology, and neonatal outcomes.

In this hospital, fetal monitoring during labor includes intermittent or continuous cardiotocography (CTG), chosen based on the progress of labor, high-risk factors, and the mother's level of cooperation. Continuous CTG is used during the active and second stages of labor unless the mother adopts a free position. Abnormal FHR patterns were classified according to National Institute of Child Health and Human Development Research Workshop guidelines.[7] FHR monitoring was interpreted by two obstetricians with over 5 years of experience.

Results

From January 1, 2015, to May 31, 2023, a total of 149,450 deliveries were performed at Fujian Maternity and Child Health Hospital. Eighteen cases of umbilical cord vessel rupture or umbilical cord hematoma were identified in the discharge or pathological diagnosis records using the keywords "umbilical cord vessel rupture" and "umbilical cord hematoma." After excluding cases suspected to be caused by placental delivery and those occurring before labor onset, 12 cases remained. The incidence of umbilical cord vascular rupture during childbirth at this tertiary hospital was 0.08%.

Among these cases, five occurred in the second stage, two in the active phase (cervical dilation of 8–9 cm), and five in the latent phase of labor. The FHR before delivery exhibited various patterns: one case with baseline tachycardia and minimal variability, four with variable or late decelerations and absent FHR variability, three with prolonged decelerations (including one with FHR disappearance after 2 min), and three with undetectable FHR. ►**Fig. 1** shows prolonged

Fig. 1 Prolonged decelerations in fetal heart rate (FHR) monitoring of Case 6. The figure depicts a sequence of prolonged decelerations in the FHR monitoring for Case 6, which persisted for approximately 2 minutes and were followed by a period where the FHR could not be detected. Prior to the occurrence of these decelerations, the FHR pattern had been normal. bpm, beats per minute. UC, uterine contraction pressure.

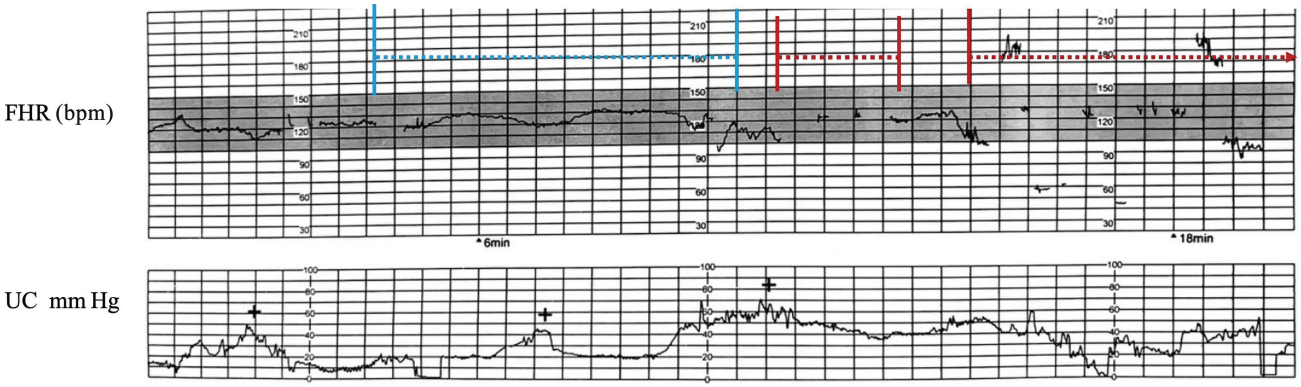

Fig. 2 Absence of fetal heart rate (FHR) baseline variability before deceleration in Case 8. This figure illustrates the absence of FHR baseline variability prior to deceleration in Case 8. The blue line area indicates the absence of FHR variability, followed by the appearance of FHR deceleration. The red line area denotes the zone of FHR deceleration, which is displayed less clearly in the figure due to difficulties in FHR capture. bpm, beats per minute.

decelerations in FHR monitoring before Case 6's emergency cesarean section, while ►**Fig. 2** illustrates the absence of FHR baseline variability before deceleration in Case 8.

Regarding the delivery mode, 2 cases involved vaginal delivery, while the remaining 10 required emergency termination of pregnancy: 3 via forceps delivery and 7 through emergency cesarean section. The BDI ranged from 6 to 26 minutes. Further clinical characteristics are detailed in ►**Table 1** and summarized in ►**Table 2**.

Of the 12 cases, 5 had velamentous cord insertion (VCI) and three had marginal cord insertion (MCI). ►**Fig. 3** illustrates the second-trimester ultrasound image of Case 9, demonstrating a VCI. No cases of excessively short umbilical cords were observed, but seven had relatively short cords (37–50 cm) with entanglement. Eight cases showed ruptured umbilical vessels or their branches (fetal surface vessels) with bloody amniotic fluid, while four exhibited an umbilical cord or subchorionic hematoma on the fetal side of the placenta. Macroscopic examination of the placentas revealed vein rupture in six cases, with unspecified vessel types in the rest.

Three cases (Cases 2, 4, and 10) had undetectable FHR upon discovery, leading to two stillbirths and one neonatal death. Ultrasonography detected isolated valvular motion in these fetuses before immediate delivery; however, adverse outcomes persisted despite delivery intervals of 2 to 6 minutes. In Case 7, FHR deceleration progressed to FHR disappearance, and the newborn was delivered 6 minutes later, with Apgar scores of 0 at 1 minute, 0 at 5 minutes, 0 at 10 minutes, 1 at 15 minutes, 2 at 17 minutes, and 3 at 25 minutes. Despite the initial challenges, the newborn was discharged from the hospital in good health.

Among the nine patients discharged in good health, two underwent mother–infant rooming-in, while seven were admitted to the neonatal intensive care unit. Neonatal hemoglobin levels ranged from 60 to 118 g/L, with the main complications including hemorrhagic shock in seven cases, hypoxic–ischemic encephalopathy in six cases, and neonatal respiratory failure in seven cases. Details of the newborn outcomes are presented in ►**Table 3**.

Discussion

Spontaneous umbilical cord vascular rupture before delivery is rare and severe. Monitoring the FHR during labor is crucial for timely intervention and increasing the live birth rate. Our study unveiled the incidence of umbilical cord vascular rupture during labor as 0.08%, with a stillbirth and neonatal mortality rate of 27.27%, lower than the reported rate of 50% in the literature,[1,2] encompassing cases during pregnancy.

Risk factors contributing to the occurrence of umbilical cord vascular rupture include morphological anomalies of the umbilical cord such as abnormal length and thickness, presence of true knots, cord prolapse, traction or torsion, VCI of the cord, vessel wall abnormalities, umbilical cord cysts, abdominal trauma during pregnancy, infection, deficiency of Wharton's jelly, congenital defects, and other unexplained factors.[8] In our study, we observed that 7 out of 12 cases had a cord length of 37 to 50 cm and were accompanied by a nuchal cord, resulting in a shorter effective cord length. Abnormal cord insertions such as VCI and MCI, are known to increase the risk of adverse pregnancy outcomes.[9,10] This is due to the lack of protection provided by Wharton's jelly in VCI and scanty placental tissue support in MCI. While VCI and MCI occur in 0.4 to 11% and 6.3% of all singleton pregnancies, respectively, we observed a significantly higher incidence of 72.73% (five cases of VCI and three cases of MCI) in our study. Therefore, abnormal cord insertion, particularly VCI, should be carefully assessed when evaluating the risk of labor.

The research pinpointed additional possible reasons, such as chorioamnionitis (four cases), Wharton's jelly deficiency (one case), and insufficient development of villous smooth muscle (one case), as influential contributors. Nonetheless, targeted placental pathological evaluation was missed in certain instances, hindering our capacity to identify the root causes of umbilical vessel rupture or hematoma development.

Christensen et al[11] reported that fetal blood loss exceeding 40 mL/kg significantly increased the risk of stillbirth or major morbidity. In our study, hemorrhagic shock was diagnosed in 7 of 10 live births, emphasizing the urgent need for prompt intervention when umbilical vessel rupture occurs.

Table 1 Clinical characteristics of the umbilical cord vascular rupture in labor

Case	Parity	GA (wk)	Cervical dilation (cm)	Complications	FHR abnormalities	BDI (min)	Delivery mode	Length of cord (cm)/ UCAN (loop)	Cord insertion	Amniotic fluid	Macroscopic lesion	Relevant placental pathologies	Neonatal outcome
1	1	39	10	PROM	Absent baseline variability with recurrent variable decelerations	10	Forceps delivery	65/0	VCI	Normal	Fetal surface vessel rupture with a 10.0 cm × 10.0 cm subamniotic hematoma at UCI	No specific findings	Discharged well
2	0	39	3	Placental abruption	FHR was not detectable, isolated valve movement was detected by ultrasonography 5 minutes before delivery	–	UCD	37/1	VCI	Bloody	Umbilical vein rupture at the UCI	Extravascular Wharton's jelly was scarce. Thrombosis in the intervillous space with focal hemorrhage	Stillbirth
3	1	39	2	PROM	Tachycardia (170 bpm) with minimal variability lasting for over 1 hour	–	UCD	45/1	MCI	Normal	Fetal surface vascular rupture with a 5 × 4 cm subamniotic hematoma at the UCI	No specific findings	Discharged well
4	1	38	4	PROM, placental abruption	FHR was not detectable, isolated valve movement was detected by ultrasonography 2 minutes before delivery	–	UCD	48/1	VCI	Bloody	Umbilical vein rupture at the UIC	Partial ischemia of the chorionic villi, focal vascular dilation, and bleeding on the maternal side of the placenta	Newborn death
5	1	38	10	PROM	Absent baseline variability with recurrent variable decelerations	6	Vaginal delivery	38/1	CCI	Bloody	Umbilical vein rupture at the UCI	Chorioamnionitis	Discharged well
6	0	39	8	–	Prolonged deceleration and FHR was not detectable 2 minutes later	8	UCD	40/1	CCI	Bloody	Umbilical vein rupture at the UCI	No specific findings	Discharged well
7	0	39	9	–	Prolonged deceleration	18	UCD	45/1	MCI	Bloody	Umbilical vein rupture at the UCI	Chorioamnionitis	Discharged well
8	0	38	2	PROM	Absent baseline variability with variable decelerations	26	UCD	60/0	VCI	Bloody	Umbilical vascular rupture at the UCI	No specific findings	Discharged well
9	0	39	10	Oligohydramnios	Absent baseline variability with recurrent late decelerations. The FHR nadir was 65 bpm	19	Forceps delivery	60/0	VCI	Normal	Fetal surface vascular rupture with a 4.5 × 5.0 cm subamniotic hematoma	Chorioamnionitis	Discharged well
10	0	39	10	–	FHR was not detectable, isolated valve movement was detected by ultrasonography 6 minutes before delivery	–	Forceps delivery	40/0	MCI	Bloody	Fetal surface vascular rupture 1.5 cm away from the UCI	Poor development of the villous smooth muscle and the terminal villi were significantly hypoxic	Stillbirth
11	0	41	2	–	Prolonged deceleration (50–60 bpm)	22	UCD	65/0	CCI	Normal	Umbilical vascular rupture with a 3.0 × 3.0 cm hematoma at the UCI	Chorioamnionitis	Discharged well
12	0	39	10	Precipitate labor	No FHR abnormalities detected	–	Vaginal delivery	50/1		Bloody	Umbilical vascular rupture at the UCI	Chorioamnionitis	Discharged well

Abbreviations: BDI, fetal bradycardia-to-delivery interval; bpm, beats per minute; CCI, central cord insertion; FHR, fetal heart rate; GA, gestational week; MCI, marginal cord insertion; PROM, premature rupture of membrane; UCAN, umbilical cord around the neck; UCD, urgent cesarean delivery; UCI, umbilical cord insertion; VCI, velamentous cord insertion.

Table 2 Neonatal outcomes

Case	Sex	Neonatal weight (g)	GA (weeks)	Apgar 1-5-10 min	Admission to the NICU	Hgb (g/L)	Hct	pH	Hospital stay (days)	Major complications	Neonatal outcome
1	Male	3,600	39	9-10-10	No	–	–	–	–	No	MIS, discharged well
2	Female	2,950	39	0-0-0; 0 25 minutes	–	–	–	–	–	–	Stillbirth
3	Female	3,950	39	9-10-10	No	–	–	–	–	No	MIS, discharged well
4	Male	3,560	38	0-1-2	Yes	60	17.6	7.17	1	Hemorrhagic shock, HIE, NRF, MODS	Neonatal death within 24 hours
5	Female	3,245	38	2-4-6	Yes	78	22.9	7.38	9	Hemorrhagic shock, NRF, HIE, DIC	Discharged well
6	Male	3,180	39	0-0-0; 1 15 minutes, 2 17 minutes, 3 25 minutes	Yes	88	23.8	7.06	24	Hemorrhagic shock, NRF, HIE, pneumorrhagia	Discharged well
7	Female	2,620	39	0-6-10	Yes	118	35	6.81	10	Hemorrhagic shock, NRF, HIE	Discharged well
8	Male	2,920	38	3-3-6	Yes	86	24.5	7.35	8	Hemorrhagic shock, NRF, HIE	Discharged well
9	Male	3,180	39	5-8-8	Yes	110	35.6	7.31	11	Hemorrhagic shock, NRF	Discharged well
10	Female	3,410	39	0-0-0; 0 20 minutes	–	–	–	–	–	–	Stillbirth
11	Female	2,955	41	1-6-9	Yes	119	34.4	7.31	6	Hemorrhagic shock, NRF, HIE	Discharged well
12	Female	3,160	39	10-10-10	Yes	110	31.8	7.2	6	No	Discharged well

Abbreviations: DIC, disseminated intravascular coagulation; GA, gestational age; Hct, hematocrit; Hgb, hemoglobin; HIE, hypoxic–ischemic encephalopathy; MIS, mother–infant rooming-in; MODS, multiple organ dysfunction syndrome; NICU, neonatal intensive care unit; NRF, neonatal respiratory failure.

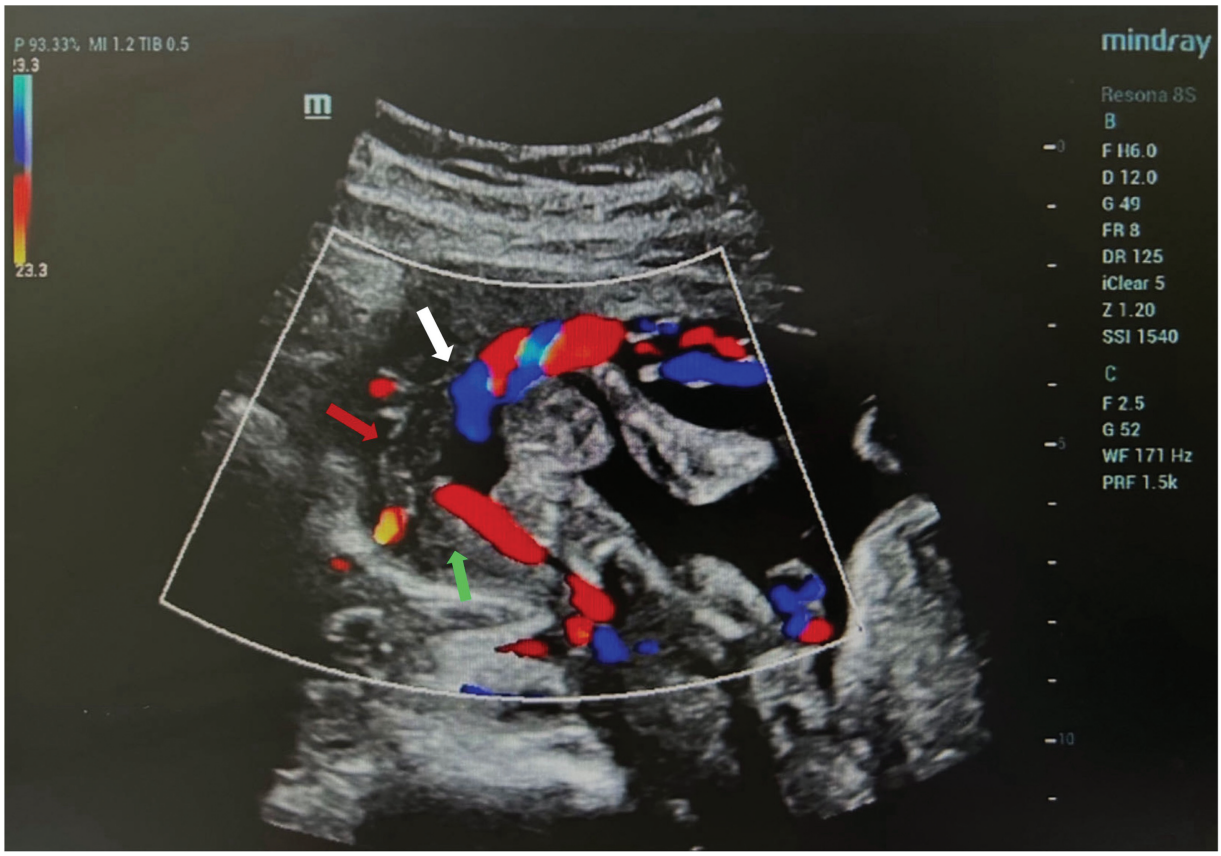

Fig. 3 Ultrasound image of velamentous cord insertion in Case 9. Second-trimester ultrasound image of Case 9 reveals velamentous cord insertion. The white arrow points to the location of the umbilical cord insertion, while the red arrow indicates the amniotic membrane and the green arrow denotes the placenta.

Table 3 Summary of clinical characteristics

Indicators	Total ($n = 12$)
FHR abnormalities	
Tachycardia with minimal variability	1
Absent baseline variability with variable decelerations	3
Absent baseline variability with recurrent late deceleration	1
Prolonged deceleration	3
FHR was not detectable	3
No FHR abnormalities detected	1
Complications	
PROM	5
Placental abruption	2
Oligohydramnios	1
Stages of labor	
Latent phase	5
Active phase	2
Second stage of labor	5
Delivery mode	
UCD	7
Forceps delivery	3
Vaginal delivery	2
Umbilical cord attachment	
VCI	5
MCI	3
CCI	4
Neonatal outcome	
Stillbirth	2
Newborn death	1
Discharged well	9
Apgar (5 min) >5	6
Apgar (5 min) ≤5	4

Abbreviations: CCI, central cord insertion; FHR, fetal heart rate; MCI, marginal cord insertion; PROM, premature rupture of membranes; UCD, uncomplicated delivery; VCI, velamentous cord insertion.

Among cases with detectable FHR abnormalities (9/13), deceleration was the predominant pattern observed, accompanied by a decrease or disappearance of baseline variability and tachycardia. These findings are consistent with those of previous reports on fetal heart characteristics in cases of acute fetal blood loss during labor.[6,12] The nine newborns in our study had favorable outcomes, with a BDI ranging from 6 to 26 minutes. Emergency delivery, as long as fetal heart activity is present, offers a significant chance of survival, depending on the hospital's emergency response and neonatal resuscitation capabilities.

An undetectable FHR could signal fetal cardiac arrest. In theory, the most efficient revival actions should commence within the initial 4 to 6 minutes postevent. However, precisely determining the timing of fetal cardiac arrest presents challenges. The time required for health care personnel to respond and make decisions may delay immediate resuscitation, as demonstrated in Cases 2, 4, and 10 of our study. In Case 7, worsening of bradycardia led to an undetectable heart rate, and successful delivery occurred in just 6 minutes. Subsequently, immediate resuscitation of the newborn ensued, resulting in the survival of the newborn. Therefore, making urgent clinical decisions in situations where the FHR remains undetectable during labor is not only critical but also presents significant challenges.

Conclusion

In conclusion, the continuous application of intrapartum FHR monitoring, optimization of emergency termination of pregnancy procedures, and advancements in neonatal resuscitation have significantly increased the success rate of rescuing patients with umbilical cord vascular rupture during delivery. However, if fetal heart activity cannot be detected, the likelihood of adverse neonatal outcomes is high when emergency pregnancy termination is performed. Targeted examinations of the placenta, including gross inspection and pathological analysis, may offer valuable insights into the underlying factors.

Ethical Approval

Ethics approval for this study was granted by the Ethics Committee of Fujian Maternity and Child Health Hospital (approval no.: 2024KY053).

Authors' Contributions

R.C. conceptualized and designed the study, and curated and analyzed the data with L.L. R.C. wrote the manuscript and conducted a critical review. Both R.C. and L.L. reviewed the final manuscript, giving their approval for publication.

Funding

This work was supported by Joint Funds for the Innovation of Science and Technology, Fujian province (grant no.: 2023Y9392).

Conflict of Interest

None declared.

Acknowledgments

The authors are grateful to all the participants.

References

1 Breen JL, Riva HL, Hatch RP. Hematoma of the umbilical cord; a case report. Am J Obstet Gynecol 1958;76(06):1288–1290
2 Irani PK. Haematoma of the umbilical cord. BMJ 1964;2(5422):1436–1437
3 Dipple AL. Haematomas of the umbilical cord. Surg Gynecol Obstet 1940;70:51–57
4 Chou SY, Chen YR, Wu CF, Hsu CS. Spontaneous umbilical cord hematoma diagnosed antenatally with ultrasonography. Acta Obstet Gynecol Scand 2003;82(11):1056–1057
5 Seoud M, Aboul-Hosn L, Nassar A, Khalil A, Usta I. Spontaneous umbilical cord hematoma: a rare cause of acute fetal distress. Am J Perinatol 2001;18(02):99–102
6 Towers CV, Juratsch CE, Garite TJ. The fetal heart monitor tracing in pregnancies complicated by a spontaneous umbilical cord hematoma. J Perinatol 2009;29(07):517–520
7 Ross MG. The 2008 National Institute of Child Health and Human Development workshop report on electronic fetal monitoring: update on definitions, interpretation, and research guidelines. Obstet Gynecol 2009;113(01):230
8 Scutiero G, Bernardi G, Iannone P, Nappi L, Morano D, Greco P. Umbilical cord hematoma: a case report and review of the literature. Obstet Gynecol Int 2018;2018:2610980
9 Ebbing C, Kiserud T, Johnsen SL, Albrechtsen S, Rasmussen S. Prevalence, risk factors and outcomes of velamentous and marginal cord insertions: a population-based study of 634,741 pregnancies. PLoS One 2013;8(07):e70380
10 Buchanan-Hughes A, Bobrowska A, Visintin C, Attilakos G, Marshall J. Velamentous cord insertion: results from a rapid review of incidence, risk factors, adverse outcomes and screening. Syst Rev 2020;9(01):147
11 Christensen RD, Lambert DK, Baer VL, et al. Severe neonatal anemia from fetomaternal hemorrhage: report from a multihospital health-care system. J Perinatol 2013;33(06):429–434
12 Ayres AW, Johnson TR, Hayashi R. Characteristics of fetal heart rate tracings prior to uterine rupture. Int J Gynaecol Obstet 2001;74(03):235–240

