

# Complete Rupture of the Pregnant Uterus: A 10-year Retrospective Descriptive Study\*

Qiong ZHOU, Xuan ZHOU, Ling FENG, Shao-shuai WANG<sup>#</sup>

*Department of Obstetrics and Gynecology, Tongji Hospital, Tongji Medical College, Huazhong University of Science and Technology, Wuhan 430030, China*

© Huazhong University of Science and Technology 2022

**[Abstract] Objective:** The goal of this work is to analyze the incidence, etiology, clinical characteristics, maternal and neonatal outcomes of complete uterine rupture during pregnancy. **Methods:** The information of complete uterine rupture between June 2010 and May 2020 was investigated retrospectively at a tertiary center, and included demographic data, delivery characteristics, intraoperative findings, and maternal and neonatal outcomes. The prevalence rate of uterine rupture in the early group (hospitalized from June 2010 to May 2015) and late group (June 2015 to May 2020) was compared and analyzed. **Results:** There were 37 (0.056%) cases of complete uterine rupture in 66 092 births, including 27 (0.041%) of scar uterus and 10 (0.015%) of non-scarred uterus. High-risk factors for scarred uterine rupture included: previous cesarean section (13, 48.1%), myomectomy (8, 29.6%), corneal pregnancy resection (6, 22.2%), history of uterine rupture (1, 3.7%), and uterus perforation during abortion (1, 3.7%). Compared to the early group, the number of uterine ruptures caused by previous cesarean section was significantly reduced in the late group. Of the 10 patients with non-scarred uterine rupture, 3 (30%) occurred during delivery and 7 (70%) were spontaneous. Among the 37 complete rupture patients, 3 (8.1%) died of uterine scar rupture, 19 (51.3%) cases were reported with fetal/newborn deaths, 5 (13.5%) cases underwent hysterectomy and the rest were treated with uterine repair. **Conclusion:** Complete uterine rupture often has catastrophic effect on pregnancy outcomes. Obstetrics doctors should be vigilant to identify the risk factors and clinical presentations of uterine rupture during pregnancy. Strict prenatal management is beneficial to improve pregnancy outcomes.

**Key words:** complete uterine rupture; scarred uterine rupture; spontaneous uterine rupture; pregnancy outcome

Uterine rupture is a serious complication that directly endangers the life of the mother as well as that of the fetus. The maternal mortality rate is about 15.9% and the perinatal mortality rate is about 60.6%<sup>[1]</sup>. The occurrence of a ruptured uterus varies in different parts of the world. In developing countries, the incidence of uterine rupture is 0.5–7.9 per 10 000<sup>[2]</sup>, which is higher than that in the developed countries<sup>[3, 4]</sup>. By contrast, the incidence of uterine rupture in China is 1–6 per 10 000<sup>[5]</sup>.

In 2015, the Chinese government implemented the “universal two-child policy” to address the trend of population aging. Due to the high rate of cesarean section in China, women will face a high risk of uterine rupture when they get pregnant again<sup>[6, 7]</sup>. A series of

prenatal prevention measures, such as hierarchical management of high-risk pregnancy, have been implemented, and the effectiveness of these measures must be evaluated.

We conducted a retrospective study on patients who suffered from total uterine rupture during pregnancy at the Tongji Hospital affiliated with Huazhong University of Science and Technology in the past 10 years. The prevalence rate of uterine rupture between June 2010 and May 2015 (early group) and that between June 2015 and May 2020 (late group) was compared. Moreover, the clinical features, and maternal and neonatal outcomes were summarized. The results will help in finding the key points for the prevention and treatment of such high-risk groups in the future.

## 1 MATERIALS AND METHODS

### 1.1 Research Subjects

Patients with complete uterine rupture in the

Qiong ZHOU, E-mail: [zhouqiong8819@126.com](mailto:zhouqiong8819@126.com)

<sup>#</sup>Corresponding author, E-mail: [colombo2008@sina.com](mailto:colombo2008@sina.com)

\*This work was supported by the National Key Research and Development Program of China (No. 2016YFC1000405).

middle and late stages of their pregnancy were admitted to Department of Obstetrics and Gynecology, Tongji Hospital, Tongji Medical College, Huazhong University of Science and Technology (China), between June 2010 and May 2020. In this study, complete uterine rupture was described as a full thickness rupture of the uterine muscle wall, with the uterine cavity connected to the abdominal cavity. A scarred uterus referred to the traumatic operation history of a cesarean section, penetrating myomectomy, surgery of corneal pregnancy, hysteroscopy, curettage or perforation.

### 1.2 Research Content

Various data were collected from the participants. The demographic data included the following: maternal age, gestational age, gravidity, parity, abortions and cesarean section. Obstetric risk factors included a previous caesarean section, previous uterine operation other than caesarean section, complications of previous curettage, and history of uterine rupture. Similarly, antenatal and intrapartum complications placenta implantation included the presence of uterine over-distension (polyhydramnios, and macrosomia), *in vitro* fertilization embryo transfer (IVF-ET), and abnormal labor. Clinical characteristics of uterine rupture were as follows: maternal blood loss, site of uterine rupture and involved organs. Maternal and neonatal outcomes (live, birth/stillbirth) were also classified. Finally, we also compared and analyzed the incidence of uterine rupture between early (hospitalized from June 2010 to May 2015) and late group (June 2015 to May 2020). The groups were divided according to the occurrence time of uterine rupture. The study was approved by

the Ethical Committee of Tongji Medical College. Informed consent was obtained from all individual participants included in the study.

### 1.3 Statistical Analysis

All statistical analysis was performed using the SAS 9.4 software (USA) for statistical analysis. Normally distributed data were represented as mean±standard deviation, and were compared using a *t*-test. Non-normally distributed data were represented as the median and interquartile ranges, and were compared using a Mann-Whitney *U*-test. Categorical data were expressed as number and percent, and were compared using a Fisher's exact test. Statistical significance was considered as a two-sided *P*-value <0.05.

## 2 RESULTS

### 2.1 General Information

Thirty-seven (0.056%) cases out of 66 092 deliveries were complicated by complete uterine rupture, and included 3 cases of maternal death (8.10%), 5 cases of hysterectomy (13.51%), and 19 cases of fetal/neonatal death (51.35%). There were 15 (0.066%) cases of complete uterine rupture in 22 721 births in the early group, and 22 (0.050%) cases of complete uterine rupture in 43 371 births in the late group. No significant differences in age or in the number of gestations and abortions were observed between the two groups (*P*>0.05). Compared to the late group, the average gestational age of the early group was younger, while the frequency of cesarean section was higher (*P*<0.05) (table 1).

**Table 1 General information of patients**

	All cases ( <i>n</i> =37) (June 2010–May 2020)	Anterior group ( <i>n</i> =15) (June 2010–May 2015)	Posterior group ( <i>n</i> =22) (June 2015–May 2020)	<i>P</i> value
Maternal age (mean±SD)	31.0 (5.5)	30.6 (6.7)	31.3 (4.7)	0.70
Gestational age (weeks)	32 (27–35)	28 (17–33)	33 (29–37)	0.03
Gravidity	3 (2–4)	3 (2–4)	3.5 (2–4)	0.93
Parity	1 (0–1)	1 (0–1)	1 (0–1)	0.51
Abortion	1 (0–2)	0 (0–2)	1 (0–2)	0.59
Frequency of cesarean sections	0 (0–1)	1 (0–1)	0 (0–0)	0.004

### 2.2 Analysis of the Cause of Complete Uterine Rupture in Patients with a Scarred Uterus

A total of 27 cases of complete uterine rupture in patients with a scarred uterus were collected during the study period (10 years), and accounted for 72.8% of the total uterine ruptures. Cesarean section was the main cause of a scarred uterine rupture (13/27, 48.1%), followed by myomectomy (8/27, 29.6%) and corneal pregnancy resection (6/27, 22.2%). Compared to the early group, the number of cases with cesarean section history was significantly reduced in the late group (*P*<0.05). However, the number of cases with myomectomy history and corneal pregnancy rupture

history was greater in the late group, while there were no statistically significant differences because of the small sample size (table 2).

### 2.3 Analysis of the Causes of Complete Uterine Rupture in Patients with an Unscarred Uterus

In the past 10 years, 10 cases of complete uterine rupture were identified from patients with a non-scarred uterus, which represented 27.0% of the total uterine ruptures. Among these cases, 3 (3/10, 30%) were ruptured during delivery and 7 (7/10, 70%) were spontaneous before birth. There was no significant difference in the cause of rupture between the early and late groups (*P*>0.05) (table 3).

**Table 2 Comparison of etiology of complete uterine rupture (scarred uterus)**

	All cases (n=27) (June 2010–May 2020)	Early group (n=11) (June 2010–May 2015)	Late group (n=16) (June 2015–May 2020)	P value
Cesarean section frequency, n (%)	13 (48.1)	9 (81.8)	4 (25)	0.006
1	11 (40.7)	7 (63.6)	4 (25)	0.06
≥2	2 (7.4)	2 (18.2)	0 (0)	0.16
Pregnancy interval <12 months, n (%)	2 (7.4)	2 (18.2)	0 (0)	0.16
VBAC, n (%)	2 (7.4)	1 (9.1)	1 (6.3)	>0.99
Uterine fibroids excision, n (%)	8 (29.6)	2 (18.2)	6 (37.5)	0.40
1	6 (22.2)	0 (0)	6 (37.5)	0.054
≥2	2 (7.4)	2 (18.2)	0 (0)	0.16
Laparotomy, n (%)	2 (7.4)	2 (18.2)	0 (0)	0.16
Laparoscopy, n (%)	6 (22.2)	0 (0)	6 (37.5)	0.054
Operation interval <12 months, n (%)	1 (3.7)	0 (0)	1 (6.3)	>0.99
Cornual pregnancy excision, n (%)	6 (22.2)	0 (0)	6 (37.5)	0.054
History of uterine rupture, n (%)	1 (3.7)	0 (0)	1 (6.3)	>0.99
Abortion perforation, n (%)	1 (3.7)	0 (0)	1 (6.3)	>0.99

VBAC: vaginal birth after cesarean

**Table 3 Comparison of the etiology of complete uterine rupture (unscarred uterus)**

	All cases (n=10) (June 2010–May 2020)	Early group (n=4) (June 2010–May 2015)	Late group (n=6) (June 2015–May 2020)	P value
Spontaneous rupture, n (%)	7 (70)	3 (75)	4 (66.7)	>0.99
No incentive, n (%)	1 (10)	1 (25)	0 (0)	0.40
History of salpingectomy, n (%)	3 (30)	2 (50)	1 (16.7)	0.50
Placenta implantation, history of uterine cavity operation ≥3, n (%)	2 (20)	0 (0)	2 (33.3)	0.47
Other: twin pregnancy, polyhydramnios, oligohydramnios, IVF-ET, n (%)	1 (10)	0 (0)	1 (16.7)	>0.99
Rupture during labor, n (%)	3 (30)	1 (25)	2 (33.3)	>0.99

IVF-ET: *in vitro* fertilization embryo transfer

#### 2.4 Analysis of Delivery Characteristics, Intraoperative Findings, Maternal and Neonatal Outcomes of Patients with Scarred Uterus

A total of 27 cases of scarred uterus had an average bleeding volume of 1600 (300–2800) mL. All patients had symptoms of abdominal pain, 7 (7/27, 25.9%) had shock symptoms and 3 (3/27, 11.1%) had maternal cardiac arrest and death; most patients underwent repair of the rupture site, 4 (4/27, 14.8%) routine hysterectomy; 14 (14/27, 51.8%) fetal/newborn deaths (table 4).

Among the 13 patients with a history of cesarean section, the rupture was mostly found in uterine isthmus and old cesarean scar, which might be accompanied with symptoms of bleeding in vagina. Three cases (3/13, 23.0%) had shock symptoms and no maternal sudden cardiac arrest and death; 4 cases (4/13, 30.8%) routine hysterectomy; 9 cases (9/13, 69.2%) fetal/newborn deaths.

Among the 8 patients who underwent uterine fibroids excision, the rupture sites were mostly found on the fundus and the front/back walls of the uterus. Intra-abdominal bleeding was the main symptom. Shock occurred in 4 cases (4/8, 50.0%), 3 cases (3/8, 37.5%) of maternal cardiac arrest and death, no case (0/8, 0%) of routine hysterectomy, 4 cases (4/8, 50.0%)

of fetal/newborn deaths.

Among the 6 patients who underwent tissue resection for cornual pregnancy, the site of rupture was the original cornual resection site, mainly causing intra-abdominal hemorrhage. None suffered shock, hysterectomy or death; 3 cases (3/6, 50.0%) had fetal/newborn deaths.

#### 2.5 Analysis of Delivery Characteristics, Intraoperative Findings, Maternal and Neonatal Outcomes of Complete Uterine Rupture in Patients with an Unscarred Uterus

The average bleeding volume of 10 non-scarred uterus patients with uterine rupture was 1800 (300–3000) mL, which was not significantly different from the scarred uterus group ( $P=0.562$ ). Patients with prenatal uterine rupture presented with persistent abdominal pain, abnormal fetal heart rate or fetal death. By contrast, during postpartum uterine rupture, patients presented with symptoms such as hematuria, postpartum hemorrhage, and disseminated intravascular coagulation (DIC). Of the 10 non-scarred uterus patients, 5 (5/10, 50.0%) exhibited shock symptoms, and none (0/10, 0%) exhibited maternal cardiac arrest and death. Overall, most patients underwent repair of the rupture site with one case (1/10, 10.0%) undergoing hysterectomy and 5 (5/10, 50.0%) exhibiting fetal/

**Table 4 The clinical features and maternal and neonatal outcomes of complete uterine rupture (scarred uterus group)**

No.	Gestational weeks	History of surgery	Presentation	Bleeding (mL)	Site of rupture	Maternal outcome	Newborn ending
1	17	CS <sup>1*</sup> +IO <sup>1</sup>	Persistent abdominal pain	200	Uterine isthmus	URR	SB
2	20	CS <sup>1</sup> +IO <sup>1</sup>	Paroxysmal abdominal pain, vaginal bleeding, stillbirth	300	Old cesarean scar	URR	SB
3	32	CPE <sup>1</sup> +IO <sup>2</sup>	Persistent abdominal pain, stillbirth	300	Left cornua uteri	URR	SB
4	25	CS <sup>2</sup>	Paroxysmal abdominal pain after trauma, vaginal bleeding, stillbirth	150	T-shaped laceration near the old cesarean scar	URR	SB
5	33	CS <sup>1*</sup> +IO <sup>5</sup>	Abdominal pain, abnormal fetal heart rate	1000	Old cesarean scar	URR	LB
6	33	CS <sup>1</sup> +UM <sup>2</sup> +IO <sup>2</sup>	Bleeding after vaginal delivery, accompanied by shock, respiratory and cardiac arrest	3000	Left corpus uteri	MM	LB
7	40	CS <sup>1</sup> +IO <sup>1</sup>	Hemorrhagic shock after vaginal delivery	1000	Old cesarean scar and right corpus uteri	URR	LB
8	28	CS <sup>1</sup> +IO <sup>2</sup>	Abdominal distension and abdominal pain	2500	Right of the lower uterus segment	HE	LB
9	40	CS <sup>1</sup>	Paroxysmal abdominal pain	200	Old cesarean scar	URR	LB
10	31	CS <sup>2</sup> +IO <sup>1</sup>	Abdominal pain, shock, stillbirth	1600	Left corner uteri	HE	SB
11	33	UM <sup>1</sup> +IO <sup>1</sup>	Anus bulging, abdominal pain, fainting, abnormal fetal heart rate	3000	Fundus and back wall of the uterus	URR	LB
12	16	CS <sup>1</sup> +IO <sup>2</sup>	Abdominal pain and peritoneal irritation after induced labor with rivanol	2000	A longitudinal slip on the right of the lower uterine segment	URR	SB
13	16	CS <sup>1</sup>	Persistent abdominal pain after induced labor with rivanol	200	Old cesarean scar	URR	SB
14	16	CS <sup>1</sup>	Persistent abdominal pain and vaginal bleeding after induced labor with rivanol	2000	Longitudinal dehiscence of cervical isthmus	HE	SB
15	33	UM <sup>1</sup>	Abdominal pain, vomiting, abnormal fetal heart rate	2500	Anterior corpus uteri	URR	LB
16	33	CS <sup>1</sup> +UM <sup>2</sup> +IO <sup>4</sup>	Persistent abdominal pain, abnormal fetal heart rate	1600	Right of the posterior corpus uteri	URR	LB
17	39	CS <sup>1</sup>	Increased heart rate after 1 h of vaginal delivery	1300	Right of the posterior corpus uteri	URR	LB
18	30	IO <sup>1</sup>	Discovered during cesarean section	200	The anterior wall of the uterus, surrounded by omentum	URR	LB
19	34	CPE <sup>1</sup> +IO <sup>2</sup>	Abdominal pain, bloody amniotic fluid, abnormal fetal heart rate	1500	Right cornua uteri	URR	LB
20	21	CPE <sup>1</sup> +URR <sup>1</sup> +IO <sup>2</sup>	Abdominal pain, complete fetus breaking into the abdominal cavity, stillbirth	2200	Splits horizontally on the fundus from the left to the right cornua uteri	URR	SB
21	27	UM <sup>1</sup> +IO <sup>1</sup>	Abdominal pain with shock, cardiac arrest	3000	Right of posterior corpus uteri	MM	SB
22	32	UM <sup>1</sup> +IO <sup>1</sup>	Abdominal pain with shock, cardiac arrest, and fetus breaking into the abdominal cavity	3000	Fundus uteri	MM	SB
23	29	UM <sup>1</sup> +CPE <sup>1</sup> +CS <sup>1</sup> +IO <sup>2</sup>	Abdominal pain, peritoneal irritation	1000	Left anterior wall near the fundus uteri	URR	SB
24	39	CPE <sup>1</sup> +FTE <sup>2</sup> +IO <sup>1</sup>	Abdominal pain	2000	Right cornua uteri	URR	LB
25	25	CS <sup>1</sup> +IO <sup>3</sup>	Abdominal pain, shock, stillbirth	5000	Fundus uteri	HE	SB
26	33	UM <sup>1</sup> +IO <sup>1</sup>	Abdominal pain, shock, stillbirth	2800	Longitudinal split from the fundus to the posterior wall of uterus	URR	SB
27	39	CPE <sup>1</sup> +IO <sup>1</sup>	Abdominal pain, bloody amniotic fluid	1500	Right cornua uteri	URR	LB

\*The arabic number indicates the times of operations; CS: cesarean section; FTE: fallopian tube excision; CPE: corneal pregnancy excision; UM: uterine myomectomy; IO: intrauterine operation; HE: hysterectomy; URR: uterine rupture repair; LB: live born; SB: stillbirth; MM: maternal mortality

newborn deaths (table 5).

Among the 7 patients with prenatal uterine rupture, one exhibited a rupture of the anterior wall of the uterus without any inducement. The patient developed shock symptoms and the fetus passed away, so uterine repair was not performed. Three cases had undergone a salpingectomy, with the rupture site located at the corner of the uterus on the side of the original salpingectomy. For these cases, the uterine rupture was repaired. In addition, one fetus died. Two cases exhibited a large area of placenta accreta (corner/posterior wall), and the patients suffered from abdominal pain that was aggravated intermittently for several weeks and was accompanied by heavy bleeding in the abdomen, shock and stillbirth.

Uterine rupture occurred in 3 cases during childbirth. The rupture was found in the lower uterus segment and the anterior/posterior lobes of the broad ligament. One case was accompanied by a bladder hematoma and bilateral broad ligament hematoma. Hysterectomy was performed on this patient due to heavy bleeding and unstable vital signs. All 3 newborns survived.

### 3 DISCUSSION

#### 3.1 Epidemiology of Complete Uterine Rupture

Uterine rupture in the second and third trimester of pregnancy is one of the rarest albeit critical conditions in obstetrics, which seriously endangers the health of pregnant women and the fetus. Our study indicates that the incidence of uterine rupture at Tongji Hospital in the past 10 years is about 0.056%, which is significantly lower than the average level in China (0.1%–0.6%), but

higher than that reported by the International Network of Obstetric Survey Systems (INOSS) in Belgium and other multi-national and multi-center studies (0.033%)<sup>[4]</sup>. The incidence of uterine rupture and the outcome of the mother and neonate are significantly correlated with the national economic, educational and medical level, and whether women have regular prenatal examinations. Our data show that the incidence of uterine rupture between June 2015 and May 2020 was slightly lower than that between June 2010 and May 2015, even though the two-child policy has been fully implemented since 2015. This might be associated with the implementation of policies, especially the improvement of medical care, the implementation of five-color management in prenatal examination, and the orderly referral of high-risk pregnant women.

#### 3.2 Clinical Features of Complete Uterine Rupture in Patients with a Scarred Uterus

High-risk factors for uterine rupture include a history of uterine surgery, obstructive dystocia, improper use of uterine contraction drugs, congenital uterine malformations, and placental implantation. The results of this study indicated that a scarred uterus was still the main risk factor for uterine rupture during pregnancy, which is consistent with various previous works<sup>[8]</sup>. However, the incidence of uterine rupture in secondary cesarean section scars at Tongji Hospital was significantly lower after 2015. The possible reason for this might be the full implementation of China's two-child policy in 2015 whereby people began to pay more attention to the risks and benefits of cesarean section and the delivery methods for re-pregnancy. In addition, the improvement of uterine suture technology, the grasp of trial of labor after cesarean (TOLAC)

**Table 5 The clinical features and maternal and neonatal outcomes of complete uterine rupture (unscarred uterus group)**

	Gestational weeks	Proposed etiology	Presentation	Bleeding (mL)	Site of rupture	Maternal outcome	Newborn ending
1	35	FTE (right)	Burst abdominal pain, Fetal distress	300	Fundus and right cornua uteri	URR	SB
2	33	FTE (left)	Persistent abdominal pain	400	Left cornua uteri	URR	LB
3	32	FTE (right)	Burst abdominal pain	300	Right cornua uteri	URR	LB
4	29	PP	Persistent abdominal pain, shock, stillbirth	4500	Posterior wall of placenta implantation site	URR	SB
5	37	PP	Persistent abdominal pain, shock, stillbirth	3000	Back wall of placenta implantation site	URR	SB
6	28	Twins, IVF-ET	Intermittent upper right abdominal pain, severe anemia, twin stillbirths	300	Right cornua uteri	URR	SB
7	35	Unknown	Continuous abdominal pain, shock, stillbirth	3000	Anterior wall of the uterus	URR	SB
8	36	Childbirth	Postpartum hemorrhage, shock	1400	Lower part of the left wall, the anterior and posterior leaves of the broad ligament are torn	URR	LB
9	38	Childbirth	Postpartum hemorrhage, hematuria, shock	3000	In front of the lower uterus segment, bladder hematoma, bilateral broad ligament hematoma	HE	LB
10	37	Childbirth	Bloody amniotic fluid, abnormal fetal heart rate, postpartum hemorrhage, DIC	2200	In front of the lower uterus segment, longitudinal tear of the left broad ligament	URR	LB

FTE: fallopian tube excision; PP: placenta percreta; LB: live born; SB: stillbirth; HE: hysterectomy; URR: uterine rupture repair



indications and the rich experience in related clinical treatments have decreased the failure rate of TOLAC and the incidence of uterine rupture. In this study, the uterine rupture of 13 patients with a history of cesarean section was mostly found in the uterine isthmus and old cesarean scars. As a result, maternal and neonatal outcomes were not as serious as expected, which may be explained by the fewer vascular sites of rupture<sup>[2]</sup>. Moreover, well-equipped and immediate cesarean section facilities with well-trained treatment teams may be able to alleviate the adverse outcomes of mothers and children<sup>[9, 10]</sup>.

In recent years, more and more attention has been paid to uterine rupture secondary to gynecological surgery. Our study reported that the number of patients with uterine rupture after uterine fibroids excision accounted for 29.6% of the total number of scarred uterine ruptures, which was followed by corneal pregnancy resection 22.2%, with high maternal and neonatal mortality. It has been reported that the incidence of uterine rupture after uterine myomectomy ranges from 0.1%–4%<sup>[11, 12]</sup>, after laparoscopic surgery about 0.26%–1%, and after abdominal surgery is about 0.24%–5.3%. However, there is no evidence that the incidence of uterine rupture after minimally invasive surgery is higher than that of traditional open surgery<sup>[13]</sup>. The size and number of fibroids, the method of wound sutures, and poor healing of uterine wounds caused by excessive use of energy equipment during surgery are all high-risk factors of uterine rupture<sup>[14]</sup>.

Previous surgical history of corneal pregnancy can lead to a weak uterine horn muscle layer, and re-pregnancy after surgery is prone to rupture in the weakened muscle layer and to hemorrhagic shock. Although the patients in the angular pregnancy resection group did not report shock or death in this study, there were still 50% fetal/newborn deaths. The most common surgical method for corneal pregnancy is a wedge resection of the uterine horn or uterine horn incision for embryo extraction. Studies have shown that the incidence of uterine rupture in pregnancy after laparoscopic wedge resection is as high as 30%<sup>[15]</sup>. Wedge resection of the uterine horn is more harmful to the uterus than the incision and removal of embryos. Therefore, uterine horn incision for embryo extraction and uterine horn repair are more suitable for patients with fertility requirements<sup>[16]</sup>.

This study reported two patients who have each undergone myomectomy and cesarean section. The uterine rupture in this pregnancy was in the body of the uterus, and was considered as the rupture of the myoma excavation site. One case underwent three operations, including angular pregnancy excision, uterine fibroids excision and a cesarean section. The rupture site occurred at the left anterior wall near the fundus uteri, and was considered to be the rupture of the original

angular pregnancy excision site. The possible reason is that the contraction intensity of the uterine horn, fundus and body is significantly higher than that of the lower uterine segment. Nevertheless, whether uterine horns and uterine body scars after gynecological surgery are more likely to rupture than scars of lower cesarean section needs further study.

### 3.3 Clinical Features of Complete Uterine Rupture in Patients with a Non-Scarred Uterus

In this study, the proportion of uterine rupture in the non-scarred group (27.0%) was significantly lower than that in the scar group (73.0%), and the incidence did not change significantly in the past 10 years. There was no significant difference in the average bleeding volume between the scarred and unscarred groups, but the mortality, hysterectomy, and neonatal mortality of the non-scarred group were significantly lower. It has been reported that compared with a scarred uterus, the maternal and neonatal outcomes of unscarred patients are worse<sup>[17, 18]</sup>. The possible reason for this is that the ruptures of an unscarred uterine are often irregular, and the blood vessels in non-scarred myometrium are more abundant than those in scar tissue. Therefore, it is easy to tear large blood vessels. By contrast, clinicians usually have little vigilance regarding the detection of unscarred uterine rupture, which can significantly delay its diagnosis. Obstructive dystocia during childbirth is an important factor for non-scarred uterine rupture, and our research institution is the emergency and critical care center for pregnant women in Central China, which has well-trained medical staff with notable treatment experience. This may be one of the contributing factors for better maternal and neonatal outcomes in the non-scarred group observed in this work.

In this study, 7 cases of uterine rupture in the non-scarred group occurred before delivery, and two cases were thought to be caused by multiple intrauterine manipulations and a penetrating placenta (PP). Multiple intrauterine manipulations can damage the myometrium and predispose the placenta to accrete easily, thus leading to an increased risk of uterine rupture<sup>[19]</sup>. A PP is the most serious type of placenta accreta disease<sup>[20]</sup>. Placenta villus invades the entire layer of the uterus and reaches the serosal layer. In severe cases, the adjacent organs of the uterus, such as the parauterine tissues, cervix and bladder, can be invaded. With the progression of gestational age, the risk of spontaneous rupture of a PP can lead to severe bleeding and hysterectomy increases. There have only been a few reports of non-scarred uterine rupture caused by PP<sup>[21, 22]</sup>, in which the rates of maternal and fetal death and hysterectomy were extremely high. The common characteristics of the two patients with placenta accreta in this study were as follows: Abdominal pain lasted longer, but with stable early vital signs. Due to the unclear diagnosis, the patients

developed hemorrhagic shock in the later stage. During the operation, more than 3000 mL of abdominal bleeding was found. The placenta was attached to the bottom and posterior wall of the uterus. The placental tissue penetrated the uterine muscle wall to reach the serosal layer. Abundant and dilated blood vessels were seen on the surface of the serosal layer. The lacerations and active bleeding were found in the weak parts of the uterus. All the fetuses died. Artificial placenta peeling, uterine vascular suture and repair of the laceration were performed, and the patient recovered well. The clinical symptoms and signs of uterine rupture caused by placenta accreta in the second and third trimesters are often atypical. It is difficult to accurately distinguish this condition from recessive placental abruption, threatened preterm delivery and other acute abdominal symptoms. The diagnosis can be assisted by three-dimensional color Doppler ultrasound and MRI. High-risk factors for placenta accreta should be investigated and timely interventions should be taken to minimize the occurrence of poor maternal and neonatal outcomes.

There were 3 patients with non-scarred uterine rupture, only tubal ectopic pregnancy (non-cornuel site) and a history of laparoscopic salpingectomy. Other high-risk factors for uterine rupture were excluded, and our study classified them into the non-scarred uterus group. All three patients exhibited an onset in the third trimester (32–35 weeks). The rupture of the uterus was at the cornua on the side of the original salpingectomy, and the amount of abdominal bleeding was less than 500 mL. Two of the fetuses survived (the other fetus died) and no mother died. This is consistent with the report of Paweł *et al*<sup>[23]</sup> in that the clinical manifestations of uterine rupture in the second pregnancy after salpingectomy were mild, and the maternal and child outcomes were better. The location and type of ectopic pregnancy, the selection of surgical suture materials, suture techniques, the use of unipolar or bipolar coagulation, and the experience of the surgeons will affect the outcome of the next pregnancy<sup>[24, 25]</sup>. Laparoscopic surgery has a higher risk of uterine rupture than open surgery because the heat damage caused by electrocoagulation and cauterization may endanger the adjacent endometrial tissue. It is recommended that the uterine horn should be sutured and reinforced during a laparoscopic salpingectomy for those who are planning to get pregnant again<sup>[26]</sup>.

Another patient exhibited a spontaneous uterine rupture at 35 weeks. The patient was a 24-year-old primipara. High risk factors for uterine rupture, such as trauma, uterine surgery, hyperhydramnios, and uterine malformations, were excluded. This patient was treated in a local hospital due to irregular abdominal pain with little vaginal bleeding at 32 weeks. Two weeks later, the patient developed persistent lower abdominal pain for 7 h without vaginal bleeding. At

the time of admission, the patient had been in shock, the abdominal tension was large, with 1 cm of cervical dilatation. The B-ultrasound indicated the death of the fetus in the uterus. The laparotomy revealed 3000 mL of hemorrhage in the abdominal cavity and an irregular rupture of about 2 cm × 6 cm in the right anterior wall of the uterus. After a cesarean section and laceration repair, the patient recovered and was discharged. Spontaneous rupture of the uterine wall in a non-scarred uterus during the third trimester of pregnancy is rare. It has been reported that the prevalence rate of this phenomenon is 12 per 100 000 in developed countries<sup>[27]</sup>. The possible reasons for this are as follows: uterine dysplasia or malformation, multiple uterine cavity operations, uterine over-dilatation, uterine cavity infection, premature rupture of membranes<sup>[28]</sup> and so on. As the patient in this study had a history of vaginal bleeding, there was a possibility of placental abruption. Excessive uterine cavity pressure acted on the local uterine wall for a long time, causing muscle fiber separation, rupture and even degeneration. At the time of onset, the patient was in labor, and the strong contractions acted on the weak uterine wall, causing a local rupture of the uterus. Although there are no high-risk factors for uterine rupture during pregnancy, it is possible to have uterine rupture. If a pregnant woman complains of lower abdominal pain, with unstable vital signs and abnormal fetal heart rate, in addition to the consideration of placental abruption and other common causes, clinicians should also consider the possibility of uterine rupture.

### 3.4 Research Limitations

The data used in this study was collected from Tongji Hospital, Tongji Medical College, Huazhong University of Science and Technology. This is a center for emergency and critical care of pregnant women in Central China. However, this is a limited sample of pregnant women without complications, which may not fully reflect the true incidence rate and causes of complete rupture of uterus in pregnancy. Secondly, due to differences in regional conditions and economic levels, these results do not yet represent the overall domestic situation. Finally, since complete uterine rupture in pregnancy is rare in clinical practice, a large-scale multi-center prospective study is feasible in the follow-up study to achieve a higher level of evidence and guide clinical work.

### Conflict of Interest Statement

The authors have no conflict of interest.

### REFERENCES

- 1 Liu XH, He J, Qi HB. Midwifery. Beijing: People's Medical Publishing House, 2018:333-337
- 2 Chang YH. Uterine rupture over 11 years: a retrospective descriptive study. Aust N Z J Obstet Gynaecol, 2020, 60(5):709-713

- 3 Vilchez G, Nazeer S, Kumar K, *et al.* Contemporary epidemiology and novel predictors of uterine rupture: a nationwide population-based study. *Arch Gynecol Obstet*, 2017,296(5):869-875
- 4 Vandenberghe G, Bloemenkamp K, Berlage S, *et al.* The international network of obstetric survey systems study of uterine rupture: a descriptive multi-country population-based study. *BJOG*, 2019,126(3):370-381
- 5 Bai XX, Wang ZP, Yang XF. Clinical study on 67 cases with uterine rupture. *Chin J Obstet Gynecol*, 2014,49(5): 331-335
- 6 Al-Zirqi I, Stray-Pedersen B, Forsén L, *et al.* Uterine rupture: trends over 40 years. *BJOG*, 2016,123(5):780-787
- 7 Fogelberg M, Baranov A, Herbst A, *et al.* Underreporting of complete uterine rupture and uterine dehiscence in women with previous cesarean section. *J Matern Fetal Neonatal Med*, 2017,30(17):2058-2061
- 8 Al-Zirqi I, Stray-Pedersen B, Forsén L, *et al.* Uterine rupture after previous caesarean section. *BJOG*, 2010, 117(7):809-820
- 9 Soltzman S, Perlitz Y, Ben Ami M, *et al.* Uterine rupture after previous low segment transverse cesarean is rarely catastrophic. *J Matern Fetal Neonatal Med*. 2018,31(6),708-712
- 10 Ahmed WAS, Habash YH, Hamdy MA, *et al.* Rupture of the Pregnant Uterus - a 20 years Review. *J Matern Fetal Neonatal Med*, 2017,30(12):1488-1493
- 11 Flyckt RL, Falcone T. Uterine rupture after laparoscopic myomectomy. *J Minim Invasive Gynecol*, 2015,22(6): 921-922
- 12 Gambacorti-Passerini Z, Gimovsky AC, Locatelli A, *et al.* Trial of labor after myomectomy and uterine rupture: a systematic review. *Acta Obstet Gynecol Scand*, 2016, 95(7):724-734
- 13 Koo YJ, Lee JK, Lee YK, *et al.* Pregnancy outcomes and risk factors for uterine rupture after laparoscopic myomectomy: a single-center experience and literature review. *J Minim Invasive Gynecol*, 2015,22(6):1022-1028
- 14 Tomczyk KM, Wilczak M, Rzymyski P. Uterine rupture at 28 weeks of gestation after laparoscopic myomectomy - a case report. *Prz Menopauzalny*, 2018,17(2): 101-104
- 15 Liao CY, Tse J, Sung SY, *et al.* Cornual wedge resection for interstitial pregnancy and postoperative outcome. *Aust N Z J Obstet Gynaecol*, 2017,57(3):342-345
- 16 Wang J, Huang D, Lin X, *et al.* Incidence of interstitial pregnancy after in vitro fertilization/embryo transfer and the outcome of a consecutive series of 38 cases managed by laparoscopic cornuostomy or cornual repair. *J Minim Invasive Gynecol*, 2016,23(5):739-747
- 17 Vandenberghe G, De Blaere M, Van Leeuw V, *et al.* Nationwide population-based cohort study of uterine rupture in Belgium: results from the Belgian Obstetric Surveillance System. *BMJ Open*, 2016,6(5):e010415
- 18 Rottenstreich M, Rotem R, Hirsch A, *et al.* Delayed diagnosis of intrapartum uterine rupture - maternal and neonatal consequences. *J Matern Fetal Neonatal Med*, 2021,34(5):708-713
- 19 Pontis A, Prasciolu C, Litta P, *et al.* Uterine rupture in pregnancy: two case reports and review of literature. *Clin Exp Obstet Gynecol*, 2016,43(2):304-309
- 20 Jauniaux E, Collins S, Burton GJ. Placenta accreta spectrum: pathophysiology and evidence-based anatomy for prenatal ultrasound imaging. *Am J Obstet Gynecol*, 2018,218(1):75- 87
- 21 Enebe JT, Ofor IJ, Okafor II. Placenta percreta causing spontaneous uterine rupture and intrauterine fetal death in an unscarred uterus: a case report. *Int J Surg Case Rep*, 2019,65:65-68
- 22 Ozdemir A, Ertas IE, Gungorduk K, *et al.* Uterine preservation in placenta percreta complicated by unscarred uterine rupture at second trimester in a patient with repeated molar pregnancies: a case report and brief review of the literature. *Clin Exp Obstet Gynecol*, 2014,41(5):590-592
- 23 Staniewski PJ, Trojanowski S, Słomka A, *et al.* Spontaneous rupture of the pregnant uterus following salpingectomy: a literature review. *Gynecol Obstet Invest*, 2015,80(2):73-77
- 24 Fylstra DL. Ectopic pregnancy not within the (distal) fallopian tube: etiology, diagnosis, and treatment. *Am J Obstet Gynecol*, 2012,206(4):289-299
- 25 Agdi M, Tulandi T. Surgical treatment of ectopic pregnancy. *Best Pract Res Clin Obstet Gynaecol*, 2009, 23(4):519-527
- 26 Ng S, Hamontri S, Chua I, *et al.* Laparoscopic management of 53 cases of cornual ectopic pregnancy. *Fertil Steril*, 2009,92(2):448-452
- 27 Kaur J, Goel B, Sehgal A. Rupture uterus following blunt trauma at 16 weeks gestation. *Int J Reprod Contracept Obstet Gynecol*, 2012,1:64-66
- 28 Mourad WS, Bersano DJ, Greenspan PB, *et al.* Spontaneous rupture of unscarred uterus in a primigravida with preterm prelabour rupture of membranes. *BMJ Case Rep*, 2015,2015:bcr2014207321

(Received Nov. 13, 2020; accepted Jan. 14, 2021)