Original Research

A 10-Year Analysis of Complete Uterine Rupture in Pregnant Women with an Intact Uterus: A Multi-Center Cross-Sectional Study in Sichuan, China

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Abstract

Background: Complete uterine rupture can lead to serious adverse maternal and child outcomes. Uterine rupture is rare, and it can occur in an intact uterus. **Methods**: We identified patients with intact uterus who encountered uterine rupture between 2010 and 2020 from the medical records of 10 hospitals in Sichuan Province. **Results**: In total, 37 cases of uterine rupture in intact uteri were identified. Eight ruptures (8/37, 21.6%) occurred before spontaneous labor, 11 ruptures (11/37, 29.7%) occurred during spontaneous labor, and 18 ruptures (18/37, 48.6%) occurred during induced labor. The clinical manifestations of the patients were abdominal pain in 20 cases (20/37, 54.1%), vaginal bleeding in three cases (3/37, 8.1%), and abdominal pain and vaginal bleeding in eight cases (8/37, 21.6%). The rate of hysterectomy/death was significantly higher in patients with more than three previous vaginal deliveries ($p = 0.005$). In addition, the rate of hysterectomy/death in the spontaneous labor group was significantly higher than that in the induced labor group ($p = 0.011$). The fetal survival rate in patients with uterine rupture at the uterine horn was significantly higher than that in patients with uterine rupture at the lower uterine segment ($p = 0.007$). **Conclusions**: Uterine rupture in an intact uterus was associated with a high hysterectomy rate and high fetal/neonatal mortality rate. For pregnant women with sudden abdominal pain and abnormal fetal heart rate, we should be alert to the possibility of uterine rupture. Induction and augmentation of labor need to be performed with caution to avoid this potential obstetric emergency.

Keywords: uterine rupture; obstetric emergency; intact uterus; pregnancy

1. Introduction

Complete uterine rupture is defined as a clinically apparent, complete separation of all layers of the uterus, occurring during or before labor [1]. It is a severe obstetric complication that can lead to serious adverse maternal and child outcomes, resulting in a huge social and economic burden. The incidence of complete uterine rupture has increased over recent decades. Al-Zirqi *et al.* [2] reported that the incidence of uterine rupture increased sharply from 0.9 per 10,000 pregnancies in 1978–1988 to 6.1 per 10,000 pregnancies in 2000–2008 in Norway. Yu-Hsing *et al.* [3] reported a prevalence of 8.4 per 10,000 births in New Zealand over the past decade. However, the real incidence of uterine rupture is difficult to determine, and it varies widely worldwide.

Previous reports have suggested that a scarred uterus after previous cesarean section is the most common risk factor for uterine rupture [4,5]. Traditionally, primigravida and an intact uteri have been considered as the protective factors against uterine rupture. Generally, previous studies have focused on the clinical features and outcomes of uterine rupture in scarred uteri, and very few studies have explored the intact uteri [6–8]. However, a uterine rupture can occur in cases of intact uteri without apparent predisposing factors. Previous studies have demonstrated poor maternal morbidity rates when uterine rupture occurs in an intact uteri [9,10]. Examining the possible role of certain risk factors and elucidating the outcome of uterine rupture in intact uteri may provide deeper insights into the safety and efficacy of our current obstetric practices. Owing to the rarity of the occurrence of uterine rupture, there is a paucity of literature describing its clinical features and outcomes, especially in intact uteri [11]. Previous publications on the risk of uterine rupture in intact uteri are mostly case reports. Therefore, the present study intended to elucidate the clinical characteristics and prognosis of complete uterine rupture in patients from 10 areas of Sichuan Province in the most recent 10 years, so as to provide a reference for the clinical diagnosis and treatment of uterine rupture.

2. Materials and Methods

Based on the gross domestic product, 21 cities (prefectures) in Sichuan Province are divided into three levels of economic development: high (5 prefectures), medium (11 prefectures), and low (5 prefectures). We selected half of the areas from each group to participate in the survey. After contacting the hospitals in the target region, a total of 10 regions were willing to cooperate, and one hospital from each region was selected for investigation, with the number of deliveries ranging from <500/year to ≥5000/year.

The medical records of patients with complete uterine rupture between 2010 and 2020 were retrieved from 10 hospitals in Sichuan Province. The data were extracted as follows: first, data were extracted from the hospital database, and the cases of complete uterine rupture in intact uteri were identified by manually reviewing the medical records. We designed the case report form (CRF) in advance, modified it through pre-experiment, and used it after improvements. CRFs were distributed to the 10 hospitals for data collection. The data were collected by obstetricians from the participating medical units. The completed CRFs were returned electronically, and the data from the CRFs were analyzed. The study has been conducted according to the principles expressed in the Declaration of Helsinki. Data were anonymized and de-identified before analysis, and therefore, informed consent was not required.

A complete uterine rupture was defined as the tearing of all layers of the uterine wall, including the serosa and amniotic membranes. The data collected included demographic data, clinical characteristics, and maternal and neonatal outcomes. The demographic data included maternal age, gestational age, parity, and the number of artificial abortions. The data for clinical characteristics included labor status, whether there was induction or other mode of labor introduction, clinical symptoms, fetal antenatal monitor and color Doppler ultrasonic examination, and the location of uterine rupture. Maternal outcomes included uterine neoplasty, hysterectomy, and death. Infant outcomes included intrapartum/infant death or survival. Intrapartum death was defined as intrauterine fetal death during labor. Infant death was defined as death after birth until 1 month of age (excluding deaths due to congenital malformations).

Statistical Analyses

Data analyses were performed using SPSS 26.0 Statistics (IBM Corp., Armonk, NY, USA). Absolute number (n) and percentage frequency (%) distribution were used to evaluate the distribution of the parameters. Quantitative data are presented as means $\pm$ standard deviations (SDs). To test statistical significance, chi-square test was used for categorical variables and Student's t-test was used for continuous variables. The level of significance was set at $p < 0.05$.

3. Results

We identified 37 patients with uterine rupture in intact uteri. The median age of the patients was 31.4 $\pm$ 6.4 years (range, 18–44 years). Among them, 13 (13/37, 35.1%) were more than 35 years old, and 24 (24/37, 64.9%) were less than 35 years old. The median gestation period was 34.6 $\pm$ 5.4 weeks. The gestational age ranged from 20 weeks to 41 weeks. Among 37 women, two (2/37, 5.4%) were at the gestational age of less than 28 weeks, 17 (17/37, 45.9%) were between 28 and 36 weeks, and 18 (18/37, 48.6%) were at more than 37 weeks. Four women were those with first-

time pregnancy. The maximum gravida was eight. Fifteen women (15/37, 40.5%) had a previous vaginal delivery, and two had five previous vaginal deliveries. Twenty-five women (25/37, 67.6%) had undergone previous uterine curettage. The maximum number of uterine curettages was six. Among the 37 cases of uterine rupture in intact uteri, 8 (8/37, 21.6%) occurred before spontaneous labor, 11 (11/37, 29.7%) occurred during spontaneous labor, and 18 (18/37, 48.6%) occurred during the induction of labor. The demographic characteristics of women with uterine rupture in intact uteri are presented in Table 1.

Table 1. Demographic of the uterine ruptures of intact uterine.

Demographic	n (%)
age (n = 37)	
≥35	13 (35.1)
<35	24 (64.9)
Gestational age (n = 37)	
<28 weeks	2 (5.4)
28–36 weeks	17 (45.9)
≥37 weeks	18 (48.6)
Previous vaginal delivery (n = 37)	
0	22 (59.5)
≥1	15 (40.5)
Previous uterine curettage (n = 37)	
0	12 (32.4)
≥1	25 (67.6)

The clinical manifestations of the patients included abdominal pain in 20 women (20/37, 54.1%), vaginal bleeding in three (3/37, 8.1%), abdominal pain and vaginal bleeding in eight (8/37, 21.6%), shock in three (3/37, 10.8%), no symptoms in two (2/37, 5.4%), and death of one woman (1/37, 2.7%). Two asymptomatic patients underwent emergency cesarean section due to abnormal fetal heart rate, and uterine rupture was found during cesarean section. In addition, 15 patients had nausea, vomiting, and other discomfort.

Among the 37 patients, seven underwent emergency cesarean section due to abnormal fetal heart rate, and color Doppler ultrasound was not performed before surgery. Among 30 patients who underwent ultrasonic examination, 22 (22/30, 73.3%) had positive manifestations, which were mainly characterized by the interruption of echo continuity of the uterine muscle wall, floating fetus in the abdominal cavity, pelvic and abdominal effusion, and disordered echo of the abdominal cavity. Among the 37 patients, seven did not undergo fetal electronic monitoring, five women were induced labor due to fetal malformation, and two women were at less than 30 weeks of gestation. Among 30 patients whose fetal electronic monitoring was performed, 13 (13/30, 43.3%) were abnormal and 17 (17/30, 56.7%) were normal. Among the abnormal cases, 11 showed various types of fetal deceleration, one case presented with disap-

pearance of baseline variations of fetal heart rate, and one case presented with disappearance of fetal heart rate.

Among the 36 patients who underwent surgery after uterine rupture, the breaches of the uterus were located in the uterine body in 13 cases (13/36, 36.1%), three cases (3/36, 8.3%) were in the uterine horn, and 20 cases (20/6, 55.6%) were in the lower uterine segment. The clinical characteristics of the uterine ruptures in intact uteri are shown in Table 2.

Table 2. Clinical characteristics of the uterine ruptures of intact uterine.

Clinical characteristics	n (%)
Labor status (n = 37)	
Before labor	8 (21.6)
Spontaneous labor	11 (29.7)
Induced labor	18 (48.6)
Location of the rupture (n = 36)	
Uterine body	13 (36.1)
Uterine horn	3 (8.3)
Lower uterine segment	20 (55.6)
Clinical manifestations (n = 37)	
Abdominal pain	20 (54.1)
Vaginal bleeding	3 (8.1)
Abdominal pain and vaginal bleeding	8 (21.6)
Shock	3 (10.8)
No symptoms	2 (5.4)
Death	1 (2.7)
Fetal electronic monitoring (n = 30)	
Abnormal	13 (43.3)
Normal	17 (56.7)
Ultrasonic examination (n = 30)	
Abnormal	22 (73.3)
Normal	8 (26.7)

Table 3 presents the data pertaining to maternal and neonatal outcomes. Thirty ruptures (30/37, 81.1%) were treated by uterine neoplasty, six ruptures (6/37, 16.2%) were treated by hysterectomy, and one patient (1/37, 2.7%) died before surgery. Among the 36 survivors, 11 patients (11/36, 30.5%) had complications; four patients had coagulation dysfunction, among whom one developed into disseminated intravascular coagulation, four patients had bladder injury, two had postoperative infection, and one patient had intestinal injury. Among the 32 newborns with non-fetal malformation and induced labor, 13 fetuses (13/32, 40.7%) died during the prenatal period. Among 19 alive born fetuses, eight died (8/32, 25.0%) and 11 (11/32, 34.3%) survived.

The group of patients who underwent uterine neoplasty was compared to the group of patients who underwent hysterectomy or died. Maternal age, gestational age, number of previous uterine curettages, and the location of uterine rupture were not significantly different between the two groups. The rate of hysterectomy/death was significantly higher in patients with more than three previous vagi-

Table 3. Maternal and neonatal outcomes.

Maternal and neonatal outcomes	n (%)
Maternal outcomes (n = 37)	
Uterine neoplasty	30 (81.1)
Hysterectomy	6 (16.2)
Deaths	1 (2.7)
Maternal complications (n = 36)	11 (30.5)
Fetal outcomes (n = 32)	
Survival infant	11 (34.3)
Intrapartum deaths	13 (40.7)
Infant deaths	8 (25.0)

nal deliveries ($p = 0.005$). In addition, the rate of hysterectomy/death in the spontaneous labor group was significantly higher than that in the induced labor group ($p = 0.011$). Although there was no significant relationship between the outcomes of pregnant women and the location of uterine rupture ($p = 0.194$), the proportion of hysterectomy was higher in women with a rupture of the lower uterine segment compared to a rupture of the uterine body. The results of the correlation analysis of risk factors and maternal outcomes are presented in Table 4.

Furthermore, 32 fetuses were divided into two groups: a fetal death/neonatal death group and a neonatal survival group. There were no significant differences between the two groups based on the number of previous vaginal deliveries, the number of uterine curettages, maternal age, gestational age, and type of labor. However, there was a significant difference based on the location of uterine rupture. The fetal survival rate in patients with uterine rupture at the uterine horn was significantly higher than that in patients with uterine rupture at the lower uterine segment ($p = 0.007$). The results of the correlation analysis of risk factors and neonatal outcomes are presented in Table 5.

4. Discussion

Uterine rupture in an intact uterus is a rare and unpredictable obstetric complication. Al-Zirqi *et al.* [2] reported the rates of uterine rupture in Norway as 1.2, 0.9, 1.7, and 6.1 per 10,000 pregnancies in 1967–1977, 1978–1988, 1989–1999, and 2000–2008, respectively.

The present study found that 48.6% of uterine ruptures occurred during induced labor. Among the 18 cases of uterine rupture caused by induced labor, nine received misoprostol, two received oxytocin, and seven received a variety of medications/methods including misoprostol, oxytocin, cervical balloon, etc. Previous studies have shown that the increase in ruptures in intact uteri was mostly related to increases in the practice of labor augmentation and induction of labor with specific methods [9,12,13]. Administration of misoprostol and oxytocin is a known risk factor for uterine rupture [5]. Al-Zirqi *et al.* [14] reported that the highest risk factor for uterine rupture in Norway in recent years was induced labor with administration of miso-

Table 4. Analysis of risk factors influencing maternal outcomes.

	Uterine neoplasty	Hysterectomy/death	*p*-value
Previous vaginal delivery (times)			
<3	26	2	0.005
≥3	4	5	
Previous uterine curettage (times)			
<3	22	6	0.656
≥3	8	1	
Age (years)			
≥35	10	3	0.678
<35	20	4	
Gestational age (weeks)			
<37	15	4	0.532
≥37	15	3	
Labor status			
Before labor	4[a]	4[a]	0.011
Spontaneous labor	9[a,b]	2[a,b]	
Induced labor	17[b]	1[b]	
Location of the rupture (n = 36)			
Uterine body	15	2	0.194
Uterine horn	6	0	
Lower uterine segment	9	4	

a,b: The difference of maternal outcomes between cases before labor and induced labor was statistical significance.

Table 5. Analysis of risk factors influencing neonatal outcomes.

	Intrapartum/infant deaths	Survival infant	*p*-value
Previous vaginal delivery (times)			
<3	16	8	0.575
≥3	5	3	
Previous uterine curettage (times)			
<3	15	8	0.938
≥3	6	3	
Age (years)			
≥35	7	4	0.638
<35	14	7	
Gestational age (weeks)			
<37	10	4	0.712
≥37	11	7	
Labor status			
Before labor	7	1	0.057
Spontaneous labor	10	3	
Induced labor	4	7	
Location of the rupture (n = 36)			
Uterine body	10[a,b]	5[a,b]	0.007
Uterine horn	1[a]	5[a]	
Lower uterine segment	10[b]	1[b]	

a,b: The difference of fetal outcome between rupture occurred in the angle of uterus and lower segment of uterus was statistical significance.

prostol and oxytocin. On the other hand, mechanical induction carries the lowest risk of uterine rupture compared to prostaglandins or oxytocin [14,15]. However, in clinical practice, mechanical methods are rarely used alone, and prostaglandins or oxytocin are generally used. Sequential induction also carries a substantial risk of complete rupture [14,15].

Furthermore, multiparity is an important risk factor for uterine rupture in intact uteri and there are many reports in literature on this topic [16,17]. In our study, nine cases (9/37, 24.3%) had more than three previous vaginal deliveries, and two had five previous vaginal deliveries, and our results showed that previous multiple vaginal deliveries were associated with adverse maternal outcomes. The rate of hysterectomy/death increased significantly in patients with more than three previous vaginal deliveries.

Additionally, we found that more than half of the patients with uterine rupture had undergone a previous uterine curettage. The maximum number of uterine curettages in one individual case was six. Al-Zirqi *et al*. [18] found that when patients with previous uterine curettage and intact uteri were removed from the analysis, the rate of rupture decreased from 0.38 to 0.26 per 10,000 pregnancies. This indicates that potential weakening of the uterine wall by curettage may contribute significantly to increasing the rupture risk [19]. Nkwabong *et al*. [20] also found that a history of curettage may indicate an undetected uterine perforation. The history of a previous curettage should be considered a possible risk factor for uterine rupture during pregnancy because the possible presence of an undetected uterine scar may cause rupture.

The main symptom of rupture reported by 54.1% women was abdominal pain. Another 21.6% patients reported abdominal pain and vaginal bleeding. Very few patients presented with vaginal bleeding (8.1%), as most of the bleeding was intraabdominal. Therefore, attention should be paid to patients with abdominal pain. In this study, 30 patients underwent fetal electronic monitoring, 13 of whom presented with abnormal results, including 11 with various types of fetal deceleration. Previous studies have reported that an abnormal fetal heart rate is the most common clinical manifestation of uterine rupture, which is observed in 76–87% of the cases [15,21]. Therefore, when the fetal heart rate presents with abnormal deceleration in women with abdominal pain, urgent attention must be paid. It should be noted that there were two cases of uterine rupture without abdominal pain, vaginal bleeding, or other symptoms, and when fetal heart rate deceleration was found, and emergency cesarean section was performed, a uterine rupture was found during surgery. Sun *et al*. [22] also reported a case of uterine rupture with atypical symptoms. The patient presented with upper abdominal discomfort and vomiting for 3 days. During emergency laparotomy, the entire amniotic sac was found in the peritoneal cavity with a rupture of the uterine fundus [22]. Therefore, rupture of the intact uterus may be asymptomatic or atypical. Obstetricians should be alert to the occurrence of uterine rupture and be able to quickly diagnose it to facilitate rapid management. The possibility of uterine rupture needs to be considered in all pregnant women who present with acute abdominal pain, fluid collection in the peritoneal cavity, or specific risk factors.

Many studies have reported that the rate of hysterectomy is higher after rupture of the intact uterus [16,18]. In our study, 30 (81.1%) patients underwent uterine neoplasty, six (16.2%) underwent hysterectomy, and one (2.7%) patient had died. Gibbins *et al*. [23] found a hysterectomy rate of 35% in 20 intact uteri vs. 2.4% in 126 scarred uteri after rupture. Barger *et al*. [8] reported that severe morbidity was three times more frequent in patients with intact uteri compared to those with scarred uteri. Al-Zirqi *et al*. [14] reported a hysterectomy rate of 37.8% following rupture in intact uteri compared to 12.1% for those with scarred uteri.

Among the 36 patients who underwent surgery after uterine rupture, breaches of the uterus were located in the lower uterine segment in 20 cases (20/36, 55.6%), in the uterine body in 13 cases (13/36, 36.1%), and in the uterine horn in 3 cases (3/36, 8.3%). Although there was no significant association between the location of uterine rupture and the outcomes of pregnant women, the rate of hysterectomy in rupture of the lower uterine segment was higher than that of rupture of the uterine body. The consistency of this association may be because the ruptures occurred outside the lower uterine segment and extended further beyond the cervix. The lack of a confined weak area, such as a previous incision, increases the risk that the tear might involve vital, adjacent organs, which could lead to more serious complications [8,19].

The proportion of intrapartum/infant death was 65.7% in our study. Al-Zirqi *et al*. [18] found that 26.2% infants were classified as those with intrapartum/infant death and the death was presumed due to the hypoxic effects of uterine rupture. In our study, the fetal survival rate in patients with uterine rupture at the uterine horn was significantly higher than that in patients with uterine rupture at the lower uterine segment ($p = 0.007$). This may be because a uterine horn rupture site does not involve as many blood vessels and does not cause placental detachment. Al-Zirqi *et al*. [18] found that placental separation and/or fetal extrusion had the highest odds ratio for intrapartum/infant death (odds ratio, 17.9; 95% confidence interval, 7.5–42.4). Leung *et al*. [24] found that the highest risk of intrapartum/infant death was when the rupture was associated with placental separation and/or fetal extrusion. The fetal outcomes of uterine rupture are not only related to the severity of the disease, but also to the location of the uterine rupture.

5. Limitations

One limitation of this study is a small sample size. Since uterine rupture is a very rare disease, the sample size of our study may be not sufficient to rule out a type II error, and this may have affected the accuracy of the results. Another limitation of this study is its retrospective design. In the past decade, many changes have taken place in our obstetric practices. Moreover, without universal standardized registration during the study period, there was missing information and poor-quality information in some medical records. For these reasons, it was not possible to assess the length of delivery as a risk factor for uterine rupture; nor was it possible to assess the influence of socioeconomic factors. Further analyses of uterine ruptures are needed in large-scale, long-term, multicenter studies. Furthermore, there is a need for future studies estimating the risk of rupture related to dosages and duration of prostaglandins and oxytocin use.

6. Conclusions

Uterine rupture is rare, but it can occur in the intact uterus. Uterine rupture in an intact uterus is associated with a high hysterectomy rate and high fetal/neonatal mortality rate. There is an imperative need to remain vigilant for the possibility of uterine rupture in pregnancies without typical risk factors. For pregnant women with sudden abdominal pain and abnormal fetal heart rate, we should be alert to the possibility of uterine rupture. However, it should be noted that some patients have no symptoms or atypical symptoms before uterine rupture. Induction and augmentation of labor needs to be performed with caution to avoid this potential obstetric emergency.

Author Contributions

LZ, CS, and GH contributed to data collection and the conceptualization of the study. LZ and CS contributed to the study design. LZ, XL, and MC contributed to data analysis. All the authors contributed to data interpretation, manuscript preparation, editing, and review. All authors have read and approved the final manuscript.

Ethics Approval and Consent to Participate

Ethics Committee of the West China Second University Hospital of Sichuan University (approval number: 033). Data were anonymized and de-identified before analysis, and therefore, informed consent was not required.

Acknowledgment

Not applicable.

Conflict of Interest

The authors declare no conflict of interest.

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