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Original Article

Rupture of the scarred and unscarred gravid uterus: Outcomes and risk factors analysis

Shu-Han You [a, b], Yao-Lung Chang [a, b], Chih-Feng Yen [a, b, *]

[a] Department of Obstetrics and Gynecology, Chang Gung Memorial Hospital at Linkou, Tao-Yuan, Taiwan
[b] Chang Gung University College of Medicine, Tao-Yuan, Taiwan

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ABSTRACT

Objective: To study the maternal and fetal outcomes and assess the risk factors in patients with rupture at the lower-segment or non-lower-segment scarred, or unscarred gravid uterus.
Materials and Methods: Gravid patients with uterine rupture were retrospectively collected in Chang-Gung Memorial Hospital from November 2004 to July 2017. The rupture timing and location in association with maternal and fetal outcomes were collected as well as the possible risk factors including surgical history and interval prior to conception were analyzed.
Results: Thirty patients were included [mean age (±SEM), 34.4 ± 0.7 years; mean body mass index, 25.0 ± 0.6 kg/m^2] with mean onset of rupture at 34.2 ± 0.9 weeks, in which, 12 occurred at term and 18 at preterm (range 20–34 weeks). Four fetal demises, 22 transferals to neonatal intensive care unit, and 17 maternal blood transfusions without maternal mortality were noted. Twenty-two patients presented with acute abdominal pain and/or abnormal fetal heart rate tracing were managed with emergent cesarean delivery. Four ruptures were found in postpartum of vaginal delivery, in which 3 were after trials of labor after cesarean delivery and 1 was unscarred uterus, and two of the four eventually underwent hysterectomy. Unscarred uterus (n = 6) without identifiable risk factor ruptured in significantly later gestation associated with higher fetal birthweights than those of the scarred uterus (n = 24) (both $p < 0.05$), both of which yielded morbidity. The rupture timing between patients of non-lower-segment scar (n = 14) and lower-segment scar (n = 10) were not significantly different.
Conclusion: Rupture of gravid uterus prevalently occurred after 30 weeks of gestation with remarkable morbidity. Unscarred uterus could rupture in later gestation than the scarred ones without identifiable risk factor. Alertness to the acute abdominal pain, atypical from uterine contraction or the suspicious fetal heart rate tracing is the key to the timely rescue and successful management.

Introduction

Rupture of the gravid uterus, defined as complete disruption of all uterine layers during pregnancy, is a rare incidence but can lead to catastrophic maternal and fetal consequences. Although previously reported at around 0.8 to 5.3 per 10,000 births in literature [1,2], the incidence gradually increased over the recent decades [3,4], which may be associated with the increasing trend of advanced maternal age, increasing numbers of transmyometrial surgeries prior to conception [5] as well as a higher rate of induction or augmentation with prostaglandin or oxytocin. The complications could be severe, including maternal hemorrhage, blood transfusion, hysterectomy, bladder injury, maternal death, as well as the fetal prematurity, lower Apgar scores, and death [6,7]. The poorer outcomes may result from the delayed identification and management because of the unexpectedness and rareness.

The risk factors of uterine rupture included advanced maternal age, overdue pregnancy, macrosomia, shorter interval of deliveries, single-layer uterine closure, multiple previous cesarean deliveries, and trial of labor after cesarean section (TOLAC), as well as laparoscopic or abdominal myomectomy [8,9] or adenomyomectomy [10]. However, there were reports of rupture in unscarred gravid uteri [2,11]. The risk factors may be associated with the weakness of the myometrium due to trauma, congenital anomaly, or multiple gestation and the use of uterotonic drugs. Nevertheless, none of

* Corresponding author. Department of Obstetrics and Gynecology, Chang Gung Memorial Hospital at Linkou, 5, Fu-Hsin St, Kwei-Shan, Tao-Yuan, 33305, Taiwan.
E-mail address: yen2158@cgmh.org.tw (C.-F. Yen).

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these risk factors of scarred or unscarred uterine rupture was clinically reliable to predict individual risk of antepartum or intrapartum uterine rupture.

Moreover, literature found an increasing trend of uterine rupture in the past 40 years in both scarred and unscarred uteri during pregnancy, ranged from 0.9/10,000 to 6.1/10,000 and sharply increased in scarred uteri from 14.2/10,000 to 66.8/10,000 [3]. Some studies comparing outcomes of scarred and unscarred uterine rupture in pregnancy and showed higher composite of maternal and neonatal morbidity in the unscarred uterus [2,11]. However, there was no further comparison between lower segment scar (low transverse cesarean scar) and non-lower segment scar (myomectomy in fundus or corpus) rupture in pregnancy. The lower uterine segment, composed by uterine isthmus and inner cervical os, was formed in the third trimester and contained less muscle fibers. During labor, the upper segment would actively undergo periodic retraction and progressively the lower segment would be passively stretched and become thinning. We presumed that the different physiological changes in upper and lower uterine segments with uterine contraction may lead to different characteristics and outcomes of uterine rupture in pregnancy. Thus, the aim of this study was to assess uterine rupture and compare the characteristics, risk factors, and maternal and perinatal outcomes among lower or non-lower segment scar and unscarred uterine ruptures in pregnancy.

Material and method

This study retrospectively included patients treated in Linkou Chang-Gung Memorial Hospital, a tertiary referral center, and hence was reviewed and granted approval by its Human Investigation Review Board (IRB No. 201601145B0).

Patients

Patients with rupture of the gravid uterus from November 2004 to July 2017 was identified using code of international Statistical Classification of Disease (ICD-9 code 66,500 and 66,511 from 2004 to 2015, as well as ICD-10 code O710 and O711 from 2016 to 2017) and verified in the operation records by a notable full-thickness defect with visible chorioamniotic membrane or fetal parts. The antepartum or intrapartum course as well as the surgical history were determined from hospital records. The lower segment uterine scar was defined as previous low transverse cesarean section, while the non-lower segment scars were those with classical cesarean section and other uterine surgeries either through laparoscopy or laparotomy. Excluded from the current study were surgical complication related uterine lacerations or birth trauma (Fig. 1).

Data collection

Detailed clinical information were obtained from chart review, including maternal demographics (age, parity, and body mass index [BMI]), obstetric history (type of previous cesarean section and the interpregnancy interval), the interval between prior surgeries and the estimated conception date, clinical course such as tocolysis for preterm labor or medication for induction or augmentation, if any, onset and manifestation at rupture, delivery method, maternal complication, and neonatal outcomes.

Known risk factors for the rupture of gravid uterus, including advanced maternal age, multiparity, inter-pregnancy interval <6 months, parturition induction or augmentation, overstretched uterus (including the overdue pregnancy, macrosomia [birthweight > 4000 gm], or multiple gestation), undergoing TOLAC, and history of prior uterine surgery, were especially highlighted during the chart review. Outcomes including postpartum hemorrhage (estimated blood loss >1000 mL), maternal blood transfusion or hysterectomy, neonatal transferal to intensive care unit (NICU), and maternal or neonatal death, if any, were all assessed.

Statistical analysis

Age and BMI were considered as continuous variables and parity as discrete variables. Normality testing of data distribution was performed with the Kolmogorov–Smirnov test. Data with normal distributions were presented as mean ± SEM, while data without normal distributions were presented as median value and interquartile [25th–75th percentile] range. Incidence was presented as percentage (%). Nonparametric test, such as Mann–Whitney U test and Kruskal Wallis test, was used to compare the variances in maternal characteristics, risk factors, and outcomes of the lower segment or non-lower segment scarred uterus, and the unscarred uterus. Statistical calculation was performed using SPSS for Windows (release 17.0.0/2008; IBM-SPSS, Inc, Chicago, Illinois). Significance was defined as $P < 0.05$.

Result

We found 37 uterine ruptures in the survey; however, 7 patients were excluded as thought of surgical complication or birth trauma, in which, 2 were cervical lacerations extending into lower corpuses after vaginal deliveries, four were tearing of the incision angles in cesarean sections, and one was an iatrogenic uterine perforation after instrumental removal of undiagnosed placenta percreta (Fig. 1). Among the 30 patients experienced uterine ruptures, 24 (80%) women had scarred uterus while the other 6 were unscarred uterus. For the scarred uterus, prior uterine surgeries included laparoscopic myomectomy (n = 5), laparoscopic adenomyomectomy (n = 4), laparoscopic resection of cornual pregnancy (n = 2), laparotomic myomectomy (n = 2), low transverse cesarean section (n = 10), and classical cesarean delivery (n = 1). Moreover, there were 51,462 deliveries during the study period; hence the rupture rate of gravid uterus was estimated around 5.8 per 10,000 deliveries.

The result of total thirty maternities revealed mean maternal age 34.4 ± 0.7 years, median parity 1, and mean BMI 25.0 ± 0.6 kg/m^2, respectively. The mean interval between pregnancy and prior surgery was 43.3 ± 9.0 months, in which 6 women had intervals <6 months. Table 1 demonstrates detailed maternal characteristics and Table 2 listed the clinical risk factors. The mean gestational age of uterine rupture was 34.2 ± 0.9 weeks in the current series. In addition to 12 uterine ruptures happened in term pregnancy, 18 patients encountered ruptures and led to preterm birth with 16 of them (88.9%) occurring at ≥ 30 weeks of gestation. The distribution of gestational age in women with uterine rupture is illustrated in Fig. 2. The extremely preterm births at 20 and 24 weeks both had abrupt courses while presenting at our emergent department. The one ruptured at 20 weeks, twin pregnancy with only history of cesarean section once presented with acute abdominal pain and significant intra-peritoneal fluid. Magnetic resonance image (MRI) was arranged owing to the inadequate ultrasound image and demonstrated pending cornual rupture. The emergent laparotomy verified the protruding of one of the fetal parts at left cornus. The other one, ruptured at 24 weeks at fundus manifested intra-peritoneal fluid and fetal bradycardia on the ultrasound scan at presentation. However, the history of laparotomy myomectomy 10 years ago could not be obtained.

Acute symptoms followed by subsequent emergent cesarean delivery were noted in 22 patients, in which the majority were in

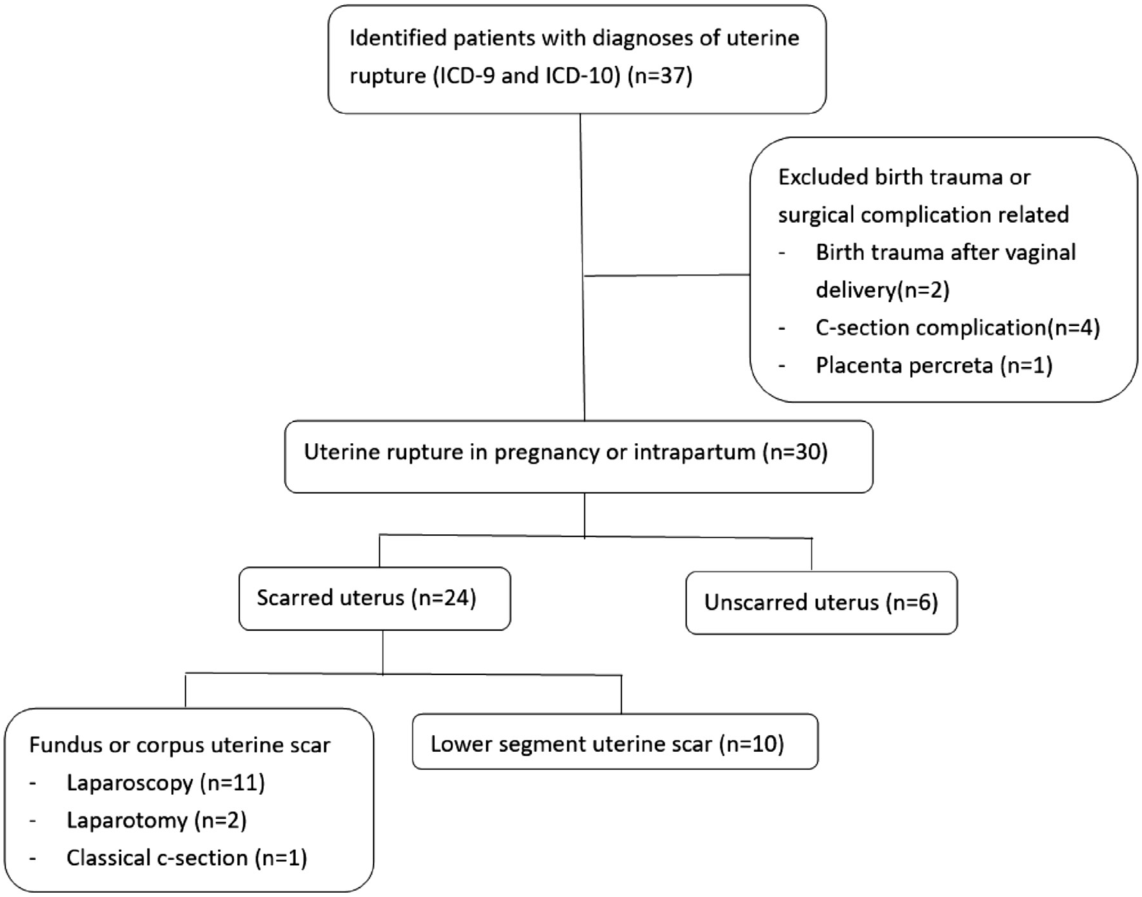

Fig. 1. Flow diagram of patient selection.

Table 1
Patient demographics (n = 30).

Maternal age (years)	34.4 ± 0.7
Parity, median (range)	1 (0–3)
Body mass index at delivery (kg/m^2)	25.0 ± 0.6
Previous uterine surgeries	24 (80%)
L's myomectomy	5 (16.7%)
L's adenomyomectomy	4 (13.3%)
L's resection of cornual pregnancy[a]	2 (6.7%)
Open myomectomy	2 (6.7%)
Cesarean section[b]	11 (36.7%)
No surgery	6 (20%)
Interval of previous surgery to conception (months, n = 24)	43.3 ± 9.1
Occurrence of uterine rupture (weeks)	34.2 ± 0.9
≥37weeks	12 (40.0%)
32 ≤ 37 weeks	10 (33.3%)
30 weeks around	6 (20.0%)
24 weeks around	1 (3.33%)
20 weeks around	1 (3.33%)
Tocolysis before rupture	6 (20.0%)
Ruptures found in postpartum	4 (13.3%)

Data are presented as mean ± SEM, or n(%).
L's = Laparoscopic.
[a] One patient had both laparoscopic resection of cornual pregnancy and cesarean delivery.
[b] Including one patient with classical cesarean delivery.

Table 2
Risk factors statistics (n = 30).

Prior uterine surgery	24 (80%)
Multipara	19 (63.3%)
Advanced maternal age (>35 y/o)	17 (56.6%)
Interval <6 months between previous surgery and conception	6 (20.0%)
TOLAC	3 (10%)
Induction with prostaglandin	1 (3.33%)
Augmentation with oxytocin	1 (3.33%)
Overdue pregnancy	4 (13.3%)
Macrosomia	0
Twin pregnancy	3 (10.0%)

Data are presented as n(%).
TOLAC = trial of labor after cesarean section.

the indication of either non-reassuring fetal heart rate tracing (NRFHT) or acute abdominal pain suspecting placental abruption. Only few patients were suspecting uterine rupture because of bizarre fetal location or ultrasonographical findings. Another one patient revealed rupture in cesarean section due to second arrest of cervical dilatation and three presented somehow like silent uterine rupture in elective cesarean delivery with good fetal outcomes. However, the other four patients experienced untypical postpartum abdominal pain or shock status after vaginal deliveries, including patients with TOLAC (n = 3) and unscarred vaginal delivery (n = 1). Only 6 patients in the preterm-group had tocolysis before rupture, ranging from 1 to 84 days, due to preterm labor (n = 1), preterm premature rupture of membrane (n = 2) or placenta previa with antepartum hemorrhage (n = 3).

No maternal death was noted but 12 had postpartum hemorrhage with 17 (56.7%) blood transfusions as well as one bladder rupture and two hysterectomies (Table 3). The common uterine rupture sites were previous cesarean scars or lower segment (n = 13) and fundus (n = 7). In the 4 cornual ruptures, 2 had previous laparoscopic resection of cornual pregnancy but another 2

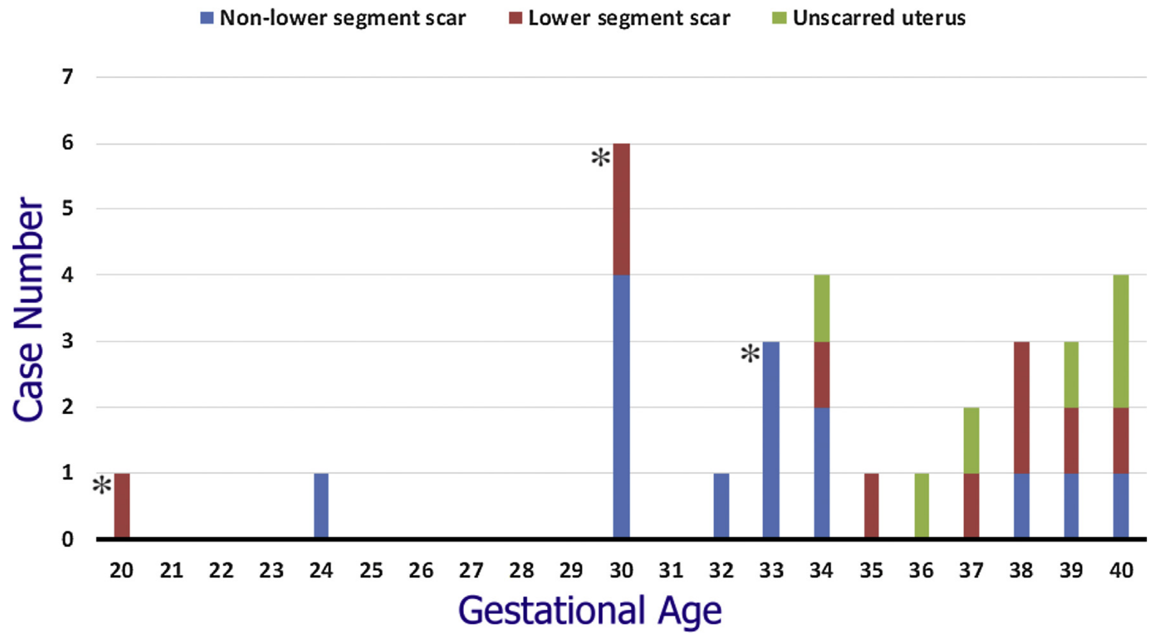

Fig. 2. Distribution of gestational ages of uterine rupture subdivided into patients with non-lower segment scarred (n = 14), lower-segment scarred (n = 10), and unscarred uterus (n = 6). Each asterisk indicates one patient of twin pregnancy.

Table 3
Maternal morbidities and Neonatal outcomes (n = 30).

Maternal morbidities	
Maternal estimated blood loss (mL)	1352.3 ± 219.6
Maternal blood transfusion	17 (56.7%)
Postpartum hemorrhage	12 (40%)
Bladder rupture	1 (3.33%)
Uterine rupture site	
Fundus	7 (23.3%)
Anterior wall	2 (6.7%)
Posterior wall	4 (13.3%)
Cornus	4 (13.3%)
Previous c/s wound or lower segment[a]	13 (43.3%)
Hysterectomy	2 (6.7%)
Neonatal outcomes	
Fetal body weight (g)	2263.7 ± 171.6
Admission to NICU	22 (66.7%)
Fetal or neonatal death	4 (12.2%)
1 min Apgar score <7	18 (54.5%)
5 min Apgar score <7	8 (24.2%)

Data are presented as mean ± SEM, or n(%).
NICU = neonatal intensive care center; C/S = cesarean section.
[a] Including one in classical cesarean section.

were twin pregnancies without prior cornual surgery. Besides, 2 hysterectomies occurred among 4 postpartum diagnosed uterine ruptures, one of which was postpartum of TOLAC and other was a sequel of an unscarred uterus rupture. Fetal demise was noted in 4 and neonatal transferal to NICU in 22 (66.7%) because of prematurity or low Apgar scores.

There were 6 in 30 ruptures (20%) happened in unscarred gravid uteri (Table 4) either at term or 30–36 weeks preterm gestation. In which, 3 of the 6 (50%) were presented with NRFHT, 2 presented with severe abdominal pain, 1 presented with 2nd arrest of cervical dilatation, and 1 had undergone tocolysis for antepartum hemorrhage. Five of the 6 patients were multi-para. No predominance was shown on the location of rupture site. All maternities were delivered by emergent cesarean delivery, except one whose uterine rupture was not aware until postpartum of vaginal delivery, suffered from profuse hemoperitoneum, and eventually underwent hysterectomy.

As the majority of patients (80%) with uterine rupture in the current series had uterine scars, we further subdivided these maternities into groups of either lower segment scar or non-lower segment scar to explore the possible characteristics and risk factors (Table 5). Median maternal parities were primi-para in the non-lower segment scar group but multi-para in lower segment scar and unscarred uterine groups ($p = 0002$). Though the median intervals of prior surgery to conception interval of patients ruptured at the non-lower segment scar seemed shorter than those ruptured at lower segment scar, the difference was not statistical significance (median [interquartile range]: 18 [5.25–50] months *vs.* 61 [8.25–90.5] months, $p = 0.212$). The occurrence of uterine rupture was significantly in later gestation in patients with unscarred uterus than those with scarred uterus (median [interquartile range]: 38 [36.25–39.75] weeks *vs.* 33.5 [30–38] weeks, respectively; $p = 0.034$), and hence the fetal body weights in patient with unscarred uterus were significantly higher than those with scarred uterus (median [interquartile range]: 3130.0 [2741.3–3301.3] gm *vs.* 2117.5 [1720.0–3055.0] gm, $p = 0.043$). In patients with scarred uteri, the timing of rupture had a slight earlier tendency in those with non-lower segment scar than those with lower segment scar (median [interquartile range]: 33 [30–34] weeks *vs.* 36 [31–38] weeks) but the difference did not achieve statistical significance. If the rupture timing and fetal birthweight were tested among the 3 groups, the differences of rupture time became a marginal trend toward significance ($p = 0.057$) and the fetal body weights were not different. Furthermore, factors such as maternal age, BMI, and outcomes including estimated maternal blood loss, and neonatal Apgar scores showed no difference among the three groups.

According to the chart review in the study period, 3 of the 30 women had subsequent pregnancies after the event of uterine rupture. Two of the unscarred rupture patients delivered at 37 weeks and 1 of the non-lower segment rupture delivered at 33 weeks due to preterm labor. All the 3 cesarean deliveries had good maternal and fetal outcomes without evidence of recurrent uterine rupture.

Table 4
Characteristics of the unscarred gravid uterus and outcomes afer rupture.

Case no.	Age	Parity	BMI	GA	Cervical dilatation at rupture[a]	Clinical symptoms	Delivery mode	FBW (g)	Apgar score[b]	NICU admission	Rupture site	EBL (mL)	BT	Hysterectomy
1	36	0	20.6	39	1.5 cm	Abd. pain	CS	3060	3, 8	Yes	Lower segment	1200	Yes	No
2	39	1	28.3	34	N/A[1]	NRFHT and APH	CS	1940	8, 10	Yes	Fundus	650	No	No
3	26	1	24.3	36	3 cm	NRFHT	CS	3335	7, 8	Yes	Fundus	800	Yes	No
4	36	2	26.6	40	0 cm	NRFHT	CS	3900	1, 3	Yes	Posterior wall	300	No	No
5	33	1	19.5	37	5 cm	2nd arrest	CS	2635	9, 10	No	Lower segment	300	No	No
6	40	3	22.8	40	N/A[2]	Abd. pain	VD	3200	9, 10	No	Lower segment	4200	Yes	Yes

BMI = body mass index; GA = gestational age; FBW = fetal body weight; NICU = neonatal intensive care center; EBL = estimated blood loss; BT = blood transfusion; Abd. = abdominal; NRFHT = Non-reassurance fetal heart rate tracing; APH = antepartum hemorrhage; CS = Cesarean delivery; VD = vaginal delivery.
[a] N/A: Data not available because of [1]placenta previa, [2]noted at postpartum.
[b] Apgar scores are evaluated in 1 and 5 mintues, respectively.

Table 5
Comparisons among groups with rupture site of uterine scars at non-lower segment and lower segment, and unscarred uterus.

	Scarred uterus		Unscarred uterus (n = 6)	*P* value
	Non-lower segment (n = 14)[a]	Lower segment (n = 10)		
Maternal age (years)	35.7 ± 0.4	32.1 ± 1.5	35.0 ± 2.1	0.167
Parity (median)	0	1	1	0.002[b]
BMI at delivery (kg/m^2)	24.5 ± 0.5	26.4 ± 1.5	23.8 ± 1.4	0.479
Interval of prior surgery to conception (months)	18 [5.25–50]	61.5 [8.25–90.5]	N/A	0.212
Occurrence of uterine rupture (weeks)	33.5 [30–38]		38 [36.25–39.75]	0.033[c]
0	33 [30–34]	36 [31–38]	38 [36.25–39.75]	0.057
Birthweight (g)	2117.5 [1720.0–3055.0]		3130.0 [2741.3–3301.3]	0.044[c]
	2192.5 [1833.8–3081.3]	2107.5 [1615.0–3022.5]	3130.0 [2741.3–3301.3]	0.086
Apgar score	(n = 16)	(n = 11)	(n = 6)	
1 min	5.5 [4.5–9]	6 [2–10]	7.5 [4–10]	0.643
5 min	8 [9–9]	9 [4–10]	9 [8–10]	0.412
Maternal estimated blood loss (mL)	1200 [500–2375]	750 [500–1265.5]	725 [387.5–1100]	0.715

Data are presented as mean ± SEM, or median [interquartile range].
N/A = Data not available.
[a] Including the one patient with classical cesarean section.
[b] Significance, Kruskal–Wallis Test.
[c] Significance, Mann–Whitney Test.

Discussion

The current study revealed 24 patients with history of prior cesarean deliveries or gynecologic uterine surgeries as well as 6 unscarred gravid uterine ruptures within a span of 13 years. The gestational age of rupture in unscarred uteri was significantly later than those in scarred gravid uterus, and hence associated with higher fetal weights. However, maternal blood loss in scarred versus unscarred rupture were not significantly different. In addition, this study revealed that both gestational age and fetal body weights were no difference between ruptures in lower- and non-lower uterine scars.

Most patients presented with acute symptoms, such as NRFHT or severe abdominal pain resembling the possible hypertonic uterus; however, few patients manifested with subtle and atypical symptoms, and the other few could be unveiled until postpartum after vaginal delivery. Therefore, uterine rupture especially in unscarred gravid uteri may delay awareness and management, leading to maternal and fetal disasters. We believed the experiences of gravid uterine rupture in the study would offer function of education in practicing obstetrics.

The incidence of uterine rupture in the study was 5.8 per 10,000 deliveries with 2 neonatal demise among 31 fetus deliveries at ≧ 24 weeks (rate = 64.5/1000), in a rate similar to the finding from WHO systematic review [1]. Independent risk factors of uterine rupture in previous multivariable analyses included previous cesarean delivery, malpresentation, multiparity, and dystocia during the first and second stage [4,12]. Other risk factors such as induction of labor, macrosomia, advanced maternal age have been reported [6]. Women older than 30 years old had reported 2 to 3 times of risk compared with women younger than 30 [6,13], which could explain our result of 34.4 ± 3.9 years of mean maternal age as well as 26 in 30 (86.6%) maternities more than 30-year-old. Owing to the increasing birth rates for women 30 years of age from 1970 to 2000 [14], the factor of advanced maternal age should be laid emphasis on. In addition, multiparity was another risk factor noted in our study. The median parity was 1 in the 30 women except the group with non-lower segment scars. Primiparity in the group of non-lower segment scar could not only be interpreted as pregnancy occurring after laparoscopic or laparotomy surgeries but also reminded obstetricians to take precaution of uterine rupture in primipara women with non-lower segment scars.

The onsets and rupture areas were variant in patients; however, most of uterine ruptures occurred after 30 weeks of gestational age and located at previous scars. The occurrence after 30 weeks may be associated with the acceleration of uterine enlargement in the third trimester or subclinical uterine contractions. To our knowledge, there was no specific etiology about myometrial tension for uterine rupture has been identified. Interestingly, larger size of rupture was noted at fundus based on medical records. However, we lacked of an objective measurement of rupture size in the retrospective chart review to precisely present the association between rupture size and location. In addition, four cornual ruptures occurred at three cornual scars including one twin pregnancy and another twin pregnancy with prior cesarean scar only. We assumed that the latter twin pregnancy without cornual scar could be a delayed diagnosis of one cornual ectopic pregnancy. However, more studies are required to identify if multiple gestation was an independent factor susceptible to cornual rupture.

In patients with rupture at previous scars, the mean interval between prior uterine surgery and conception was 43.3 ± 9.1 weeks, in which 6 of the 24 (25.0%) women had interval < 6 months (Table 1). Stamilo et al. have shown that short interpregnancy interval of TOLAC would associate with increased risk of uterine rupture, and hence result in major morbidity and blood transfusion [15]. In the current study, the intervals of the prior uterine surgery to conception was not different between the nonlower segment or lower-segment scarred gravid uterus. This result could suggest that patients who underwent lower-segment transvers cesarean delivery did not assuredly have lower risk of ruptures than those who had myomectomy or cornual resection prior to conception despite over years of interpregnancy, up to 178 months in the current study.

All the 14 non-lower segment scars had uterine ruptures before the onset of labor and only one had preterm uterine contraction with tocolysis for one day. It was remarkable that 10 in 14 women (71.4%) ruptured in 30–34 weeks presented with severe abdominal pain or NRFHT even though in absence of the evidence of uterine contraction. Koo et al. suggested 0.6% of uterine rupture during pregnancy after laparoscopic myomectomy and the risk was not associated with myoma type, diameter, or number [9]. Another meta-analysis revealed 0.75% of uterine rupture after myomectomy regardless of laparoscopic or laparotomy myomectomy [16]. Both studies indicated most of the ruptures occurred before the onset of labor, which was compatible with our findings.

There were 4 ruptures occurred after TOLAC in the series. One was diagnosed before delivery due to NRFHT and 3 were at postpartum after vaginal deliveries. Literature reported rupture rate in TOLAC was about 7.8/1000 [6]. During the study period, there were 382 successful cases of TOLAC in our institution. However, we had no data of failed TOLAC because of indications other than rupture such as NRFHT caused by other etiology, labor arrest, chorioamnionitis, and maternal request etc. Thus, the exact rupture rate of TOLAC in the series was unclear. Further prospective intension-to-treat analysis is warranted in patients with TOLAC to assess the successful and rupture rate of TOLAC.

No definite risk factor was identified in the six unscarred uterine ruptures and the labor courses were uneventful compared with normal deliveries. Congenital uterine anomaly, history of difficult dilatation and curettage (D&C) or operative hysteroscopy [17], and previous uterine perforation were risk factors for unscarred uterine rupture. However, among the 6 women, 3 had D&C once, the other 3 had no surgical history, and none of them was a recurrent perforation. Gibbins et al. reported half of the unscarred ruptured were identified during or after second stage [11]. In the current study, the 6 unscarred uterine ruptures took place after 34 weeks with one postpartum diagnosis, another 4 having no labor signs but NRFHT or abdominal pain, and the other diagnosed during cesarean delivery for second arrest of cervical dilatation (Table 4). The patient with postpartum diagnosis of uterine rupture (Table 4, Case #6) suffered from severe abdominal pain and was then transferred with shock status. The patient eventually had profound blood loss and underwent hysterectomy and repair of bladder rupture. The poorer outcome may be resulted from delayed identification and hospital transfer.

There were limitations in our study. We had no data for uncomplicated vaginal deliveries or cesarean sections after uterine surgeries. Therefore, the incidences of uterine rupture occurred in each of the three group was unobtainable. Moreover, symptoms and signs of uterine rupture were varied. Our small sample size was difficult to identify specific clinical patterns of uterine rupture or elucidate definite risk factors and could result in the type 2 errors in the statistical analysis.

Uterine rupture, a maternal and fetal life-threatening event was abrupt and not necessary to have clues of preterm uterine contraction. Scarred and unscarred ruptures both concentrated after 30 weeks of gestation. Unscarred rupture occurred in later gestation; however, it was remarkably morbid as well. Obstetricians should be vigilant with atypical low abdominal pain not only in women with uterine scars and short interval between prior surgery and conception but also the individuals without uterine scar from the third trimester till postpartum. Though there was no clinical reliable prediction or prevention for uterine rupture, doctors' awareness and timely management could decrease maternal and neonatal morbidity.

Author contributions

S.-H.Y. and C.-F.Y. conceived and designed the study; S.-H.Y. acquired the data; S.-H.Y., Y.-L.C., and C.-F.Y. analyzed and interpreted the data; S.-H.Y. drafted the manuscript; S.-H.Y. and C.-F.Y. reviewed the data and revised the manuscript critically for scientific and intellectual content. All authors approved the final version for submission.

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All the authors report no conflict of interest.

Conflict of interest statement

Drs. SH You, YL Chang, and CF Yen report no conflict of interest.

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