OBSTETRICS

Risk factors for complete uterine rupture

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BACKGROUND: Complete uterine rupture is a rare peripartum complication associated with a catastrophic outcome. Because of its rarity, knowledge about its risk factors is not very accurate. Most previous studies were small and over a limited time interval. Moreover, international diagnostic coding was used in most studies. These codes are not able to differentiate between the catastrophic complete type and less catastrophic partial type. Complete uterine rupture is expected to increase as the rate of cesarean delivery increases. Thus, we need more accurate knowledge about the risk factors for this complication.

OBJECTIVE: The objective of the study was to estimate the incidence and risk factors for complete uterine rupture during childbirth in Norway.

STUDY DESIGN: This population-based study included women that gave birth after starting labor in 1967–2008. Data were from the Medical Birth Registry of Norway and Patient Administration System, complemented with information from medical records. We included 1,317,967 women without previous cesarean delivery and 57,859 with previous cesarean delivery. The outcome was complete uterine rupture (tearing of all uterine wall layers, including serosa and membranes). Risk factors were parameters related to demographics, pregnancy, and labor. Odds ratios for complete uterine rupture were computed with crude logistic regressions for each risk factor. Separate multivariable logistic regressions were performed to calculate the adjusted odds ratios and 95% confidence intervals.

RESULTS: Complete uterine rupture occurred in 51 cases without previous cesarean delivery (0.38 per 10,000) and 122 with previous cesarean delivery (21.1 per 10,000). The strongest risk factor was sequential labor induction with prostaglandins and oxytocin, compared with spontaneous labor, in those without previous cesarean delivery (adjusted odds ratio, 48.0, 95% confidence interval, 20.5–112.3) and those with previous cesarean delivery (adjusted odds ratio, 16.1, 95% confidence interval, 8.6–29.9). Other significant risk factors for those without and with previous cesarean delivery, respectively, included labor augmentation with oxytocin (adjusted odds ratio, 22.5, 95% confidence interval, 10.9–41.2; adjusted odds ratio, 4.4, 95% confidence interval, 2.9–6.6), antepartum fetal death (adjusted odds ratio, 15.0, 95% confidence interval, 6.2–36.6; adjusted odds ratio, 4.0, 95% confidence interval, 1.1–14.2), and previous first-trimester miscarriages (adjusted odds ratio, 9.6, 95% confidence interval, 5.7–17.4; adjusted odds ratio, 5.00, 95% confidence interval, 3.4–7.3). After a previous cesarean delivery, the risk of rupture was increased by an interdelivery interval <16 months (adjusted odds ratio, 2.3; 95% confidence interval, 1.1–5.4) and a previous cesarean delivery with severe postpartum hemorrhage (adjusted odds ratio, 5.6; 95% confidence interval, 2.4–13.2).

CONCLUSION: Sequential labor induction with prostaglandins and oxytocin and augmentation of labor with oxytocin are important risk factors for complete uterine rupture in intact and scarred uteri.

Key words: antepartum fetal death, augmentation of labor with oxytocin, complete uterine rupture, medical records, previous cesarean delivery, previous miscarriage, prostaglandin, risk factor, sequential induction of labor

Complete uterine rupture is a rare peripartum complication, often associated with a catastrophic outcome for both mother and child.[1] A scarred uterus, mostly because of a previous cesarean delivery (CD), substantially increases the risk of uterine rupture.[1,2]

In Norway, the incidence of complete uterine rupture has significantly increased in recent years in both women with and without previous CD.[3] This increase was partly explained by an increase in risk factors related to labor management, mainly induction and augmentation of labor.[3] Among mothers without a previous CD in Norway, labor is induced with prostaglandins, oxytocin, amniotomy, and other mechanical methods such as transcervical balloon catheter. Oxytocin induction was predominantly used in 1967–1977, with hardly any use of prostaglandins. Prostaglandins were increasingly used since 1978.[3]

All mothers with 1 previous CD are offered a trial of labor unless there is absolute contraindication against vaginal delivery. The trial of labor after previous CD is high in Norway, around 63.6%.[4] Among those with a trial of labor, there is 80% vaginal birth.[4] Prostaglandin E2 was used in induction in this group until 2004 when the transcervical balloon started dominating.

Augmentation of labor with oxytocin has increasingly been used in recent years in which almost one third of the women giving birth receive oxytocin.[3] Here we further explore factors that may be associated with complete uterine rupture.

This study aimed to identify risk factors for complete uterine rupture after starting labor in a validated population in Norway that gave birth in 1967–2008. We performed separate analyses for women with and without a previous CD.

Materials and Methods

Overview

This population-based registry study was complemented with information from corresponding medical records. The Regional Ethics Committee (2010/1609-4) and the Data Inspectorate of Norway approved the study.

We used 2 independent data sources to identify possible cases of uterine rupture.

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First, we searched the Medical Birth Registry of Norway (MBRN), established in 1967. This national registry contains information on all births in Norway after 16 weeks of gestation regarding maternal health, information about delivery and complications, and information about the newborn. The midwives attending a birth complete and send a standardized MBRN form within 7 days after delivery.

Second, we searched the Patient Administration System (PAS), which is a local registry at each maternity unit. These registries maintain records of all diagnoses for in-patients since 1970. We requested permission to perform a PAS registry search from all maternity units (n = 48) in Norway, and 21 units agreed to participate. These 21 units were distributed throughout Norway, and they exhibited a wide range of delivery rates, from <500/year to ≥3000/year. The target population included maternities recorded in these 21 units during 1967−2008 (n = 1,443,271), which represented 59.81% of the pregnant population in Norway. We excluded individuals with missing registration numbers in the MBRN (missing = 2,716) or missing gestational age (missing = 8303). Hence, the sample included 1,432,252 maternities.

In this study, we examined risk factors for complete uterine rupture after starting labor. Thus, we excluded all individuals who gave birth through a CD before starting labor. The final sample included 1,375,826 maternities. We studied risk factors for complete uterine rupture separately for women without a previous CD (all parities) (n = 1,317,967) and those with a previous CD (parities ≥1) (n = 57,859). In general, in Norway, pregnant mothers with 1 previous lower-segment CD are offered the opportunity to attempt a labor. The majority in this study had 1 low transverse segment incision. Few had low vertical incision or classical vertical incision. Single- or double-layer suturing of the uterus at a previous CD is not registered in the MBRN.

For mothers undergoing a second delivery with a history of CD in a first delivery (parity = 1; n = 34,550 mothers), we constructed a data set, in which the first 2 deliveries for these mothers were linked. This data set was used to calculate the risk of complete uterine rupture in the second delivery, based on the previous obstetric history.

After identifying potential cases of uterine rupture in the MBRN and in the PAS, we validated the diagnosis of complete uterine rupture with corresponding medical records, which were considered the gold standard.[5] The first author of the present study (I.A.-Z.) identified these cases and studied the medical records of mothers diagnosed with uterine rupture by visiting 16 maternity units and reading posted copies of records from 5 additional units. The medical records included detailed information about the mothers and their newborns.

Measures

The outcome measure was complete uterine rupture, defined as a tear through all layers of the uterine wall, including the serosa and amniotic membranes. A partial uterine rupture was defined as a tear in the muscular layers, with intact serosa or amniotic membranes.[5] The diagnosis of uterine rupture was reported in plain text on the MBRN registration forms by the birth attendant, and the appropriate code was recorded in the electronic file by MBRN personnel.

Before 1999, the code used was 71; starting in 1999, the International Classification of Diseases (ICD), 10th revision, diagnostic codes were used (O710, O711).[6] Uterine rupture was identified in the PAS by the ICD, eighth revision, code: 956[7] (1967−1978); ICD 9 codes: 6650 and 6651[8] (1979−1998); and ICD, 10th revision, codes: O710 and O711 (1999−2008).[6] These codes did not specify rupture type. The type of rupture, whether complete or partial, was identified in the medical records. In this study we included data only from mothers with complete ruptures.

The risk factors were identified, after being recorded in registration forms in plain text or by marking prespecified tick boxes. They included demographic factors, previous miscarriage, pregnancy factors, and obstetric factors. Demographic factors included maternal age, grouped as <35 years or ≥35 years; parity, grouped as <3 or ≥3; the mother's country of birth, grouped as Western (Europe, North America, and Australia) or non-Western; and the decade of delivery, grouped by the 4 decades included in the study: first decade (1967−1977), second decade (1978−1988), third decade (1989-1999), or fourth and most recent decade (2000−2008); the fourth decade was taken as the reference.

Maternal age and parity were analyzed first as continuous variables, but there was no significant difference seen before the cutoff level mentioned in the previous text, and these were therefore grouped into categorical variables. A previous miscarriage was defined as 1 or more miscarriages that occurred in the first trimester.

Pregnancy factors included gestational age in weeks, grouped as 37−40 (reference), ≥41, or 24−36 weeks; fetal presentation, grouped as occipitoanterior vertex (reference), non−occipitoanterior, or a breech or transverse lie; antepartum fetal death, and birthweight, grouped as <4000 or ≥4000 g.

Obstetric factors included labor start, grouped as spontaneous or induced labor; augmentation of labor (defined as augmentation of contractions after an established spontaneous or induced labor), grouped as no oxytocin use or oxytocin use; and induction methods, grouped as spontaneous labor, induction with prostaglandins or oxytocin (each used with or without amniotomy or other methods), other methods (sweeping of membranes, transcervical balloon catheters, or unspecified methods), and sequential induction (prostaglandins and oxytocin combined with or without amniotomy or other methods).

The prostaglandins administered were mainly vaginal dinoprostone (prostaglandin E2); however, misoprostol (prostaglandin E1) was increasingly used in unscarred uteri, starting in 2004; also, gemeprost was used occasionally for the termination of pregnancy for those treated in the first 3 decades of the study. The maximum and total doses and the duration of prostaglandins or oxytocin administered are not registered in the MBRN form. Other labor factors included breech extraction and manual removal of the placenta after vaginal delivery.

Among mothers with a CD in a first delivery (Para1), the combined data set of the first and second deliveries was examined for risk factors that were present at the previous CD. These risk factors included maternal age, gestational age, an interdelivery interval <16 months, the type of CD (elective or emergency CD), prolonged labor, and severe postpartum hemorrhage (defined as blood loss ≥1500 mL or a need for blood transfusion, regardless of the amount of blood loss).

Data analysis

We computed the overall incidence and the incidences of complete and partial uterine rupture among groups without and with previous CD. Cross-tabulations and crude logistic regressions were used for each risk factor to calculate the risk and observed odds ratios (ORs) with the corresponding 95% confidence intervals (CIs) of complete uterine rupture. Only those that were statistically significant were included further in multivariable regression analysis. We used multivariable logistic regression in different models to calculate adjusted odds ratios (AORs). Demographic factors were adjusted first to each other. Other significant risk factors were adjusted for confounding relevant factors in separate models. Relevant cofactors preceded analyzed risk factors in time. The level of significance was set to $P < .05$. Data analyses were performed with SPSS, version 21 (SPSS Inc, Chicago, IL).

Results

We found 173 complete ruptures of a total of 292 uterine ruptures after starting labor in the period of 1967–2008. Among 1,317,967 women without a previous CD, there were 51 cases of complete rupture (0.38 per 10,000) and 5 cases of partial rupture. There were 13 complete ruptures (0.2 per 10,000) among nulliparous women after starting labor (631,813 maternities). Among 57,859 women with **a** previous CD, there were 122 cases of complete rupture (21.1 per 1000) and 114 cases of partial rupture (19.7 per 10,000). Among both groups, a complete rupture was most common in the fourth decade (2000–2008) (Tables 1 and 2).

TABLE 1
Risk factors for complete uterine rupture after starting labor in women without previous cesarean delivery (all parities) (n = 1,317,967)

Risk factors	Total number	Complete rupture		Adjusted odds ratio (95% CI)
Model 1: risk factors adjusted for each other				
Demographic factors		n	Per 10,000	
Maternal age, y				
<35	1,201,726	39	0.3	1
≥35	116,241	12	1.0	2.5 (1.3–4.9)
Parity				
<3	1,234,851	41	0.3	1
≥3	83,116	10	1.2	2.4 (1.1–5.7)
Mother's country of birth				
Western	1,242,624	43	0.3	1
Non-Western	75,343	8	1.0	2.7 (1.2–6.0)
Decades of the study				
Fourth decade (2000–2008) (referent)	302,304	16	0.5	1
First decade (1967–1977)	309,456	15	0.5	0.9 (0.4–1.8)
Second decade (1978–1988)	322,129	7	0.2	0.4 (0.2–0.9)
Third decade (1989–1999)	384,078	13	0.3	0.6 (0.3–1.3)
Model 2: adjusted for demographic factors				
Previous miscarriages ≤12 wks				
No	1,259,078	33	0.3	1
Yes	58,889	18	3.0	9.6 (5.7–17.4)
Model 3: adjusted for demographic factors, previous miscarriages, and each other				
Pregnancy factors				
Fetal presentation				
Occipitoanterior vertex	1,248,557	41	0.3	1
Not occipitoanterior	26,966	4	1.5	4.3 (1.5–12.1)
Breech/transverse lie	42,444	6	1.4	3.3 (1.3–8.0)
Antepartum fetal death				
No	1,309,643	45	0.3	1
Yes	8324	6	7.2	15.0 (6.2–36.6)
Birthweight, g				
<4000	1,068,597	31	0.3	1
≥4000	249,370	20	0.8	2.9 (1.6–5.0)
Model 4: adjusted for demographic, previous miscarriages, and pregnancy factors				
Labor factors				
Labor start				
Spontaneous labor	1,134,073	24	0.2	1
Induced labor	183,894	27	1.5	5.1 (2.9–9.1)

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Among women without a previous CD (Table 1), the absolute number of complete ruptures was very low, even in the presence of risk factors. The highest odds ratios were associated with sequential induction with prostaglandins and oxytocin (AOR, 48.0), followed by breech extraction (AOR, 42.6), labor augmentation with oxytocin (AOR, 22.5), antepartum fetal death (AOR, 15.0), and previous first-trimester miscarriages (AOR, 9.6). Other risk factors included maternal age ≥35 years, parity ≥3, malposition/malpresentation, birthweight ≥4000 g, and non-Western maternal origin.

Among women with a previous CD (Table 2), the highest odds ratio was associated with sequential induction with prostaglandins and oxytocin, which increased the risk 16-fold; the rate of rupture was close to 4% (388.1 per 10,000). The risk of a complete rupture was twice as high with a prostaglandin induction as with spontaneous labor, and a similar risk was incurred by oxytocin induction. Amniotomy and other mechanical induction methods showed the weakest associations with uterine rupture. Other risk factors significantly increased the rupture risk by around 4- to 6-fold, including antepartum fetal death, previous first-trimester miscarriage, labor augmentation with oxytocin, and manual removal of placenta. The risk of rupture was only slightly increased by fetuses ≥4000 g, gestational age ≥41 weeks, and a non-Western maternal origin.

Among patients with a complete rupture with a history of miscarriage, the medical records showed that most miscarriages occurred in the 1970s, 1980s, and early 1990s. Curettage was the treatment of choice in that period, but the records did not mention perforations.

The calculated rates of rupture after miscarriages in the fourth decade (2000–2008) were considerably lower than those in earlier decades. The AORs for complete rupture because of miscarriages in the fourth decade were 3.4 (95% CI, 1.2–9.2) among women without a previous CD and 1.5 (95% CI, 0.9–2.4) among those with a previous CD. The 18 ruptures identified among those without a previous CD and with a history of miscarriages included 5 para0, 4 para1, 5 para2, 2 para3, 1 para4, and 1 para5.

The case records of ruptures after antepartum fetal deaths showed that labor was managed aggressively, with excessive use of induction, oxytocin augmentation, and rough manipulative procedures such as internal podalic version or fundal pressure. Eight of 9 were induced, and 1 ended with hysterectomy.

Several factors that were present at a previous CD increased the risk of complete uterine rupture after starting labor in the next pregnancy (Table 3). These factors included the presence of severe postpartum hemorrhage, maternal age ≥35 years, and an interdelivery interval <16 months. The risk of complete rupture was not increased by a CD that was indicated because of a prolonged labor or by a CD performed at a preterm gestational age. The risk of rupture was lower in patients with a previous emergency CD compared with those with a previous elective CD, but the difference was not statistically significant.

TABLE 1
Risk factors for complete uterine rupture after starting labor in women without previous cesarean delivery (all parities) (n = 1,317,967) *(continued)*

Risk factors	Total number	Complete rupture		Adjusted odds ratio (95% CI)
Model 5: adjusted for demographic factors, previous miscarriages, and pregnancy factors				
Induction methods				
Spontaneous labor	1,134,073	24	0.2	1
Prostaglandins	32,286	7	2.2	4.5 (1.8–10.9)
Oxytocin	85,686	12	1.4	6.5 (3.2–13.4)
Amniotomy alone	14,244	0	0.0	Not applicable
Others[a]	47,879	0	0.0	Not applicable
Sequential (prostaglandins and oxytocin)	3799	8	21.1	48.0 (20.5–112.3)
Model 6: adjusted for demographic factors, previous miscarriages, pregnancy factors, and labor start				
Augmentation of labor				
No oxytocin use	1,116,643	11	0.1	1
Oxytocin use	201,324	40	2.0	22.5 (10.9–41.2)
Model 7: adjusted for demographic, pregnancy factors, previous miscarriages, labor start, and augmentation				
Breech extraction				
No	1,316,516	45	0.3	1
Yes	1451	6	41.4	42.6 (14.3–126.6)

CI, confidence interval.

[a] Stripping of membranes, transcervical balloon catheter, and unspecified methods.

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Comment

This study estimated the incidences of complete uterine rupture after starting labor among women with and without a previous CD in Norway during 1967–2008. The highest incidence of complete rupture occurred in the last decade of the study (2000–2008). One of the main findings was that sequential induction with prostaglandins and oxytocin showed the highest odds ratio for complete uterine ruptures in women with or without a previous CD. Other significant risk factors in both groups of women included labor augmentation

with oxytocin, antepartum fetal death, and previous miscarriage.

The strengths of this study lie in studying a rare complication in somewhat more than half the pregnant population in Norway over the past 40 years. The recruited units represented all unit sizes and geographic regions; thus, we believe that they are representative of all units in Norway. Moreover, the odds ratios for uterine rupture were approximately the same when we did an additional analysis including all 48 units (data not shown). Therefore, we do not believe that the inclusion of the 27 nonparticipating units would have affected our results.

Some risk factors might have been incorrectly registered in the MRBN; however, these misclassifications would be nondifferential; thus, they would tend to underestimate, rather than overestimate, the effects. In most previous studies, uterine ruptures were not classified because the ICD, 10th revision, international coding did not differentiate between partial and complete ruptures. This lack of classification may have resulted in incorrect or inaccurate associations. In addition, most studies were small. In Norway, we had the opportunity to study this rare complication with registry data, which followed up a large sample over a long time period. Rupture cases were validated against information in medical records; consequently, real cases of complete rupture could be reliably identified.[5]

One limitation is that sample size in some subgroups such as breech extraction and sequential induction in intact uteri may be not sufficient to rule out a type II error, especially because uterine rupture is a very rare outcome. Because this study examined uterine rupture through several decades, one should take into consideration the changes in obstetric practice over time. The case records showed more aggressive manipulative vaginal deliveries in the first decade; hence, we have adjusted for the decades.

Among women without a previous CD, the rate was 0.38 per 10,000, which was lower than the 1.3 per 10,000 reported in the industrial world.[9]

TABLE 2
Risk factors for complete uterine rupture after starting labor in women with previous cesarean delivery (parity ≥1) (n = 57,859)

	Total number	Complete rupture		Adjusted odds ratio (95% CI)
Model 1: risk factors adjusted for each other				
Demographic factors		n	Per 10,000	
Maternal age, y				
<35	48,001	93	19.4	1
≥35	9858	29	29.4	1.3 (0.8–1.9)
Parity				
<3	50,918	108	21.2	1
≥3	6941	14	20.2	0.8 (0.4–1.4)
Mother's country of birth				
Western	53,133	102	19.2	1
Non-Western	4726	20	42.3	1.8 (1.1–2.8)
Decades of the study				
Fourth decade (2000–2008) (referent)	18,615	78	41.9	1
First decade (1967–1977)	3220	10	31.0	0.7 (0.4–1.4)
Second decade (1978–1988)	13,623	7	05.1	0.1 (0.05–0.2)
Third decade (1989–1999)	22,401	27	12.0	0.3 (0.2–0.4)
Model 2: adjusted for demographic factors				
Previous miscarriages ≤12 wks				
No	52,796	82	15.5	1
Yes	5,063	40	79.0	5.0 (3.4–7.3)
Model 3: adjusted for demographic factors, previous miscarriages, and for each other				
Pregnancy factors				
Gestational age, wks				
37–40	36,505	68	18.6	1
≥41	16,281	46	28.3	1.6 (1.1–2.3)
24–36	5073	8	15.8	0.8 (0.4–1.3)
Antepartum fetal death				
No	57,235	119	20.8	1
Yes	502	3	59.8	4.0 (1.1–14.2)
Birthweight, g				
<4000	45,382	77	17.1	1
≥4000	12,477	45	36.1	2.1 (1.5–3.1)

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Similarly, among women with a previous CD, the rate was slightly lower than the incidence previously reported (39.00 per 10,000).[10] Our relatively lower incidence rates may be explained by our inclusion of only complete ruptures and the long study period. The rupture rate was as high in the first decade as in the fourth decade. The high rupture rate in the former might be due to a higher percentage of classical uterine incision and more aggressive manipulative and

operative vaginal deliveries. We showed previously[3] that the increasing rupture rate in the fourth decade may be related to an increased use of sequential induction, increasing augmentation with oxytocin, and increasing percentages of older mothers and immigrants from non-Western origin.

We demonstrated that sequential induction carried a substantial risk for complete rupture in women with and without a previous CD. Previous studies have shown the importance of sequential induction in the former group[11] but not in the latter. Studies on the risk of uterine rupture in unscarred uteri were mostly case reports. [9,12,13] The sample size of those having sequential induction among unscarred uteri in our study was small, resulting in a wide confidence interval. However, this finding may be of importance in countries with a higher percentage of multiparous women with unscarred uteri who are at increased risk for rupture.[9]

Consistent with several studies, mechanical induction carried the lowest risk of uterine rupture compared with prostaglandins or oxytocin.[4,14] Mechanical methods have recently been used as a first option for induction in scarred uteri in Norway. However, in clinical practice mechanical methods are rarely used alone, and most probably prostaglandins or oxytocin would be required. Hence, further studies are needed to explore the risk of rupture related to the dose and duration of prostaglandins or oxytocin administered.

Consistent with previous studies, labor augmentation with oxytocin carried a high risk of a complete rupture.[15] However, we lacked specific data regarding the maximum dose of oxytocin and its duration. Cahill et al[16] noted a dose-response effect with an increasing risk of rupture with a maximum higher dose of oxytocin. Their results estimated the attributable risk of a uterine rupture to be 2.9% for maximum oxytocin dose ranges above 20 mU/min. A future nested case control study using our data is needed to determine whether we get similar results.

We found that a previous miscarriage had a significant effect on uterine rupture. The only similar published studies were case reports that described ruptures in women with intact uteri after a previous perforation caused by curettage.[12,17,18] We could not determine whether the miscarriage had weakened the uterine wall or whether the effect might have been related to using surgical or medical termination of pregnancy because the MBRN did not contain sufficient information about the treatment of miscarriages. However, the medical records of rupture cases showed that the majority of miscarriages occurred in the early decades, when curettage dominated; the rate of rupture after a miscarriage was lowest in the fourth decade. This might be due to an increasing use of medical termination or to better miscarriage reporting, which provided a larger denominator in later calculations. If we remove those with previous miscarriages in nonscarred uteri, the rate of rupture decreases from 0.38 to 0.26 per 10,000. This indicates that weakening the uterine wall by potential curettage may contribute significantly in increasing rupture risk.

One previous study[19] showed the obstetric outcome in 209 mothers with a previous CD and antepartum fetal death; they found a rupture rate of 2.4%, and none of these required hysterectomy.

TABLE 2
Risk factors for complete uterine rupture after starting labor in women with previous cesarean delivery (parity ≥1) (n = 57,859) *(continued)*

	Total number	Complete rupture		Adjusted odds ratio (95% CI)
Model 4: adjusted for demographic factors, previous miscarriages, and pregnancy factors				
Labor factors				
Labor start				
Spontaneous labor	45,834	76	16.7	1
Induced labor	12,025	46	38.3	2.3 (1.6–3.3)
Model 5: adjusted for demographic factors, previous miscarriages, and pregnancy factors				
Induction methods				
Spontaneous labor	45,834	76	16.6	1
Prostaglandins	3504	19	54.2	2.5 (1.5–4.2)
Oxytocin	2727	12	44.0	2.8 (1.5–5.2)
Amniotomy alone	767	0	0.0	Not applicable
Others[a]	5142	2	4.0	0.4 (0.09–1.5)
Sequential (prostaglandins and oxytocin)	335	13	388.1	16.1 (8.6–29.9)
Model 6: adjusted for demographic factors, previous miscarriages, pregnancy factors, and labor start				
Augmentation of labor				
No oxytocin use	40,551	37	9.1	1
Oxytocin use	17,308	85	49.1	4.4 (2.9–6.6)
Model 7: adjusted for demographic factors, pregnancy factors, previous miscarriages, labor start, and augmentation				
Manual removal of placenta[b]				
No	39,279	21	5.3	1
Yes	635	3	47.2	5.9 (1.6–20.6)

CI, confidence interval.

[a] Stripping of membranes, transcervical balloon catheter, and unspecified methods; [b] Only in those delivered vaginally.

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TABLE 3
Risk of complete uterine rupture after starting labor in the second pregnancy, based on factors present during a previous cesarean delivery (parity = 1) (n = 34,550 mothers)

Risk factor during previous CD	Total number	Complete rupture		Adjusted odds ratio (95% CI)
		n	Per 10,000	
Maternal age ≥35, y				
No	33,312	67	20.1	1
Yes	1238	9	72.7	2.9 (1.4–5.9)
Gestational age, wks				
37–40	17,959	37	20.6	1
≥41	11,715	26	22.2	1.1 (0.7–1.8)[a]
24–36	4876	13	26.6	1.3 (0.6–2.3)[a]
Interdelivery interval <16 mo				
No	33,374	70	21.0	1
Yes	1176	6	51.0	2.3 (1.1–5.4)[a]
Type of previous CD				
Elective	30,524	63	32.3	1
Emergency	4026	13	20.6	0.9 (0.5–1.7)[a]
Prolonged labor				
No	20,180	42	20.8	1
Yes	14,370	34	23.7	1.2 (0.7–1.8)[a]
Severe postpartum hemorrhage				
No	34,216	70	20.5	1
Yes	334	6	179.6	5.6 (2.4–13.2)[a]

CD, cesarean delivery.

[a] Adjusted for maternal age at first cesarean delivery and the study decade of the current pregnancy.

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This rate is still higher than ours of 0.6%, although we had one resulting in hysterectomy. One does understand that it is better to avoid a repeat CD when the fetus is unviable, but one should have extra vigilance when managing such labors, even among unscarred uteri.

Risk factors such as severe postpartum hemorrhage at a previous CD and a short interdelivery interval should be taken into account when counseling about the mode of delivery because they contribute to a weakened scar.[20-22] The finding that a previous prolonged labor and a previous emergency CD were not risk factors might be due to the high degree of vigilance used in the management of these groups.

In conclusion, the risk for complete uterine rupture increases with sequential labor induction with prostaglandins and oxytocin and with oxytocin use during labor. There is a need for future studies estimating the risk of rupture related to dosages and duration of prostaglandins and oxytocin used. Mothers with unavoidable risk factors should be monitored vigilantly during labor. ■

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