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Maternal and Perinatal Outcomes Associated with a Trial of Labor after Prior Cesarean Delivery

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ABSTRACT

BACKGROUND

The proportion of women who attempt vaginal delivery after prior cesarean delivery has decreased largely because of concern about safety. The absolute and relative risks associated with a trial of labor in women with a history of cesarean delivery, as compared with elective repeated cesarean delivery without labor, are uncertain.

METHODS

We conducted a prospective four-year observational study of all women with a singleton gestation and a prior cesarean delivery at 19 academic medical centers. Maternal and perinatal outcomes were compared between women who underwent a trial of labor and women who had an elective repeated cesarean delivery without labor.

RESULTS

Vaginal delivery was attempted by 17,898 women, and 15,801 women underwent elective repeated cesarean delivery without labor. Symptomatic uterine rupture occurred in 124 women who underwent a trial of labor (0.7 percent). Hypoxic–ischemic encephalopathy occurred in no infants whose mothers underwent elective repeated cesarean delivery and in 12 infants born at term whose mothers underwent a trial of labor ($P<0.001$). Seven of these cases of hypoxic–ischemic encephalopathy followed uterine rupture (absolute risk, 0.46 per 1000 women at term undergoing a trial of labor), including two neonatal deaths. The rate of endometritis was higher in women undergoing a trial of labor than in women undergoing repeated elective cesarean delivery (2.9 percent vs. 1.8 percent), as was the rate of blood transfusion (1.7 percent vs. 1.0 percent). The frequency of hysterectomy and of maternal death did not differ significantly between groups (0.2 percent vs. 0.3 percent, and 0.02 percent vs. 0.04 percent, respectively).

CONCLUSIONS

A trial of labor after prior cesarean delivery is associated with a greater perinatal risk than is elective repeated cesarean delivery without labor, although absolute risks are low. This information is relevant for counseling women about their choices after a cesarean section.

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THE OVERALL RATE OF CESAREAN DELIVERY in the United States has risen dramatically, from 5 percent of all deliveries in 1970 to a high of 26 percent in 2002.[1] Efforts to reduce the number of cesarean births, although initially successful, failed to achieve the U.S. Public Health Service goals, set in 1990. These goals included achieving an overall rate of cesarean delivery of 15 percent, and a rate of vaginal birth after previous cesarean section of 35 percent of deliveries after previous cesarean sections, by the year 2000.[2] The Healthy People 2010 report published in 2000 proposes a target rate of vaginal birth after previous cesarean section of 37 percent.[3] During the past 25 years, as the number of repeated cesarean sections grew, vaginal birth after cesarean delivery was increasingly recommended in clinical-management guidelines, prompting a rise in the use of this approach in the United States from 3 percent of deliveries after previous cesarean section in 1981 to 31 percent in 1998.[4] However, an apparent increase in the frequency of uterine rupture and concern about maternal and perinatal morbidity have challenged the safety and appropriateness of vaginal birth after cesarean delivery.[5]

These issues, along with medicolegal pressures and the introduction of more stringent criteria for a trial of labor after cesarean delivery, have led to a substantial decline in the rate of vaginal birth after cesarean section, to 12.7 percent in 2002.[1] The magnitude of the risk of uterine rupture and the attendant morbidity remain uncertain, owing to methodologic deficiencies in the available literature and differences among studies in the definitions of and approaches to the ascertainment of uterine rupture.[6] We conducted a multicenter observational study involving women with a prior cesarean delivery to assess the risks of uterine rupture and neonatal and maternal morbidity associated with a trial of labor as compared with repeated elective cesarean delivery.

METHODS

STUDY DESIGN

We performed a prospective cohort study from 1999 through 2002 at 19 academic medical centers belonging to the National Institute of Child Health and Human Development Maternal–Fetal Medicine Units Network. Eight centers participated throughout the study, five participated only during the first two years, and six participated for part of the last two years. The cesarean registry was planned as a three-year study in order to collect sufficient data about uncommon and rare maternal complications such as uterine rupture. However, because the rate of trial of labor declined during the study period, data were collected for an additional year. This study includes all women who had a prior cesarean delivery and who had a singleton pregnancy at 20 weeks or more of gestation or whose infant had a birth weight of at least 500 g.

The labor and delivery logbook or database at each participating center was screened daily to identify all cases. Medical records for each woman and infant were reviewed by trained study nurses who were not blinded to the mode of delivery. Demographic data, details of the obstetrical history, and information about intrapartum and postpartum events were recorded. The prospective nature of the study allowed treating physicians to be contacted to resolve questions about complications of delivery. Neonatal data were collected up to 120 days after delivery or at the time of hospital discharge. Additional detailed data were collected regarding the clinical course of all infants admitted to a neonatal intensive care unit. A separate data-collection form was completed for all infants who had a clinical diagnosis of hypoxic–ischemic encephalopathy, for all women with uterine rupture, and for infants who had any of the following: seizures or cardiopulmonary resuscitation during the first 24 hours of life, umbilical-artery blood pH values below 7.0, head imaging at term, or a five-minute Apgar score of less than 4. All instances of uterine rupture, maternal death, stillbirth, and hypoxic–ischemic encephalopathy of the newborn underwent secondary review by local study investigators and a final central review by two of the authors to ensure accurate diagnoses.

Maternal and perinatal outcomes were compared between women who had a trial of labor and those who underwent elective repeated cesarean delivery without labor or other indications for cesarean delivery, such as a prior classical (up-and-down) or "inverted T" incision, breech or transverse presentation, placenta previa, prior myomectomy, nonreassuring patterns in the antepartum fetal heart rate, genital herpes, or a medical condition precluding a trial of labor. Women presenting in labor with cervical dilatation of at least 4 cm, as well as those receiving oxytocin, were classified as undergoing a trial of labor. Women presenting in early labor who subsequently underwent cesarean delivery were excluded from the analysis owing to the difficulty in

distinguishing between a failed trial of labor and a planned elective repeated cesarean delivery. The study was approved by the human subjects committee at each participating center; written consent was not required, since patient identifiers were not included in the data-collection process.

DEFINITIONS

Uterine rupture was defined as a disruption or tear of the uterine muscle and visceral peritoneum or a separation of the uterine muscle with extension to the bladder or broad ligament. Uterine dehiscence was defined as a disruption of the uterine muscle with intact serosa. Postpartum endometritis was defined as a clinical diagnosis of puerperal infection in the absence of findings suggesting a nonuterine source of infection. Fetal deaths that occurred before hospital admission were classified as antepartum stillbirths.

STATISTICAL ANALYSIS

Continuous variables were compared with the use of the Wilcoxon rank-sum test, and categorical variables with the use of the chi-square test or Fisher's exact test. Multivariate logistic-regression analysis was performed to adjust for potential confounding factors for the composite end point of the rate of maternal adverse events (endometritis, transfusion, uterine rupture, hysterectomy, death, dehiscence, and thromboembolic disease, as well as hematoma of the broad ligament, cystotomy, bowel injury, and ureteral injury) and of neonatal adverse events at term (intrapartum stillbirth, hypoxic–ischemic encephalopathy, and neonatal death). These possible confounding factors included maternal age at delivery, race or ethnic background, marital status, smoking status during pregnancy, type of insurance at the time of delivery, number of previous cesarean deliveries, birth weight of the infant in the current delivery, prior vaginal delivery, and underlying medical disease. Nominal two-sided P values are reported. SAS software, version 8 (SAS Institute), and Stat-Xact, version 5 (Cytel Software), were used for the analyses.

RESULTS

DELIVERY

There were 378,168 births during the study period. Among the 45,988 women who had a singleton gestation and a history of cesarean delivery, 17,898 (38.9 percent) underwent a trial of labor and 15,801 (34.4 percent) had an elective repeated cesarean delivery. Of the remaining 12,289 women undergoing repeated cesarean delivery, 9013 had indications for a repeated operation. There were 3276 women (7.1 percent) who presented in early labor without a documented plan for a trial of labor before a cesarean section. The rate of trial of labor ranged from 18.7 percent to 63.2 percent among the 19 centers. The rate of trial of labor declined significantly during the study period (1999, 48.3 percent; 2000, 42.7 percent; 2001, 34.4 percent; 2002, 30.7 percent; P for trend, <0.001).

Demographic and perinatal characteristics of women and infants in the two groups are presented in Table 1. As compared with women who underwent elective repeated cesarean delivery, women who underwent a trial of labor were more likely to be less than 30 years of age, black, unmarried, nonobese, and in receipt of government assistance (Medicaid or Medicare), and to have a preterm delivery (delivery before 37 weeks of gestation) or a delivery at 41 or more weeks of gestation. Women with a prior vaginal delivery or a prior successful vaginal delivery after cesarean delivery were more likely to undergo a trial of labor. The overall success rate for vaginal delivery was 13,139 of 17,898 women (73.4 percent).

MATERNAL COMPLICATIONS

Maternal complications are presented in Table 2. There were 124 cases of uterine rupture among women who underwent a trial of labor (14 after vaginal delivery, and 110 identified at the time of cesarean section). The rate of uterine rupture did not change significantly during the study period. The rates of rupture were 105 of 14,483 (0.7 percent) for women with a prior low transverse incision, 2 of 102 (2.0 percent) for those with a prior low vertical incision, and 15 of 3206 (0.5 percent) for those with an unknown type of prior incision. Two uterine ruptures were recorded in 105 women (1.9 percent) with a prior classical, inverted T, or J incision who either presented in advanced labor or refused a repeated cesarean delivery. In addition, two women who underwent a trial of labor could not be classified, owing to missing information.

The rates of uterine rupture according to labor status are presented in Table 3. Augmentation of labor with oxytocin and induction of labor, regardless of method, were associated with a significantly greater risk of uterine rupture than was spontaneous labor without the use of oxytocin (P<0.001 for both).

Table 1. Characteristics of Women Undergoing a Trial of Labor or an Elective Cesarean Section after a Prior Cesarean Delivery.*

Characteristic	Trial of Labor (N=17,898)	Elective Repeated Cesarean Delivery (N=15,801)	P Value
Maternal age at delivery — yr	28.7±5.8	29.9±5.6	<0.001
≤17 yr — no. (%)	141 (0.8)	65 (0.4)	
18–34 yr — no. (%)	14,593 (81.5)	12,201 (77.2)	
≥35 yr — no. (%)	3,164 (17.7)	3,534 (22.4)	
Race or ethnic group — no. (%)†			<0.001
Black	6,461 (36.1)	3,367 (21.3)	
White	6,454 (36.1)	7,197 (45.5)	
Hispanic	4,081 (22.8)	4,501 (28.5)	
Other or unknown	902 (5.0)	736 (4.7)	
Married — no. (%)	9,854 (55.1)	10,437 (66.1)	<0.001
Smoker during pregnancy — no. (%)	2,880 (16.1)	1,924 (12.2)	<0.001
Body-mass index at delivery‡	31.9±6.7	33.5±7.0	<0.001
Payer — no. (%)			<0.001
HMO or PPO (private)	4,772 (26.7)	5,631 (35.6)	
HMO or PPO (Medicaid)	3,865 (21.6)	2,399 (15.2)	
Other private insurance	2,535 (14.2)	2,260 (14.3)	
Medicaid	4,251 (23.8)	2,898 (18.3)	
No coverage	2,471 (13.8)	2,609 (16.5)	
Prior vaginal delivery — no. (%)	8,854 (49.8)	2,488 (15.8)	<0.001
Prior successful vaginal birth after cesarean delivery — no. (%)	5,766 (34.0)	838 (5.4)	<0.001
Number of previous cesarean sections — no. (%)			<0.001
1	16,916 (94.5)	9,761 (61.8)	
2	876 (4.9)	4,696 (29.7)	
3 or more	106 (0.6)	1,344 (8.5)	
Maternal disease — no. (%)§	3173 (17.7)	3468 (22.0)	<0.001
Neonatal birth weight — g	3233.1±703.4	3437.9±512.9	<0.001
≤1500 — no. (%)	590 (3.3)	32 (0.2)	
1501–2499 — no. (%)	1,324 (7.4)	428 (2.7)	
2500–3999 — no. (%)	14,364 (80.3)	13,349 (84.5)	
≥4000 — no. (%)	1,607 (9.0)	1,991 (12.6)	
Gestational age at delivery — no. (%)			<0.001
<37 wk	2,521 (14.1)	782 (5.0)	
37–41 wk	13,126 (73.5)	14,344 (90.8)	
>41 wk	2,212 (12.4)	670 (4.2)	

* Plus–minus values are means ±SD. Data on age at delivery and marital status were missing for one woman in the elective-repeated-cesarean-delivery group, data on smoking status were missing for 14 women in the trial-of-labor group and 9 in the elective-repeated-cesarean-delivery group, data on body-mass index at delivery were missing for 1461 women in the trial-of-labor group and 762 women in the elective-repeated-cesarean-delivery group, data on payer status were missing for 4 women in each group, data on prior vaginal delivery were missing for 110 women in the trial-of-labor group and 90 women in the elective-repeated-cesarean-delivery group; data on prior successful vaginal birth after cesarean delivery were missing for 946 women in the trial-of-labor group and 218 in the elective-repeated-cesarean-delivery group, data on maternal disease were missing for 2 women in the trial-of-labor group and 4 women in the elective-repeated-cesarean-delivery group, data on birth weight were missing for 13 women in the trial-of-labor group and 1 woman in the elective-repeated-cesarean-delivery group, and data on gestational age at delivery were missing for 39 women in the trial-of-labor group and 5 women in the elective-repeated-cesarean-delivery group. Because of rounding, percentages may not total 100. HMO denotes health maintenance organization, and PPO preferred-provider organization.

† Race or ethnic group was self-reported.

‡ The body-mass index is the weight in kilograms divided by the square of the height in meters.

§ Maternal disease includes asthma, diabetes, chronic hypertension, seizure disorder, thyroid disease, renal disease, and connective-tissue disease.

Table 2. Maternal Complications.*

Complication	Trial of Labor (N=17,898)	Elective Repeated Cesarean Delivery (N=15,801)	Odds Ratio (95% CI)	P Value
	no. (%)			
Uterine rupture	124 (0.7)	0	—	<0.001
Uterine dehiscence†	119 (0.7)	76 (0.5)	1.38 (1.04–1.85)	0.03
Hysterectomy	41 (0.2)	47 (0.3)	0.77 (0.51–1.17)	0.22
Thromboembolic disease‡	7 (0.04)	10 (0.1)	0.62 (0.24–1.62)	0.32
Transfusion	304 (1.7)	158 (1.0)	1.71 (1.41–2.08)	<0.001
Endometritis	517 (2.9)	285 (1.8)	1.62 (1.40–1.87)	<0.001
Maternal death	3 (0.02)	7 (0.04)	0.38 (0.10–1.46)	0.21
Other maternal adverse events§	64 (0.4)	52 (0.3)	1.09 (0.75–1.57)	0.66
One or more of the above	978 (5.5)	563 (3.6)	1.56 (1.41–1.74)	<0.001

* CI denotes confidence interval, and a dash not applicable.
† Not all women underwent examination of their scars after vaginal delivery.
‡ Thromboembolic disease includes deep venous thrombosis or pulmonary embolism.
§ Other adverse events include broad-ligament hematoma, cystotomy, bowel injury, and ureteral injury.

Maternal endometritis and transfusion were both significantly more common with a trial of labor than with an elective cesarean delivery (Table 2). The frequencies of hysterectomy and maternal death were not significantly different between the two groups. The three maternal deaths among women who underwent a trial of labor were due to severe preeclampsia with hepatic failure, sickle cell crisis with cardiac arrest, and postpartum hemorrhage. Of the seven maternal deaths among the women who had elective repeated cesarean delivery, two could be attributed to cesarean section (one resulted from hemorrhage and the other from anesthetic complications). Of the five remaining deaths, four were caused by suspected amniotic-fluid embolism and one by aortic dissection.

Eighty-eight women underwent hysterectomy. Of the 41 cases that occurred after a trial of labor, 19 were performed at cesarean section for the following reasons: atony (8 patients), unrepairable rupture (5), placenta accreta (3), and other (3). Of the 22 cases requiring postpartum laparotomy, 21 were performed for hemorrhage and 1 for infectious complications. The indications for hysterectomy among the 47 cases that occurred in the women undergoing elective repeated cesarean delivery were atony (17 patients), placenta accreta (12), unspecified hemorrhage (5), extension or laceration (2), myomata (3), cancer (5), and other (3).

After adjustment for demographic factors and the presence of maternal diseases, the odds ratio for maternal adverse events (one or more of the complications listed in Table 2) associated with a trial of labor was 1.96 (95 percent confidence interval, 1.73 to 2.22). Maternal adverse events were more frequent among women who had an unsuccessful trial of labor than among women who had a successful vaginal delivery (Table 4).

PERINATAL COMPLICATIONS

Perinatal outcomes for term infants are presented in Table 5. The frequency of antepartum stillbirth was higher among the women who underwent a trial of labor than among the women who underwent elective repeated cesarean delivery. The rate of antepartum stillbirth at 39 or more weeks of gestation was increased only marginally with a trial of labor. Among term infants, intrapartum and neonatal death rates were similar in the two groups (Table 5) and remained similar when we adjusted for the number of prior cesarean deliveries (data not shown).

The frequency of hypoxic–ischemic encephalopathy was significantly greater among the infants of women who underwent a trial of labor at term than among the infants of women who had elective repeated cesarean delivery (12 vs. 0, P<0.001). Four cases occurred after the induction of labor, two occurred after augmentation, and six occurred with spontaneous labor without the use of oxytocin. Sev-

Table 3. Rates of Uterine Rupture According to Labor Status.*

Type of Labor	No. of Patients	Uterine Rupture	Odds Ratio (95% CI)	P Value
		no. (%)		
Spontaneous†	6685	24 (0.4)	1.00	—
Augmented	6009	52 (0.9)	2.42 (1.49–3.93)	<0.001
Induced	4708	48 (1.0)	2.86 (1.75–4.67)	<0.001
With any prostaglandins, with or without oxytocin	926	13 (1.4)	3.95 (2.01–7.79)	<0.001
With prostaglandins alone‡	227	0	—	—
With no prostaglandins§	1691	15 (0.9)	2.48 (1.30–4.75)	0.004
With oxytocin alone	1864	20 (1.1)	3.01 (1.66–5.46)	<0.001
Not classified	496	0	—	—

* CI denotes confidence interval, and a dash not applicable.
† Women with spontaneous labor served as the reference group.
‡ Of the 227 patients, 52 received misoprostol, 111 dinoprostone, 60 prostaglandin E_2 gel, and 4 combined prostaglandins.
§ Induction with no prostaglandins includes mechanical dilation with or without oxytocin.

en of the 12 cases of hypoxic–ischemic encephalopathy were associated with uterine rupture. In the cases that occurred without uterine rupture, four women underwent cesarean delivery because of nonreassuring patterns in the fetal heart rate. Of the 671 women at term who had had more than one prior cesarean section, none had infants with hypoxic–ischemic encephalopathy. Multivariate logistic-regression analysis, with control for demographic factors and maternal disease, also revealed significant associations between a trial of labor and the risk of stillbirth, neonatal death, or hypoxic–ischemic encephalopathy in term infants, as compared with the risk among infants of women who had elective repeated cesarean delivery (odds ratio, 2.72; 95 percent confidence interval, 1.49 to 4.97).

The perinatal outcomes after uterine rupture in term pregnancies are presented in Table 6. There were no instances of intrapartum fetal death. Of the seven infants with hypoxic–ischemic encephalopathy, two died during the neonatal period.

DISCUSSION

Our data indicate that a trial of labor by women with a history of cesarean delivery is associated with an increased risk of adverse perinatal outcomes and a higher rate of maternal adverse events, as compared with elective repeated cesarean delivery. The magnitude of these risks is small; however, this information is important for women and health care providers who are making choices about the type of delivery. The strengths of this study are its large size, its multicenter design, and its prospective process of data collection by trained obstetrical research nursing staff with the use of standardized definitions.

In the absence of randomized, controlled trials, most data used to inform women and health care providers about the choice between a trial of labor and cesarean delivery, after a previous cesarean delivery, have come from retrospective population-based studies that used data from birth certificates or large retrospective multicenter or single-institution cohort studies. Meta-analyses of these data have been limited by a lack of comparability between women undergoing a trial of labor and those undergoing elective repeated cesarean delivery.[7,8]

A primary consideration when counseling women is the perinatal morbidity and mortality that are directly attributable to uterine rupture. However, it is unclear from published studies how often uterine rupture results in perinatal death.[9,10] Our study design involved abstraction of chart data for all cases of uterine rupture and confirmation by two separate review processes. Among 17,898 trials of labor and 124 ruptures, we found two neonatal deaths, for an overall rate of rupture-related perinatal death of 0.11 per 1000 trials of labor. A recent review of 880 maternal uterine ruptures during a 20-year period showed 40 perinatal deaths in 91,039 trials of labor, for a rate of 0.4 per 1000.[10]

Perinatal hypoxic brain injury is recognized as an underreported adverse outcome related to uterine rupture. Perinatal asphyxia has been poorly defined in studies of vaginal birth after cesarean delivery, and variables such as cord-blood gas levels and Apgar scores are reported in only a small fraction of cases.[6,10] We found a significant increase in the rate of hypoxic–ischemic encephalopathy related to uterine rupture among the children of women who underwent a trial of labor at term, as compared with the children of women who underwent elective repeated cesarean delivery (0.46 per 1000 trials of labor versus no cases, respectively).

The reported incidence of hypoxic–ischemic encephalopathy unrelated to uterine rupture at term in our study (5 cases in 15,177 trials of labor) is similar to an overall reported rate of 1.6 per 10,000 births, which includes both trials of labor and elec-

Table 4. Maternal Complications According to the Outcome of a Trial of Labor.

Complication	Failed Vaginal Delivery (N=4759)	Successful Vaginal Delivery (N=13,139)	Odds Ratio (95% CI)*	P Value
	no. (%)			
Uterine rupture	110 (2.3)	14 (0.1)	22.18 (12.70–38.72)	<0.001
Uterine dehiscence	100 (2.1)	19 (0.1)	14.82 (9.06–24.23)	<0.001
Hysterectomy	22 (0.5)	19 (0.1)	3.21 (1.73–5.93)	<0.001
Thromboembolic disease†	4 (0.1)	3 (0.02)	3.69 (0.83–16.51)	0.09
Transfusion	152 (3.2)	152 (1.2)	2.82 (2.25–3.54)	<0.001
Endometritis	365 (7.7)	152 (1.2)	7.10 (5.86–8.60)	<0.001
Maternal death	2 (0.04)	1 (0.01)	5.52 (0.50–60.92)	0.17
Other maternal adverse events‡	63 (1.3)	1 (0.01)	176.24 (24.44–1271.05)	<0.001
One or more of the above	669 (14.1)	309 (2.4)	6.81 (5.93–7.83)	<0.001

* CI denotes confidence interval.
† Thromboembolic disease includes deep venous thrombosis or pulmonary embolism.
‡ Other adverse events include broad-ligament hematoma, cystotomy, bowel injury, and ureteral injury.

tive cesarean sections.[11] In a study that did not document the type of prior delivery, Badawi and colleagues reported that elective cesarean delivery is associated with a reduced risk of encephalopathy in newborns, as compared with spontaneous labor (odds ratio, 0.17; 95 percent confidence interval, 0.05 to 0.56).[11] Although we observed no cases of hypoxic–ischemic encephalopathy after elective repeated cesarean delivery, it remains unclear whether having a scarred uterus affects the risk of this complication in women in labor who do not have uterine rupture.

Previous data have suggested a trend toward a greater risk of fetal death among women who undergo a trial of labor.[6] In our study, the overall rate of combined intrapartum stillbirth at term and neonatal death was not significantly different in the two groups (9.8 per 10,000 in women undergoing trial of labor vs. 4.7 per 10,000 in women undergoing elective repeated cesarean delivery). Intrapartum stillbirths at term, which might have been avoided by an elective cesarean delivery, were uncommon with a trial of labor (2 of 15,338 attempts). Our findings are consistent with those of McMahon and colleagues, who also reported no increase in perinatal deaths at term among women undergoing a trial of labor.[9] The corrected rates of perinatal death in our study (after the exclusion of deaths associated with congenital malformations) were 4.0 per 10,000 in women undergoing a trial of labor and 1.4 per 10,000 in women undergoing elective repeated cesarean delivery.

With regard to the observed increased frequency of term antepartum stillbirths, some of these probably occurred after 39 weeks before the onset of labor and might have been avoided by a scheduled repeated operation. Alternatively, some of this increase might be due to the encouragement by care providers of a trial of labor after the recognition of stillbirth.

It has generally been accepted that vaginal delivery is associated with lower maternal morbidity and mortality rates than is cesarean section. In contrast to an earlier meta-analysis,[7] we found an increased risk of both endometritis and transfusion in women who underwent a trial of labor. The exclusion from the study of women who presented in early labor and subsequently underwent repeated cesarean delivery probably lowered the risk of these complications in the group of women undergoing elective repeated cesarean delivery. We confirmed that many of the excess adverse events accompanying a trial of labor are attributable to the failure of labor and the requirement for a repeated cesarean operation.[9]

Of women attempting vaginal delivery after prior cesarean delivery, the greatest risk of serious complications occurs in those in whom uterine rupture develops. This study shows that the risk of uterine rupture is increased with the induction of labor.[12,13] However, we did not confirm the findings of Lydon-Rochelle and colleagues of an increased risk of rupture associated with the use of prostaglandin agents, as compared with oxytocin alone.[12] Our methods did permit us to distinguish clearly between types

Table 5. Perinatal Outcomes for Term Infants.*

Outcome	Trial of Labor (N=15,338)	Elective Repeated Cesarean Delivery (N=15,014)	Odds Ratio (95% CI)	P Value
	no. (%)			
Antepartum stillbirth†‡				
37–38 wk	18 (0.40)	8 (0.10)	2.93 (1.27–6.75)	0.008
≥39 wk	16 (0.20)	5 (0.10)	2.70 (0.99–7.38)	0.07
Intrapartum stillbirth‡				
37–38 wk	1 (0.02)	0	—	0.43
≥39 wk	1 (0.01)	0	—	1.00
Hypoxic–ischemic encephalopathy	12 (0.08)	0	—	<0.001
Neonatal death	13 (0.08)	7 (0.05)	1.82 (0.73–4.57)	0.19
One or more of the above	59 (0.38)	20 (0.13)	2.90 (1.74–4.81)	<0.001

* CI denotes confidence interval, and a dash not applicable.
† Antepartum stillbirths include a total of five malformations: four in the trial-of-labor group (one at 37 to 38 weeks and three at 39 weeks or more) and one in the elective-repeated-cesarean-delivery group at 37 to 38 weeks.
‡ The percentages are based on the number of stillbirths during the gestational period.

of induction, which is not possible when investigators rely on procedure codes for the use of prostaglandins that do not exclude the concomitant use of oxytocin. Thus, our findings suggest that the effect of the use of prostaglandins on the risk of uterine rupture remains uncertain.

Although increased maternal mortality after cesarean delivery, as compared with the rate after vaginal delivery, has been a consideration when pregnant women are counseled, the infrequency of death and of confounding variables such as maternal disease, and the classification of an operation as either an emergency or a nonemergency procedure, complicate comparisons of mortality. Maternal deaths were not significantly more common with elective repeated cesarean delivery in our study, but such deaths are rare events, and our study was not powered to detect a difference. Of the seven maternal deaths in the group that underwent elective repeated cesarean delivery, two were considered attributable to the cesarean delivery.

Table 6. Perinatal Outcomes after Uterine Rupture in Term Pregnancies.

Outcome	Term Pregnancies with Uterine Rupture (N=114)
	no. (%)
Intrapartum stillbirth	0
Hypoxic–ischemic encephalopathy*	7 (6.2)
Neonatal death	2 (1.8)
Admission to the neonatal intensive care unit	46 (40.4)
5-Minute Apgar score ≤5	16 (14.0)
Umbilical-artery blood pH ≤7.0†	23 (33.3)

* The outcome was missing for one infant.
† The umbilical-artery blood pH was documented for 69 infants.

The possibility that bias affected the results of this study must be considered. Women who, on the advice of their physicians, choose to undergo a trial of labor have characteristics that are different from the characteristics of women who undergo elective repeated cesarean delivery, and these differences might affect outcomes. Although we tried to control for some of these differences in our analysis, the decision by women or their physicians to select a trial of labor as opposed to a repeated cesarean delivery may have occurred in a systematic way, thereby affecting our findings. We also recognize that women who presented in advanced labor were classified as undergoing a trial of labor, despite their possible prior intention to have a repeated cesarean operation. Nonetheless, we limited our study group to women who were apparently eligible for either type of delivery, and we excluded women whose ul-

timate choice of a type of delivery could not be reasonably classified.

Overall, our data suggest a risk of an adverse perinatal outcome at term among women with a previous cesarean delivery of approximately 1 in 2000 trials of labor (0.46 per 1000), a risk that is quantitatively small but greater than that associated with elective repeated cesarean delivery. We believe that these estimates of risk can be extrapolated to institutions with resources, similar to ours, that are available to provide a trial of labor,[14] and along with other factors, will facilitate the counseling of women who have to make a choice between a trial of labor and elective repeated cesarean delivery after a prior cesarean delivery.

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APPENDIX

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