Maternal Morbidity with Repeated Cesarean Deliveries

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Abstract

Objective This study aimed to estimate the association between adverse maternal outcomes and the number of repeated cesarean deliveries (CDs) in a single obstetrical practice.

Study Design Retrospective cohort study of all CDs between 2005 and 2020 in a single maternal fetal medicine practice. We used electronic records to get baseline characteristics and pregnancy/surgical outcomes based on the number of prior CDs. We performed two subgroup analyses for women with and without placenta previa. Chi-square for trend and one-way analysis of variance (ANOVA) were used.

Results A total of 3,582 women underwent CD and met inclusion criteria. Of these women, 1,852 (51.7%) underwent their first cesarean, 950 (26.5%) their second, 382 (10.7%) their third, 191 (5.3%) their fourth, 117 (3.3%) their fifth, and 84 (2.3%) their sixth or higher CDs. The incidence of adverse outcomes (placenta accreta, uterine window, uterine rupture, hysterectomy, blood transfusion, cystotomy, bowel injury, need for a ventilator postpartum, intensive care unit admission, wound complications, thrombosis, reoperation, and maternal death) increased with additional CDs. However, the absolute rates remained low. In women without a placenta previa, the likelihood of adverse outcome did not differ across groups. In women with a placenta previa, adverse outcomes increased with increasing CDs. However, the incidence of placenta previa did not increase with increasing CDs (<5% in each group). The incidence of a uterine dehiscence increased significantly with additional CDs: first, 0.2%; second, 2.0%; third, 6.6%; fourth, 10.3%; fifth, 5.8%; and sixth or higher, 10.4% ($p < 0.001$).

Conclusion Maternal morbidity increases with CDs, but the absolute risks remain low. For women without placenta previa, increasing CDs is not associated with maternal morbidity. For women with placenta previa, risks are highest, but the incidence of placenta previa does not increase with successive CDs. The likelihood of uterine dehiscence increases significantly with increasing CDs which should be considered when deciding about timing of delivery in this population.

Keywords

- repeat cesarean
- maternal morbidity
- multiparity
- grand multiparity
- uterine window

Key Points

- Maternal morbidity increase with each CD.
- Absolute adverse outcomes remains low in highest order CDs.
- In women without placenta previa, there is no added morbidity with additional CDs.

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Nearly one-third of births in the United States today occurs via cesarean, representing a rise of over 600% in the last five decades.[1] This was due, at least in part, to the overwhelming ethos in the middle to late 20th century obstetric practice that "once a cesarean, always a cesarean." Concerns about the clinical and medical legal risks of trial of labor after cesarean (TOLAC) account for the low past and current rates of vaginal birth after cesarean delivery (VBAC), estimated at 13.3% in 2018.[1] However, each additional cesarean delivery (CD) a woman undergoes is associated with increased maternal risk. A landmark prospective, multicenter study published in 2006 by Silver et al established an exposure-response relationship between multiple repeat CDs and maternal morbidity. For each additional CD, there was an added risk of adhesions, hemorrhage requiring transfusion, surgical injury (cystotomy or bowel injury), intensive care admissions and prolonged hospital stays, and abnormal placentation (i.e., placenta previa and placenta accreta spectrum [PAS])[2]. Other studies have shown that the risks of the above complications and composite maternal morbidity increase considerably in women who have had any number of CDs and have a placenta previa at the time of delivery compared with women without placenta previa.[3]

Contemporary data may differ due to changes in labor floor management and recent focus on hemorrhage prevention. Our objective was to accurately quantify the adverse maternal outcomes associated with increasing number of repeated CDs in a single, large obstetrical private practice. We hypothesized that, like Silver et al and other investigators, we would find an increased morbidity with each subsequent CD. We expected, as others have reported, that adverse outcomes associated with repeat CD would be more prevalent in patients with placenta previa than women without placenta previa. With the advent of modern approaches to labor floor management of complex cases at a single tertiary care facility, we explore a more contemporary cohort experience than prior publications which has the potential to improve counseling in these patients.

Materials and Methods

After Biomedical Research Alliance of New York Institutional Review Board approval was obtained, we reviewed the charts of all patients with singleton pregnancies who underwent CD in a single obstetrical and maternal fetal medicine practice over a 15-year period between 2005 (when our electronic medical record was established) and 2020. This practice cares for women in all risk categories, ranging from low-risk nulliparous women to women with a wide range of high-risk conditions. Women who underwent a prior abdominal myomectomy or who had pregnancies with multiple gestations were excluded from the study. We reviewed electronic medical records for each woman to obtain demographic and baseline clinical information, as well as pregnancy and surgical outcomes. Over the course of the study period, all patients were delivered at a single tertiary care center with 24-hour in-house obstetrical anesthesia, neonatology, as well as a fully functioning blood bank. One or two of the obstetricians or maternal fetal medicine specialists in the practice performed the operation at the discretion of the providers. Residents were scrubbed and involved in all CDs, unless one was unavailable at the time of the cesarean.

We compared baseline characteristics between women undergoing their first, second, third, fourth, fifth, and sixth or more CDs. Baseline characteristics included maternal age, body mass index at the time of surgery, medical morbidities, gestational age, and the number of attending surgeons who scrubbed in the operation (one or two). We recorded if the patient had a placenta previa diagnosed prior to delivery. We also examined if the patient labored prior to the cesarean and differentiated if she intended to labor (i.e., was attempting a vaginal delivery) or not (i.e., she had spontaneous labor or rupture of membranes prior to a scheduled cesarean and underwent cesarean at the time of admission). We also noted if the patient had a history of a uterine rupture or uterine dehiscence (sometimes referred to as uterine window) in a prior pregnancy. Uterine dehiscence was defined as an incomplete and clinically occult uterine scar separation with intact serosa[4]; uterine rupture was defined as a clinically apparent, complete scar separation in labor or before labor.[4] In our practice, postpartum pharmacologic anticoagulation is not given universally but only to women with prepregnancy obesity, a clinical history of deep vein thrombosis (DVT)/pulmonary embolism (PE), or known genetic or acquired thrombophilia. All other women received pneumatic compression boots.

We compared outcomes, based on the number of prior CDs. Maternal outcomes examined included placenta accreta, uterine window, uterine rupture, hysterectomy, any blood transfusion, cystotomy, bowel injury, need for a ventilator postpartum, intensive care unit admission (maternal), wound complications, thrombosis (DVT or PE), reoperation, and maternal death. Placenta accreta was diagnosed clinically if focal, or on pathologic examination if the patient underwent hysterectomy. Wound complications were defined as either an infection requiring antibiotics, or a separation requiring packing. Retained products of conception was defined as any postdischarge event requiring dilation and curettage or medical treatments to remove products of conception.

We performed a planned subgroup analyses in women with and without placenta previa, given the strong association between placenta previa and adverse outcomes in women undergoing CD.[2] We also examined the likelihood of uterine rupture or dehiscence based on the number of prior CDs. For this analysis, we excluded all women with a history of either uterine rupture or dehiscence from the analysis. Therefore, this analysis examined the likelihood of uterine rupture or finding a uterine dehiscence in a woman without a history of either undergoing her first cesarean, or second cesarean, third cesarean, etc. Chi-square for trend and linear regression was used when appropriate (SPSS for Windows 16.0, Chicago, IL). A p-value of <0.05 was considered statistically significant.

Results

Over the course of the study period, 3,582 women were delivered by cesarean and met inclusion criteria. Of these

Table 1 Baseline characteristics of the population based on number of prior cesarean deliveries

	First cesarean ($n=1,858$)	Second cesarean ($n=950$)	Third cesarean ($n=382$)	Fourth cesarean ($n=191$)	Fifth cesarean ($n=117$)	Sixth or higher cesarean ($n=84$)	p[a]
Maternal age (y)	34.7 ± 6.2	35.5 ± 5.7	34.9 ± 5.4	34.7 ± 4.9	35.1 ± 3.8	37.9 ± 3.6	0.023
Gestational age (wk)	38.4 ± 2.7	38.4 ± 2.1	37.6 ± 2.5	37.1 ± 1.9	36.9 ± 1.9	37.1 ± 1.4	<0.001
Labor intended	54.5	18.2	4.5	0.5	0	0	<0.001
Labored	66.6	32.8	16.8	11.5	7.7	7.1	<0.001
In vitro fertilization	21.8	15.8	9.0	6.8	3.4	2.4	<0.001
White race	79.0	84.6	90.8	97.4	96.6	97.6	<0.001
Antepartum anticoagulation	3.9	5.6	8.7	4.7	6.2	2.4	0.076
Chronic hypertension	4.0	3.7	3.9	2.6	6.0	2.4	0.713
Preeclampsia	7.5	4.6	3.2	3.2	1.8	1.2	<0.001
Any diabetes	10.8	11.2	11.0	11.1	14.7	10.8	0.460
BMI at delivery (kg/m^2)	29.6 ± 5.6	30.2 ± 5.6	30.8 ± 5.6	31.1 ± 5.9	31.6 ± 6.0	32.3 ± 6.4	<0.001
Placenta previa	4.6	2.5	4.7	1.6	4.3	4.8	0.287
Prior uterine rupture	0.1	0.3	6.5	11.0	10.3	4.8	<0.001
Prior uterine window	0.0	0.2	6.5	14.7	18.8	17.9	<0.001
Number of attending surgeons scrubbed							
Two or more	16.6	24.8	42.4	74.2	98.7	89.2	<0.001
One	83.4	75.2	57.6	25.8	11.3	10.8	

Abbreviation: BMI, body mass index.
Note: Data listed as % or mean (±standard deviation).
[a]Linear regression or Chi-square for trend.

women, 1,852 (51.7%) underwent their first cesarean, 950 (26.5%) their second, 382 (10.7%) their third, 191 (5.3%) their fourth, 117 (3.3%) their fifth, and 84 (2.3%) their sixth or higher cesarean. Baseline characteristics and demographic information based on the number of prior CDs are shown in ►Table 1. Women with higher order CDs were more likely to be older, white, have a greater body mass index, have a prior uterine window or uterine rupture, and have two attending surgeons scrubbed for the operation. Additionally, they were less likely to have undergone in vitro fertilization, attempted to labor or labored at all, have preeclampsia, and they delivered at earlier gestational ages. The rate of placenta previa was similar across groups, ranging from 2 to 5%.

Maternal outcomes according to number of prior CDs are shown in ►Table 2. As expected, the incidence of adverse outcomes increased across the groups. However, the absolute rates remained low, even in the highest order groups. For example, the likelihood of hysterectomy was under 5% in all groups, and the likelihood of reoperation, intensive care unit admission, prolonged ventilation, and bowel or bladder injury was under 4%. Moreover, the rates of intrapartum or postpartum thrombosis was remarkably low in our population, with only 3 cases from a total of 3,582 (0.08%), despite only using pharmacologic prophylaxis selectively for women with prepregnancy obesity or thrombophilia.

We repeated our analyses in women with and without a preoperative diagnosis of placenta previa and the results are shown in ►Tables 3 and 4. In women without a placenta previa (►Table 3), the likelihood of any severe adverse outcome was under 2% in all groups, and many of the outcomes did not differ across groups. For example, the likelihood of hysterectomy or reoperation were both under 1% in all groups and did not differ across groups. In women with placenta previa (►Table 4), adverse outcomes were significantly higher and did increase with increasing number of prior CDs. For example, the likelihood of hysterectomy was 2.4% in women with a placenta previa undergoing their first CD, but for women with a previa undergoing their second, third, and fourth or more cesarean, the likelihood of hysterectomy was 25, 77.8, and 50%, respectively ($p<0.001$).

We examined the likelihood of a uterine rupture or the finding of a uterine dehiscence in women without a history of either and the results are shown in ►Table 5. Whereas the incidence of uterine rupture was low and did not differ across groups, the incidence of a uterine dehiscence found at delivery increased significantly based on the number of prior cesareans: first cesarean, 0.2%; second cesarean, 2.0%; third cesarean, 6.6%; fourth cesarean, 10.3%; fifth cesarean, 5.8%; and sixth or higher cesarean, 10.4% ($p<0.001$). This was despite the fact that the patients undergoing higher order cesareans delivered at earlier gestational ages and were less likely to have labored or intended to labor prior to delivery (►Table 1).

Discussion

Our study's primary objective was to quantify maternal morbidity associated with increasing CDs in a single private

Table 2 Maternal outcomes based on the number of prior cesarean deliveries

	First cesarean ($n = 1,858$)	Second cesarean ($n = 950$)	Third cesarean ($n = 382$)	Fourth cesarean ($n = 191$)	Fifth cesarean ($n = 117$)	Sixth or higher cesarean ($n = 84$)	p^a
Placenta accreta	1.0	1.8	3.9	2.1	1.7	2.4	0.008
Hysterectomy	0.6	1.3	3.9	0.5	4.3	1.2	<0.001
Any blood transfusion	1.7	1.8	5.5	0.5	6.0	2.4	0.007
Cystotomy	0.1	0.2	1.3	0.0	3.4	1.2	<0.001
Bowel injury	0.0	0.0	0.5	0.0	0.0	1.2	0.003
Ventilator	0.0	0.2	2.4	0.0	3.4	0.0	<0.001
Intensive care unit admission	0.3	0.8	2.6	0.5	2.6	1.2	0.001
Wound infection or separation	3.7	4.1	7.1	3.7	5.1	10.7	0.003
Thrombosis	0.1	0.0	0.5	0.0	0.0	0.0	0.527
Reoperation	0.3	0.8	1.8	0.0	1.7	0.0	0.066
Maternal death	0.0	0.0	0.0	0.0	0.0	0.0	NA
Uterine rupture	0.1	0.7	0.8	0.5	0.9	0.0	0.096
Uterine dehiscence	0.2	2.0	8.6	9.9	7.7	9.5	<0.001
Retained products of conception	0.6	0.2	0.0	0.0	0.0	0.0	0.023

Abbreviation: NA, not available.
Note: Data listed as %.
[a]Chi square for trend.

Table 3 Maternal outcomes in women without placenta previa based on the number of prior cesarean deliveries

	First cesarean ($n = 1,772$)	Second cesarean ($n = 926$)	Third cesarean ($n = 364$)	Fourth cesarean ($n = 188$)	Fifth cesarean ($n = 112$)	Sixth or higher cesarean ($n = 80$)	p^a
Placenta accreta	0.5	0.9	0.5	1.6	0.0	0.0	0.806
Hysterectomy	0.5	0.6	0.3	0.0	0.9	0.0	0.532
Any blood transfusion	1.4	1.1	1.6	0.0	1.8	1.3	0.002
Cystotomy	0.1	0.1	0.5	0.0	1.8	1.3	0.002
Bowel injury	0.0	0.0	0.5	0.0	0.0	1.3	0.003
Ventilator	0.0	0.0	0.5	0.0	0.9	0.0	0.012
Intensive care unit admission	0.3	0.3	0.8	0.5	0.9	1.3	0.062
Wound infection or separation	3.8	4.0	6.6	3.2	4.5	11.3	0.015
Thrombosis	0.1	0.0	0.3	0.0	0.0	0.0	0.899
Reoperation	0.3	0.8	0.8	0.0	0.9	0.0	0.573
Maternal death	0.0	0.0	0.0	0.0	0.0	0.0	NA
Uterine rupture	0.1	0.6	0.8	0.5	0.9	0.0	0.091
Uterine dehiscence	0.2	1.8	8.8	10.1	8.0	7.5	<0.001
Retained products of conception	0.6	0.2	0.0	0.0	0.0	0.0	0.040

Abbreviation: NA, not available.
Note: Data listed as %.
[a]Chi square for trend.

practice affiliated with a large, modern tertiary care hospital. We found an exposure-response relationship between number of CDs and several morbidity outcomes including placenta accreta, blood transfusions, surgical injury, and hysterectomy. However, like other published studies,[5,6] the absolute risk of adverse outcomes was low, even in women undergoing the highest order CDs, and we did not see this trend in women without placenta previa. Increasing CDs was associated with an increased risk of uterine dehiscence.

Our data confirmed that placenta previa was the key risk factor for adverse outcomes in women undergoing CD. Similar to the 2006 analysis by Silver et al and the 2020 analysis by

Table 4 Maternal outcomes in women with placenta previa based on the number of prior cesarean deliveries

	First cesarean ($n = 86$)	Second cesarean ($n = 24$)	Third cesarean ($n = 18$)	Fourth or higher cesarean ($n = 12$)	p[a]
Placenta accreta	11.6	37.5	72.2	41.7	<0.001
Hysterectomy	2.4	25.0	77.8	50.0	<0.001
Any blood transfusion	8.1	29.2	83.3	58.3	<0.001
Cystotomy	0.0	4.2	16.7	16.7	<0.001
Bowel injury	0.0	0.0	0.0	0.0	NA
Ventilator	0.0	8.3	38.9	25.0	<0.001
Intensive care unit admission	1.2	20.8	38.9	16.7	<0.001
Wound infection or separation	1.2	8.3	16.7	16.7	0.002
Thrombosis	0.0	0.0	5.6	0.0	0.186
Reoperation	0.0	4.2	22.2	8.3	0.001
Maternal death	0.0	0.0	0.0	0.0	NA
Uterine rupture	0.0	4.2	0.0	0.0	0.752
Uterine dehiscence	0.0	8.3%	5.6	16.7	0.003
Retained products of conception	2.3	0.0	0.0	0.0	0.327

Abbreviation: NA, not available.
Note: Data listed as %.
[a]Chi-square for trend.

Table 5 Risk of uterine rupture and uterine dehiscence in women with no history of either based on number of prior cesarean deliveries

	First cesarean ($n = 1,857$)	Second cesarean ($n = 945$)	Third cesarean ($n = 332$)	Fourth cesarean ($n = 146$)	Fifth cesarean ($n = 86$)	Sixth or higher cesarean ($n = 67$)	p[a]
Uterine rupture	0.1	0.7	0.6	0.0	1.2	0.0	0.166
Uterine dehiscence	0.2	2.0	6.6	10.3	5.8	10.4	<0.001

Note: Data listed as %.
[a]Chi-square for trend.

Oben et al, we found markedly higher rates of adverse outcomes in women with placenta previa, and the risk increased significantly with each successive CD.[2,7] However, we did not find an increased incidence of placenta previa with increasing CDs. Other studies suggested that the incidence of placenta previa does. This differs from other studies that showed an association between numbers of CDs and the incidence of placenta previa.[8–10]

In our study, for women without placenta previa, the rates of adverse outcomes were very low and did not increase with successive CDs. This suggests that for women undergoing a CD, the greatest risk factor for adverse outcomes is the presence of placenta previa or not. However, this can only be assessed once a woman is pregnant and in her second or third trimester. Therefore, counseling prior to pregnancy would have to refer to the data on all women, with the understanding that there is 1 to 5% chance that she will have a placenta previa but this is not related to the number of prior CDs.

One area of uncertainly for women undergoing high-order CDs is the ideal timing of delivery.[11] Earlier delivery could allow for a planned operation with appropriate staffing and resources available. However, earlier deliveries have the potential to increase neonatal morbidity. One additional potential benefit to an earlier delivery is avoiding labor and uterine rupture. However, since this is a rare outcome, it is difficult to study with adequate power. In our study, we had a very low incidence of uterine rupture, but we also delivered women undergoing high-order CDs either in the late preterm or the early term period prior to labor. However, we did find that the rate of uterine dehiscence—defined as an incomplete uterine disruption—in our cohort significantly increased with increasing CDs. In women with no history of a prior uterine dehiscence, there was 0.2, 2.0, 6.6, 10.3, 5.8, and 10.4% rates at time of first, second, third, fourth, fifth, and sixth or higher CDs ($p < 0.001$), respectively. It is unknown that how many of these women would have experienced a

uterine rupture had we planned to deliver them later in gestation. Providers may choose to take this into account when making decisions about timing of delivery in these women.

Limitations

Our study has several limitations. First, its retrospective design limits the strength of conclusion that can be drawn from our results. Second, since our study centers on a single practice, its generalizability to populations whose baseline demographics differ from the patients in our practice is limited. Additionally, as a practice that includes maternal fetal medicine specialists, our population may reflect a more complex cohort with more medical and obstetric comorbidities than the general population. Conversely, our cohort may reflect a lower risk cohort of patients that self-selected to become pregnant because of fewer complications with prior surgical deliveries. Our study does not address the risks specifically associated with repeat CD in the setting of labor versus no labor which is an important consideration in counseling for trial of labor, as well as timing of delivery. Due to the low incidence of adverse outcomes, we did not have adequate power to do a complete regression analysis controlling for maternal characteristics, nor did we have power to find differences in rare outcomes. Additionally, by not considering parity (including vaginal deliveries) as an independent risk factor in our study design, our study does not address whether parity serves as a confounder for any morbidity outcomes. Lastly, since we excluded women with vaginal deliveries placenta previa may be overrepresented in women undergoing a primary or secondary CD and may have skewed our analysis of the rates of previa with successive CDs.

Since the Silver et al paper was published in 2006, protocols pertaining to complicated deliveries (e.g., drills, massive transfusion protocols, preoperative obstetric anesthesia consults, and interdisciplinary meetings) have been contemporized. Our study has the potential to inform clinical practice in the setting of a modernized labor floor and update appropriate patient counseling for women with previous CDs who are or are not candidates for VBAC and are considering future pregnancies. Additionally, since our study is from a single obstetrical practice, there is less variability in surgical technique and clinical decision-making which could confound the results in the multicenter studies. Furthermore, we looked at outcomes of interest not reflected in the literature such as the presence of a uterine dehiscence which could impact recommendations regarding timing of delivery and safety of future pregnancies. These results, however, do not point to any absolute numerical threshold beyond which future pregnancies should be discouraged. Finally, we found that the rate of uterine dehiscence increases with increased CDs, suggesting the importance of scheduling CDs prior to labor. This recommendation should apply to all women given the low sensitivity of antepartum sonographic detection of uterine window.[12]

Conclusion

In conclusion, maternal morbidity increases with increasing CDs but the absolute risks remain low. For women without placenta previa, increasing CDs is not associated with maternal morbidity. For women with placenta previa, risks are highest, but the incidence of placenta previa does not increase with successive CDs. The likelihood of uterine dehiscence increases significantly with increasing CDs which should be taken into consideration when making decisions about timing of delivery in this population.

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Conflict of Interest
None declared.

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