

CHAPTER 31: Prior Cesarean Delivery

The occurrence of pregnancy after a Caesarean section, however, is not always devoid of danger, cases have been reported in which the uterine cicatrix ruptured in the latter part of a subsequent gestation. It is also stated that the adhesions that sometimes form between the uterus and the abdominal wall occasionally exert a deleterious influence in subsequent pregnancies.

—J. Whitridge Williams (1903)

INTRODUCTION

From the above, there was an early appreciation for some of the major problems encountered in women with a prior cesarean delivery. Few issues in modern obstetrics have been as controversial as the management of these women. Indeed, the dangers associated with uterine rupture led to the oft-quoted remark by Cragin in 1916: “Once a cesarean, always a cesarean.” As we reach the 100-year mark of Cragin’s pronouncement, the issue remains largely unsettled.

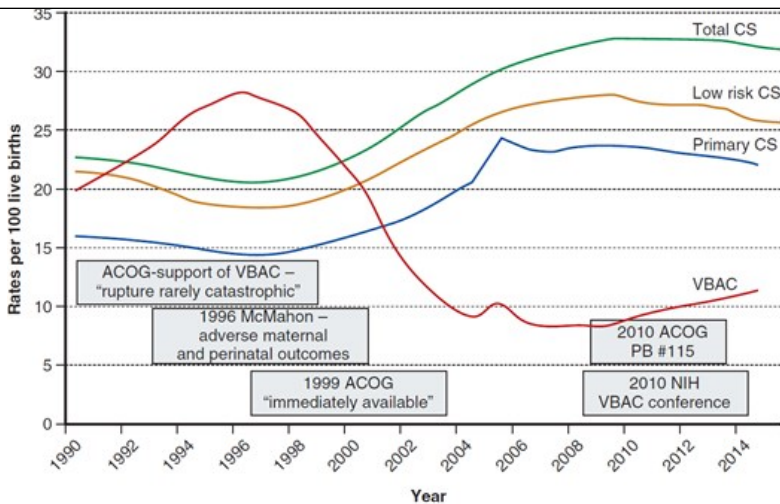
100 YEARS OF CONTROVERSY

By the beginning of the 20th century, cesarean delivery had become relatively safe. But, as women survived the first operation and conceived again, they were now at risk for rupture of the uterine scar. Still, the specter of rupture did not result in strict adherence to repeat cesarean delivery. Indeed, [Eastman \(1950\)](#) described a 30-percent postcesarean vaginal delivery rate at Johns Hopkins Hospital. The uterine rupture incidence was 2 percent and associated with a 10-percent maternal mortality rate. During the 1960s, observational studies suggested that vaginal delivery was a reasonable option ([Pauerstein, 1966](#), [Pauerstein, 1969](#)). Germane to this is that through the 1960s, the overall cesarean delivery rate approximated only 5 percent. Since then, as the primary cesarean rate escalated, the rate for repeat cesarean delivery followed ([Rosenstein, 2013](#)).

During the 1980s, a [National Institutes of Health \(NIH\) Consensus Development Conference \(1981\)](#) was convened, and it questioned the necessity of routine repeat cesarean delivery. With support and encouragement from the [American College of Obstetricians and Gynecologists \(1988, 1994\)](#), enthusiastic attempts were begun to increase the use of *vaginal birth after cesarean*—VBAC. These attempts were highly successful, and VBAC rates increased from 3.4 percent in 1980 to a peak of 28.3 percent in 1996. These rates, along with a concomitant decline in total cesarean delivery rates for the United States, are shown in [Figure 31-1](#).

FIGURE 31-1

Total, primary, and low-risk cesarean delivery (CS) rates and vaginal birth after previous cesarean (VBAC) rates in the United States, 1989–2015. Epochs denoted within rectangles represent contemporaneous ongoing events related to these rates. ACOG = American College of Obstetricians and Gynecologists; NIH = National Institutes of Health; PB = practice bulletin. (Data from [Hamilton, 2015, 2016](#); [National Institutes of Health: NIH Consensus Development Conference, 2010](#).)



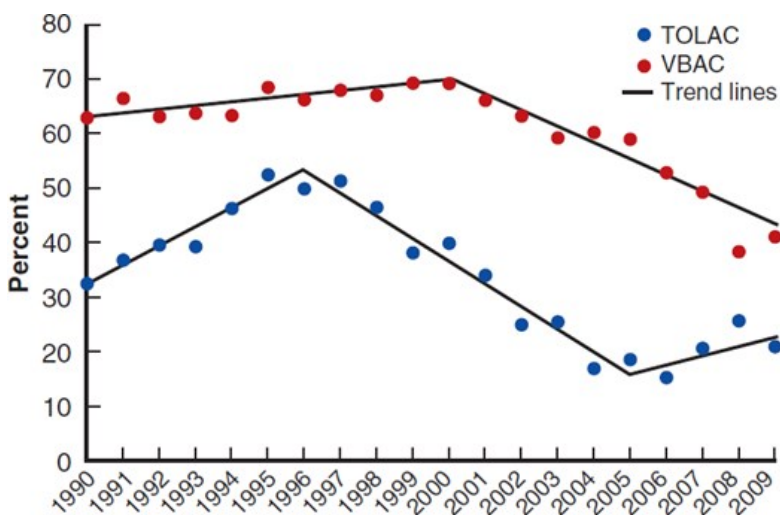
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As the vaginal delivery rate increased, so did reports of uterine rupture-related maternal and perinatal morbidity and mortality (McMahon, 1996; Sachs, 1999). These complications dampened prevailing enthusiasm for a *trial of labor after cesarean section (TOLAC)* and stimulated the American College of Obstetricians and Gynecologists (1998) to caution that such trials should be attempted only in appropriately equipped institutions with physicians readily available to provide emergency care. Less than a year later, the College (1999) recommended that physicians should be immediately available. Many believe that this change of one word— from *readily* to *immediately* available—was in large part responsible for the decade-long decline in national VBAC rates illustrated in Figure 31-1 (Cheng, 2014; Leeman, 2013).

Uddin and colleagues (2013) reported the proportion of women with a prior cesarean delivery who underwent TOLAC. This number peaked in 1995, when slightly more than half of all of these women chose this option. Since that time, the proportion of women attempting TOLAC declined to a nadir in 2006 of about 16 percent and has subsequently increased to 20 to 25 percent through 2009. These investigators further reported that the percentage of VBACs reached its peak in 2000 with approximately 70 percent of women being successful, but this has subsequently declined to a nadir of 38 percent in 2008 (Fig. 31-2).

FIGURE 31-2

Percentage of births with trial of labor among all deliveries with a prior cesarean delivery and percentage of successful trials of labor among all trials of labor after caesarean delivery in the United States, 1990–2009. TOLAC = trial of labor after cesarean delivery; VBAC = vaginal birth after cesarean delivery. (Data from Uddin SFG, Simon AE: Rates and success rates of trial of labor after cesarean delivery in the United States, 1990–2009. *Matern Child Health J* 17:1309, 2013.)



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In reality, several other interrelated factors—both medical and nonmedical—have undoubtedly contributed to declining VBAC rates. Because of their complexity and importance, the Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD) and the Office of Medical Applications of Research (OMAR) convened an [NIH Consensus Development Conference Panel \(2010\)](#) to study the issues of VBAC. The panel report included a contemporaneous summary concerning the risks and benefits of repeat cesarean versus vaginal delivery. These findings are subsequently described along with summaries of current recommendations by various professional organizations. Importantly, data from California indicate that VBAC rates have not perceptibly increased since the 2010 NIH Consensus Conference ([Barger, 2013](#)).

INFLUENCING FACTORS

For the woman who has had a previous cesarean delivery, planning for future pregnancies and the delivery route should begin with preconceptional counseling and be addressed once again early in prenatal care. Importantly, any decision is subject to continuing revisions as dictated by exigencies that arise during pregnancy. Assuming no mitigating circumstances, there are two basic choices. First, a *TOLAC* offers the goal of achieving *VBAC*. If cesarean delivery becomes necessary during the trial, then it is termed a “failed trial of labor.” A second choice is *elective repeat cesarean delivery (ERCD)*. This includes scheduled cesarean delivery as well as unscheduled but planned cesarean delivery for spontaneous labor or another indication.

The ultimate decision should weigh clinical factors known to influence *TOLAC* success as well as benefits and risks. As expected, these rates vary between institutions and providers. Factors that influence a successful *TOLAC* are listed in [Table 31-1](#). Finally, economic, staffing, and medicolegal factors may shape the decision to offer *TOLAC*.

TABLE 31-1

Some Factors That Influence a Successful Trial of Labor in a Woman with Prior Cesarean Delivery

Low-Risk	Favors Success	Increased Failure Rate	High-Risk ^a
Transverse incision Prior vaginal delivery Appropriate counseling Sufficient personnel and equipment	Teaching hospital White race Spontaneous labor Prior fetal malpresentation 1 or 2 prior transverse incisions Nonrecurrent indication Current preterm pregnancy	Single mother Increased maternal age Macrosomic fetus Obesity Breech Multifetal pregnancy Preeclampsia EGA >40 weeks Low-vertical incision Unknown incision Labor induction Medical disease Multiple prior cesarean deliveries Education <12 years Short interdelivery interval Liability concerns	Classical or T incision Prior rupture Patient refusal Transfundal surgery Obstetrical contraindication, e.g., previa Inadequate facilities

^aMost consider these absolute contraindications.

EGA = estimated gestational age.

DELIVERY ROUTE RISKS

As evidence mounted that the risk of uterine rupture might be greater than expected, the [American College of Obstetricians and Gynecologists \(1988,](#)

1998, 1999, 2017a) issued updated Practice Bulletins supporting labor trials but also urging a more cautious approach. It is problematic that both options have risks and benefits to mother and fetus but that these are not always congruent.

Maternal Risks

Rates of uterine rupture and associated complications clearly are increased with TOLAC. Uterine rupture typically is classified as either (1) *complete*, when all layers of the uterine wall are separated, or (2) *incomplete*, when the uterine muscle is separated but the visceral peritoneum is intact. Incomplete rupture is also commonly referred to as *uterine dehiscence*. It is these risks that underpin most of the angst in attempting TOLAC. Despite this, some have argued that these factors should weigh only minimally in the decision because their absolute risk is low. One systematic review by [Guise and colleagues \(2010\)](#) concluded that the risk of uterine rupture was significantly elevated in women undergoing TOLAC—absolute risk of 0.47 percent and relative risk of 20.7—compared with those choosing ERCD.

TABLE 31-2

Complications in Women with a Prior Cesarean Delivery Enrolled in the NICHD Maternal-Fetal Medicine Units Network, 1999–2002

Complication	Trial of Labor Group n = 17,898 No. (%)	Elective Repeat Cesarean Group n = 15,801 No. (%)	Odds Ratio (95% CI)	p value
Uterine rupture	124 (0.7)	0	NA	<.001
Uterine dehiscence	119 (0.7)	76 (0.5)	1.38 (1.04–1.85)	.03
Hysterectomy	41 (0.2)	47 (0.3)	0.77 (0.51–1.17)	.22
Thromboembolic disease	7 (0.04)	10 (0.1)	0.62 (0.24–1.62)	.32
Transfusion	304 (1.7)	158 (1.0)	1.71 (1.41–2.08)	<.001
Uterine infection	517 (2.9)	285 (1.8)	1.62 (1.40–1.87)	<.001
Maternal death	3 (0.02)	7 (0.04)	0.38 (0.10–1.46)	.21
Antepartum stillbirth ^a				
37–38 weeks	18 (0.4)	8 (0.1)	2.93 (1.27–6.75)	.008
≥39 weeks	16 (0.2)	5 (0.1)	2.70 (0.99–7.38)	.07
Intrapartum stillbirth ^a	2	0	NA	NS
Term HIE ^a	12 (0.08)	0	NA	<.001
Term neonatal death ^a	13 (0.08)	7 (0.05)	1.82 (0.73–4.57)	.19

^aDenominator is 15,338 for the trial of labor group and 15,014 for the elective repeat cesarean delivery group.

CI = confidence interval; HIE = hypoxic ischemic encephalopathy; NA = not applicable; NICHD = National Institute of Child Health and Human Development; NS = not significant.

Adapted from Landon, 2004.

The Maternal-Fetal Medicine Units Network conducted a prospective study at 19 academic centers (Landon, 2004). The outcomes of nearly 18,000 women attempting TOLAC were compared with more than 15,000 gravidas undergoing ERCD. The absolute risk of uterine rupture was 0.7 percent compared with no reported uterine ruptures in the ERCD cohort (Table 31-2). Most studies suggest that the maternal mortality rate does not differ significantly between these two groups (Landon, 2004; Mozurkewich, 2000). But, the aforementioned systematic review by Guise (2010) found the risk of maternal death to be significantly reduced for women undergoing TOLAC compared with ERCD. In a retrospective Canadian cohort study, the maternal death rate for women undergoing ERCD was 5.6 per 100,000 cases compared with 1.6 per 100,000 for those attempting TOLAC (Wen, 2005).

Estimates of maternal morbidity are also conflicting. The review by Guise (2010) observed no significant differences in the risk of hysterectomy or transfusion. But, another metaanalysis reported that women undergoing TOLAC were approximately half as likely to require a blood transfusion or

hysterectomy compared with those undergoing ERCD ([Mozurkewich, 2000](#)). Conversely, in the Network study, investigators observed that the risks of transfusion and infection were significantly greater for women attempting TOLAC ([Landon, 2004](#)). This disparity is also found among other studies. Notably, compared with a successful TOLAC, the risk of these major complications was fivefold greater with an attempted vaginal delivery that failed ([Babbar, 2013](#); [Rossi, 2008](#)).

Fetal and Neonatal Risks

TOLAC is associated with significantly higher *perinatal mortality* rates compared with ERCD. The perinatal rate with TOLAC is 0.13 compared with 0.05 percent for ERCD, and the neonatal mortality rates are 0.11 versus 0.06 percent, respectively ([Guise, 2010](#)). In another study of nearly 25,000 women with a prior cesarean delivery, the vaginal-delivery-related perinatal death risk was 1.3 per 1000 among 15,515 women electing TOLAC. Although this absolute risk is small, it is *11 times greater* than the risk found in 9014 women with ERCD ([Smith, 2002](#)).

TOLAC also appears to be associated with a higher risk of *hypoxic ischemic encephalopathy (HIE)* than ERCD. The Network study reported the incidence of HIE at term to be 46 per 100,000 TOLACs compared with zero cases in women undergoing ERCD ([Landon, 2004](#)).

In the systematic review, the absolute risk of *transient tachypnea of the newborn* was slightly higher with ERCD compared with TOLAC—4.2 versus 3.6 percent ([Guise, 2010](#)). But, neonatal bag and mask ventilation were used more often in newborns delivered following TOLAC than in those delivered by ERCD—5.4 versus 2.5 percent. Finally, there are no significant differences in 5-minute Apgar scores or neonatal intensive care unit admission rates for newborns delivered by TOLAC compared with those delivered by ERCD. Birth trauma from lacerations is more commonly seen in neonates born by ERCD.

CANDIDATES FOR TRIAL OF LABOR

Few high-quality data are available to guide selection of TOLAC candidates. In a population-based cohort study of 41,450 women delivering in California hospitals, [Gregory and colleagues \(2008\)](#) reported a TOLAC success rate of 74 percent when no maternal, fetal, or placental complications were present. Several algorithms and nomograms have been developed to aid prediction, but none has demonstrated reasonable prognostic value ([Grobman, 2007b, 2008, 2009](#); [Macones, 2006](#); [Metz, 2013](#); [Srinivas, 2007](#)). A predictive model for failed trial of labor, however, was found to be somewhat predictive of uterine rupture or dehiscence ([Stanhope, 2013](#)). Despite these limitations for precision, several points are pertinent to candidate evaluation and are described in the next sections. Current recommendations of the [American College of Obstetricians and Gynecologists \(2017a\)](#) are that most women with one previous low-transverse hysterotomy are candidates, and if appropriate, they should be counseled regarding TOLAC and ERCD options. Although not our practice, those with two prior low-transverse incisions may be considered.

Prior Uterine Incision

Prior Incision Type

The type and number of prior cesarean deliveries are overriding factors in recommending TOLAC. Women with one prior low-transverse hysterotomy have the lowest risk of symptomatic scar separation ([Table 31-3](#)). The highest risks are with prior vertical incisions extending into the fundus, such as that shown in [Figure 31-3](#). Importantly, in some women, a classical scar will rupture before labor onset, and this can happen several weeks before term. In a review of 157 women with prior classical cesarean delivery, one woman had a complete uterine rupture before labor onset, whereas 9 percent had a uterine dehiscence ([Chauhan, 2002](#)).

TABLE 31-3

Types of Prior Uterine Incisions and Estimated Risks for Uterine Rupture

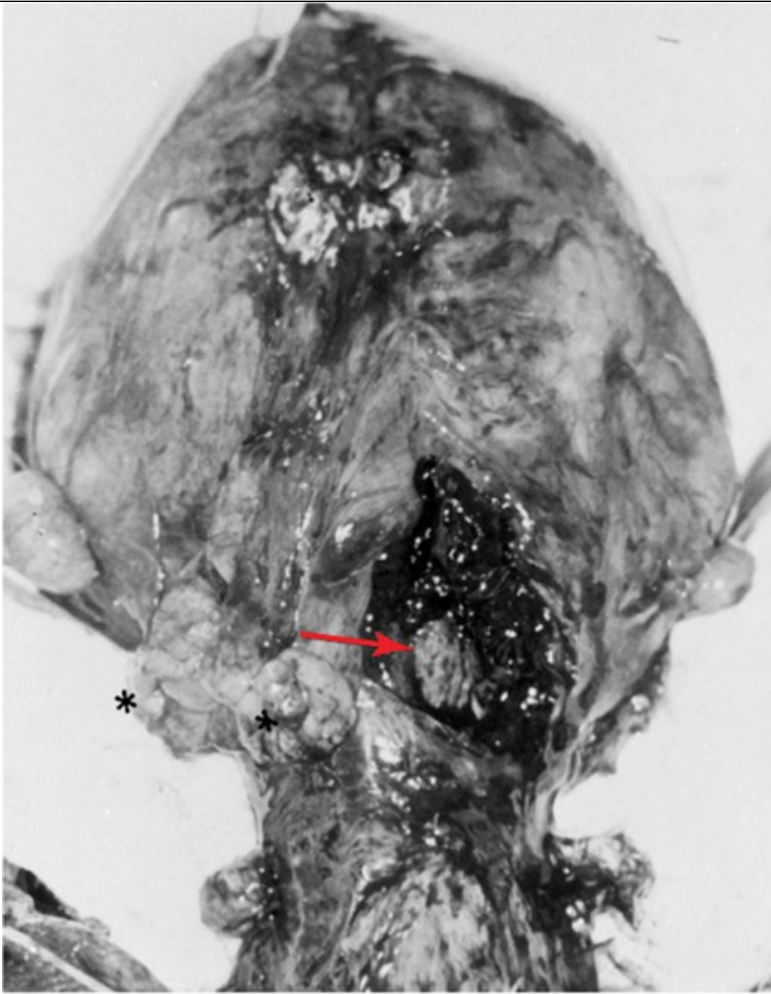
Prior Incision	Estimated Rupture Rate (%)
Classical	2–9
T-shaped	4–9
Low-vertical ^a	1–7
One low-transverse	0.2–0.9
Multiple low-transverse	0.9–1.8
Prior preterm cesarean delivery	“increased”
Prior uterine rupture	
Lower segment	2–6
Upper uterus	9–32

^aSee text for definition.

Data from the American College of Obstetricians and Gynecologists, 2017a; Cahill, 2010b; Chauhan, 2002; Landon, 2006; Macones, 2005a,b; Martin, 1997; Miller, 1994; Sciscione, 2008; Society for Maternal-Fetal Medicine, 2012; Tahseen, 2010.

FIGURE 31-3

Ruptured vertical cesarean delivery scar (*arrow*) identified at time of repeat cesarean delivery early in labor. The two black asterisks to the left indicate some sites of densely adhered omentum.



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The risk of uterine rupture in women with a prior vertical incision that did not extend into the fundus is unclear. [Martin \(1997\)](#) and [Shipp \(1999\)](#) and their coworkers reported that these low-vertical uterine incisions did not have an increased risk for rupture compared with low-transverse incisions. The [American College of Obstetricians and Gynecologists \(2017a\)](#) concluded that although evidence is limited, women with a prior vertical incision in the lower uterine segment without fundal extension may be candidates for TOLAC. This is in contrast to prior classical or T-shaped uterine incisions, which are considered by most as contraindications to labor.

Although there are few indications for a primary classical incision, 53 percent of women undergoing cesarean delivery between 24^{0/7} weeks and 25^{6/7} weeks have such an incision ([Osmundson, 2013](#)). By 28 weeks' gestation, the risk drops to 35 percent and declines to <10 percent by 32 weeks. The likelihood of classical uterine incision is also increased by noncephalic presentations. In those instances—for example, preterm breech fetus with an undeveloped lower segment—the “low vertical” incision almost invariably extends into the active segment. Prior preterm cesarean delivery may result in a twofold increased risk for rupture ([Sciscione, 2008](#)). This may be in part explained by the greater likelihood with a preterm fetus of upward uterine incision extension. [Lannon and coworkers \(2015\)](#) compared 456 women with a prior periviable cesarean delivery with more than 10,000 women whose prior cesarean delivery occurred at term. They observed uterine rupture in 1.8 percent in the prior periviable group versus 0.4 percent in the prior term group. Of the uterine ruptures in the periviable group, half were in women whose prior uterine incision was described as low transverse. [Harper and associates \(2009\)](#) did not confirm these findings.

There are also special considerations for women with uterine malformations who have undergone cesarean delivery. Earlier reports suggested that the uterine rupture risk in a subsequent pregnancy was greater than the risk in those with a prior low-transverse hysterotomy and normally formed uterus ([Ravasia, 1999](#)). But, in a study of 103 women with müllerian duct anomalies, there were no cases of uterine rupture ([Erez, 2007](#)). Given the wide range of risk for uterine rupture associated with the various uterine incision types, it is not surprising that most fellows of the American College of Obstetricians and Gynecologists consider the type of prior incision to be the most important factor when considering a TOLAC ([Coleman, 2005](#)).

Prior Incision Closure

As discussed in [Chapter 30 \(Uterine Repair\)](#), the low-transverse hysterotomy incision can be sutured in either one or two layers. A metaanalysis by [Roberge and colleagues \(2014\)](#) compared single- versus double-layer closure and locking versus unlocking suture for uterine closure. They reported that rates for uterine dehiscence or uterine rupture for these closures did not differ significantly. Single-layer closure and locked first layer, however, was associated with a reduced myometrial thickness during subsequent sonographic measurement. In contrast, [Bennich and coworkers \(2016\)](#) reported that a double-layer closure did not increase the residual myometrial thickness when saline contrast sonography was done several months postpartum. At Parkland Hospital, we routinely close the lower-segment incision with one running, locking suture line.

Number of Prior Cesarean Incisions

At least three studies report a doubling or tripling of the rupture rate in women with two compared with one prior transverse hysterotomy ([Macones, 2005a](#); [Miller, 1994](#); [Tahseen, 2010](#)). In contrast, analysis of the Network database by [Landon and associates \(2006\)](#) did not confirm this. Instead, they reported an insignificant difference in the uterine rupture rate in 975 women with multiple prior cesarean deliveries compared with 16,915 women with a single prior operation—0.9 versus 0.7 percent, respectively. As discussed in [Multiple Repeat Cesarean Deliveries](#), other serious maternal morbidity increases along with the number of prior cesarean deliveries ([Marshall, 2011](#)).

Imaging of Prior Incision

Sonographic measurement of a prior hysterotomy incision has been used to predict the likelihood of rupture. Large defects in a nonpregnant uterus forecast a greater risk for subsequent rupture ([Osser, 2011](#)). [Naji and coworkers \(2013a,b\)](#) found that the *residual myometrial thickness* decreased as pregnancy progressed and that rupture correlated with a thinner scar. In a systematic review, women with a prior low-transverse cesarean incision underwent third-trimester sonographic evaluation ([Jastrow, 2010a](#)). Investigators concluded that the thickness of the lower uterine segment was a strong predictor for a uterine scar defect in women with prior cesarean delivery. They defined this segment as the smallest measurement between urine in the maternal bladder and amniotic fluid. That said, they could not find an ideal threshold value to recommend TOLAC. This same group subsequently recruited 1856 women contemplating vaginal birth after a single low-transverse incision, and they sonographically measured lower uterine segment thickness by between 34 weeks and 39 weeks ([Jastrow, 2016](#)). They grouped women into three risk categories for uterine rupture during TOLAC based on the measured segment value: high risk <2.0 mm; intermediate risk 2.0–2.4 mm; and low risk ≥2.5 mm. The TOLAC rates were 9, 42, and 61 percent in the three categories, respectively. Of the 984 TOLACs, there were no symptomatic uterine ruptures. Overall, data are limited, and this evaluation is currently not part of our routine practice.

Prior Uterine Rupture

Women who have previously sustained a uterine rupture are at greater risk for recurrence. As shown in [Table 31-3](#), those with a previous low-segment rupture have up to a 6-percent recurrence risk, whereas prior upper segment uterine rupture confers a 9- to 32-percent risk ([Reyes-Ceja, 1969](#); [Ritchie, 1971](#)). [Fox and associates \(2014\)](#) reported 14 women with prior uterine rupture and 30 women with prior uterine dehiscence. In 60 subsequent pregnancies, they reported no uterine ruptures or severe complications if women were managed in a standardized manner with cesarean delivery prior to labor onset.

Interdelivery Interval

Magnetic resonance imaging studies of myometrial healing suggest that complete uterine involution and restoration of anatomy may require at least 6 months ([Dicle, 1997](#)). To explore this further, [Shipp and coworkers \(2001\)](#) examined the relationship between interdelivery interval and uterine rupture in 2409 women with one prior cesarean delivery. There were 29 women with a uterine rupture—1.4 percent. Interdelivery intervals ≤18 months were associated with a threefold greater risk of symptomatic rupture during a subsequent TOLAC compared with intervals >18 months. Similarly, [Stamilio and associates \(2007\)](#) noted a threefold augmented risk of uterine rupture in women with an interpregnancy interval <6 months compared with one ≥6 months.

Prior Vaginal Delivery

Prior vaginal delivery, either before or after a cesarean birth, improves the prognosis for a subsequent vaginal delivery with either spontaneous or

induced labor (Aviram, 2017; Grinstead, 2004; Hendler, 2004; Mercer, 2008). Prior vaginal delivery also lowers the risk of subsequent uterine rupture and other morbidities (Cahill, 2006; Hochler, 2014; Zelop, 1999).

Prior Cesarean Delivery Indication

Women with a nonrecurring indication—for example, breech presentation—have the highest VBAC rate of nearly 90 percent (Wing, 1999). Those with a prior cesarean delivery for fetal compromise have an approximately 80-percent VBAC rate, and for those done for labor arrest, VBAC rates approximate 60 percent (Bujold, 2001; Peaceman, 2006). Prior second-stage cesarean delivery can be associated with second-stage uterine rupture in a subsequent pregnancy (Jastrow, 2013).

Fetal Size and Lie

Most studies show that increasing fetal size is inversely related to VBAC rates. The risk for uterine rupture is less robustly linked. Zelop and associates (2001) studied outcomes of almost 2750 women undergoing TOLAC, and the rate of uterine rupture increased—albeit not significantly—with rising fetal weight. The rate was 1.0 percent for fetal weight <4000 g, 1.6 percent for >4000 g, and 2.4 percent for >4250 g. Similarly, Jastrow and colleagues (2010b) in a retrospective report of 2586 women with a prior low-transverse uterine incision, observed an elevated risk for a failed trial of labor, uterine rupture, shoulder dystocia, and perineal laceration associated with rising birthweights. Conversely, Baron and coworkers (2013) did not find higher uterine rupture rates with birthweights >4000 g. With a preterm fetus, women who attempt a TOLAC have higher VBAC rates and lower rupture rates (Durnwald, 2006; Quiñones, 2005).

Data supporting external cephalic version (ECV) for breech presentation are limited and are derived from small studies (Burgos, 2014; Weill, 2017). From these, ECV success and adverse event rates appear comparable to women without prior cesarean. The American College of Obstetricians and Gynecologists (2016) acknowledges this lack of robust data. At Parkland Hospital, we do not attempt ECV in those with a prior cesarean delivery.

Multifetal Gestation

Twin pregnancy does not appear to increase the risk of uterine rupture. Ford and associates (2006) analyzed 1850 women with twins and reported a 45-percent successful VBAC rate and a rupture rate of 0.9 percent. Similar studies by Cahill (2005) and Varner (2007) and their colleagues reported rupture rates of 0.7 to 1.1 percent and VBAC rates of 75 to 85 percent. According to the American College of Obstetricians and Gynecologists (2017a), women with twins and a prior low-transverse hysterotomy can safely undergo TOLAC.

Maternal Obesity

Multiple studies have reported an inverse relationship between prepregnancy body mass index (BMI) and VBAC rates. Hibbard and coworkers (2006) reported the following rates: 85 percent with a normal BMI, 78 percent with a BMI between 25 and 30, 70 percent with a BMI between 30 and 40, and 61 percent with a BMI ≥40. Similar findings were reported by Juhasz and associates (2005).

Fetal Death

Most women with a prior cesarean delivery and fetal death in the current pregnancy would prefer a vaginal delivery. Although fetal concerns are obviated, available data suggest that maternal risks are increased. Nearly 46,000 women with a prior cesarean delivery in the Network database had a total of 209 fetal deaths at an average gestational age of 32.8 weeks (Ramirez, 2010). There were 158 women who elected TOLAC, with a VBAC rate of 87 percent. In the entire TOLAC group, the uterine rupture rate was 2.4 percent. Of the 116 women who underwent an induction of labor, there were five uterine ruptures (3.4 percent).

LABOR AND DELIVERY CONSIDERATIONS

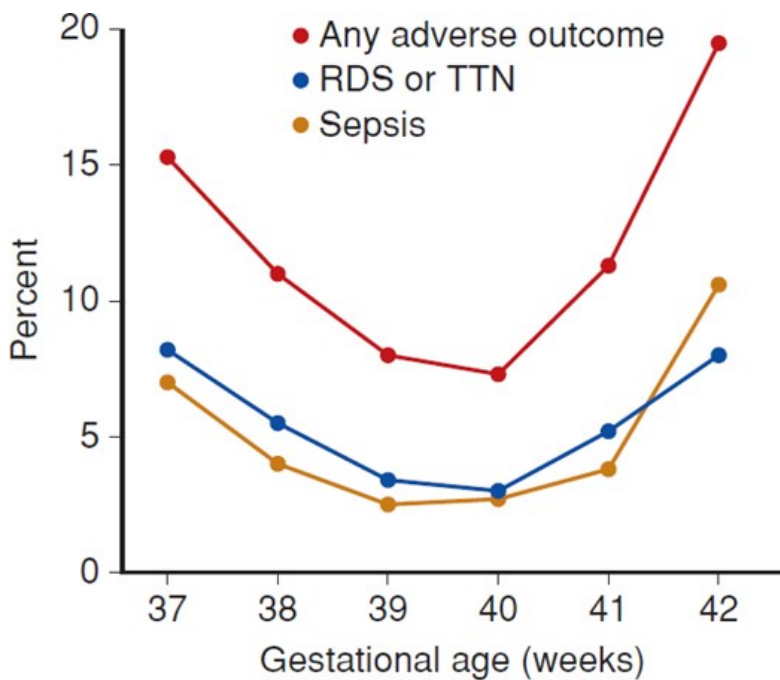
Timing

The American College of Obstetricians and Gynecologists and the Society for Maternal-Fetal Medicine (2017b) recommend delaying nonmedically indicated deliveries until 39 completed weeks of gestation or beyond. As shown in Figure 31-4, significant and appreciable adverse neonatal morbidity has been reported with elective delivery before 39 completed weeks (Chioffi, 2013; Clark, 2009). Thus, if ERCD is planned, it is essential that the fetus

be mature.

FIGURE 31-4

Neonatal morbidity rates seen with 13,258 elective repeat cesarean deliveries. Any adverse outcome includes death. Sepsis includes suspected and proven. RDS = respiratory distress syndrome; TTN = transient tachypnea of the newborn. (Data from Tita AT, Landon MB, Spong CY, et al: Timing of elective repeat cesarean delivery at term and neonatal outcomes. *N Engl J Med* 360(2):111, 2009.)



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The [American Academy of Pediatrics and the American College of Obstetricians and Gynecologists \(2017\)](#) have established the following guidelines for timing an elective cesarean delivery, and accurate gestational dating is suitable using any of these criteria.

1. Sonographic measurements taken before 20 weeks' gestation support a gestational age ≥ 39 weeks.
2. Fetal heart sounds have been documented for 30 weeks by Doppler ultrasound.
3. A positive serum or urine β -human chorionic gonadotropin (hCG) test result has been documented for ≥ 36 weeks.

Intrapartum Care

Because of uterine rupture risks for women undergoing TOLAC, the [American Academy of Pediatrics and the American College of Obstetricians and Gynecologists \(2017\)](#) recommend that such trials be undertaken only in facilities with staff immediately available to provide emergency care. Moreover, these centers should have a plan and resources for managing uterine rupture. Some argue that these provisions deny women full access to choices. For example, in an earlier survey of Ohio hospitals, 15 percent of Level I, 63 percent of Level II, and 100 percent of Level III institutions met these requirements ([Lavin, 2002](#)). Moreover, an obstetrical anesthesia workforce survey reported that due to staffing limitations, TOLAC was allowed in only 88 percent of hospitals with ≥ 1500 annual deliveries, in 59 percent of those with 500 to 1499 deliveries, and in 43 percent of those with < 500 deliveries ([Traynor, 2016](#)). In some cases, women choose to attempt TOLAC at a birthing center or at home ([Shields, 2017](#)).

Cervical Ripening and Labor Stimulation

Labor induction is associated with a higher failure rate during TOLAC. The risks for uterine rupture, however, are less clear with induction or augmentation, with the exception of prostaglandin E_1 —misoprostol—which is contraindicated ([American College of Obstetricians and Gynecologists](#),

2017a). Although most institutions are not so conservative, we do not induce or augment labor pharmacologically in women electing TOLAC at Parkland Hospital. Instead, we attempt induction only by amniotomy. Other considerations are to avoid induction or augmentation in women with an unknown prior incision type, an unfavorable cervix, or pregnancy >40 weeks.

Oxytocin

Induction or augmentation of labor with **oxytocin** has been *implicated* in increased rates of uterine rupture in women undergoing TOLAC (Zelop, 1999). In the Network study reported by Landon and colleagues (2004), uterine rupture was more frequent in women induced with **oxytocin** alone—1.1 percent—than in those in spontaneous labor—0.4 percent. Augmentation of labor was associated with uterine rupture in 0.9 percent. Among women in this trial without a prior vaginal delivery, the uterine rupture risk associated with **oxytocin** induction was 1.8 percent—a fourfold greater risk compared with spontaneous labor (Grobman, 2007a). In contrast, in one case-control study, induction was not associated with a higher risk for rupture (Harper, 2012a). Cahill (2008) and Goetzl (2001) and their coworkers reported a dose-related risk of rupture with **oxytocin**.

Prostaglandins

Various prostaglandin preparations commonly employed for cervical ripening or labor induction are discussed in Chapter 26 (Pharmacological Techniques). As a group, their safe use in women with a prior cesarean delivery is unclear because of conflicting data.

With misoprostol (PGE₁), Wing and colleagues (1998) compared it versus **oxytocin** for labor induction in women with a prior cesarean delivery. They terminated their trial after two of the first 17 women assigned to misoprostol developed a uterine rupture. Other studies confirmed this, and most consider misoprostol to be contraindicated (American College of Obstetricians and Gynecologists, 2017a).

Of other prostaglandins, studies to evaluate their use for induction are contradictory. Ravasia and coworkers (2000) compared uterine rupture in 172 women given PGE₂ gel with 1544 women in spontaneous labor. The rupture rate was significantly greater in women treated with PGE₂ gel—2.9 percent compared with 0.9 percent in those with spontaneous labor. Lydon-Rochelle and associates (2001) found similar results. However, in the Network study cited previously, the uterine rupture rate was 1.4 percent when any prostaglandin was used in combination with **oxytocin** (Landon, 2004). But, in the subgroup of 227 women in whom labor was induced with a prostaglandin alone, there were no ruptures. Similar findings were reported with intravaginal prostaglandins, which were not associated with a greater uterine rupture risk (Macones, 2005b). These latter investigators, along with Kayani and colleagues (2005), found that sequential use of a prostaglandin followed by **oxytocin** was associated with a threefold greater risk of rupture compared with spontaneous labor.

Mechanical Methods

Studies concerning the use of a transcervical Foley catheter for cervical ripening and induction of labor in women with a prior cesarean delivery are limited (Ben-Aroya, 2002; Jozwiak, 2014). In a retrospective study of 2479 women with prior cesarean delivery, the uterine rupture risk using a transcervical Foley catheter for labor induction (1.6 percent) was not significantly greater than that with spontaneous labor (1.1 percent) or with using amniotomy with or without **oxytocin** (1.2 percent) (Bujold, 2004). In contrast, Hoffman (2004) described 138 women who underwent preinduction cervical ripening with a Foley catheter compared with 536 women who entered labor spontaneously. They observed a significant and inordinately high uterine rupture risk during labor following Foley catheter cervical ripening compared with spontaneous onset of labor—6.5 versus 1.9 percent.

Epidural Analgesia

Concerns that epidural analgesia for labor might mask the pain of uterine rupture have not been verified. Fewer than 10 percent of women with scar separation experience pain and bleeding, and fetal heart rate decelerations are the most likely sign (Kieser, 2002). That said, Cahill and coworkers (2010a) documented that more frequent episodes of epidural dosing were associated with increasing uterine rupture rates. VBAC rates are similar, and in some cases higher, among women with labor epidural analgesia compared with those using other forms of analgesia (Aviram, 2017; Shmudi, 2017). Perhaps related, almost a fourth of VBAC deliveries were completed with either forceps or vacuum (Inbar, 2017). The American Academy of Pediatrics and the American College of Obstetricians and Gynecologists (2017) have concluded that epidural analgesia may safely be used during TOLAC.

Uterine Scar Exploration

Following VBAC, some clinicians routinely document the integrity of a prior scar by placing a hand through the dilated cervix and along the inner surface of the lower uterine segment. But routine uterine exploration is considered by others to be unnecessary. In a longitudinal study of 3469 women who had a VBAC, seven uterine dehiscences and one uterine rupture yielded an overall event rate of 0.23 percent (Silberstein, 1998). They concluded that transcervical evaluation need only be performed in symptomatic patients.

Currently, the benefits of routine scar evaluation in the asymptomatic woman are unclear, however, surgical correction of a dehiscence is necessary if significant bleeding is encountered. Our practice is to routinely examine these prior hysterotomy sites. Any decision for laparotomy and repair takes into consideration the extent of the tear, whether the peritoneal cavity has been entered, and the presence of active bleeding.

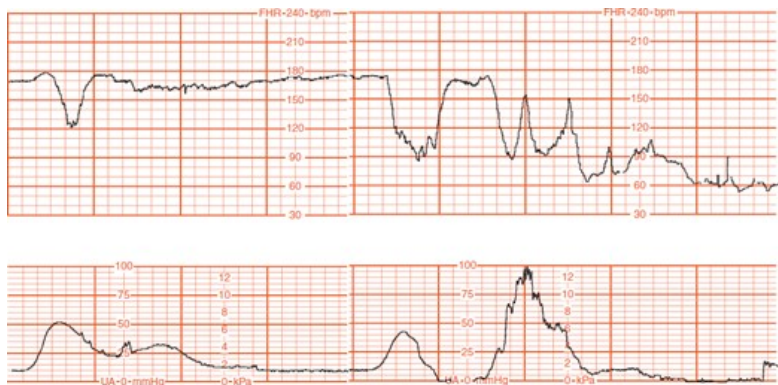
UTERINE SCAR RUPTURE

Diagnosis

Progress of labor in women attempting TOLAC is similar to normal labor, and no specific pattern presages uterine rupture (Graseck, 2012; Harper, 2012b; Sondgeroth, 2017). Before hypovolemic shock develops, symptoms and physical findings in women with uterine rupture may appear bizarre unless the possibility is kept in mind. For example, hemoperitoneum from a ruptured uterus may result in diaphragmatic irritation with pain referred to the chest. This may direct one to a diagnosis of pulmonary or amniotic fluid embolism instead of uterine rupture. As shown in Figure 31-5, the most common sign of uterine rupture is a nonreassuring fetal heart rate pattern with variable decelerations that may evolve into late decelerations and bradycardia. In 36 cases of such rupture during TOLAC, there were fetal signs of uterine rupture in 24, maternal signs in eight, and a combination of maternal and fetal in three (Holmgren, 2012). Few women experience cessation of contractions following uterine rupture, and the use of intrauterine pressure catheters does not assist reliably in the diagnosis (Rodriguez, 1989).

FIGURE 31-5

Fetal heart rate tracing in a woman whose uterus ruptured during labor while pushing. The rupture apparently stimulated a reflex push, after which uterine tone diminished and fetal bradycardia worsened.



Source: F. Gary Cunningham, Kenneth J. Leveno, Steven L. Bloom, Catherine Y. Spong, Jos S. Dasha, Barbara L. Hoffman, Brian M. Casey, Jeanne S. Sheffield. *Williams Obstetrics*, 25th Edition. Copyright © McGraw-Hill Education. All rights reserved.

In some women, the clinical appearance of uterine rupture mirrors that of placental abruption. In most, however, there is remarkably little appreciable pain or tenderness. Also, because most women in labor are treated for discomfort with either narcotics or epidural analgesia, pain and tenderness may not be readily apparent. The condition usually becomes evident because of fetal distress and occasionally because of maternal hypovolemia from concealed hemorrhage.

If the fetal presenting part has already entered the pelvis with labor, loss of station may be detected by pelvic examination. If the fetus is partly or totally extruded from the uterine rupture site, abdominal palpation or vaginal examination may be helpful to identify the presenting part, which will have moved away from the pelvic inlet. A firm contracted uterus may at times be felt alongside the fetus. Sonography may be helpful.

Decision-to-Delivery Time

With rupture and expulsion of the fetus into the peritoneal cavity, the chances for intact fetal survival are dismal, and reported mortality rates range

from 50 to 75 percent. *Fetal condition depends on the degree to which placental implantation remains intact, although this can change within minutes.* With rupture, the only chance of fetal survival is afforded by immediate delivery—most often by laparotomy—otherwise, hypoxia is inevitable. If rupture is followed by total placental separation, then very few neurologically intact fetuses will be salvaged. *Thus, even in the best of circumstances, some fetal outcomes will be impaired.* The Utah experiences are instructive here (Holmgren, 2012). Of the 35 laboring patients with uterine rupture, the decision-to-delivery time was <18 minutes in 17, and none of these infants had an adverse neurological outcome. Of the 18 born >18 minutes from decision time, the three infants with long-term neurological impairments were delivered at 31, 40, and 42 minutes. There were no deaths, thus severe neonatal neurological morbidity developed in 8 percent of this group of 35 women with uterine rupture.

In a study using the Swedish Birth Registry, Kaczmarczyk and coworkers (2007) found that the risk of neonatal death following uterine rupture was 5 percent. In the Network study cited earlier, seven of the 114 uterine ruptures associated with TOLAC—6 percent—were complicated by development of neonatal HIE (Spong, 2007).

Maternal deaths from uterine rupture are uncommon. Of 2.5 million women who gave birth in Canada between 1991 and 2001, there were 1898 cases of uterine rupture, and four of these—0.2 percent—resulted in maternal death (Wen, 2005). In other regions of the world, however, maternal mortality rates are much higher. From rural India, the maternal mortality rate associated with uterine rupture was 30 percent (Chatterjee, 2007).

Management

With complete rupture during TOLAC, hysterectomy may be required. In selected cases, however, suture repair with uterine preservation may be performed. Sheth (1968) described outcomes from a series of 66 women in whom repair of a uterine rupture was elected rather than hysterectomy. Thirteen of the 41 mothers who did not have tubal sterilization had a total of 21 subsequent pregnancies. Uterine rupture recurred in four of these—approximately 20 percent. Usta and associates (2007) reported similar results. In another study, however, women with a uterine dehiscence were not more likely to have a subsequent uterine rupture (Baron, 2014).

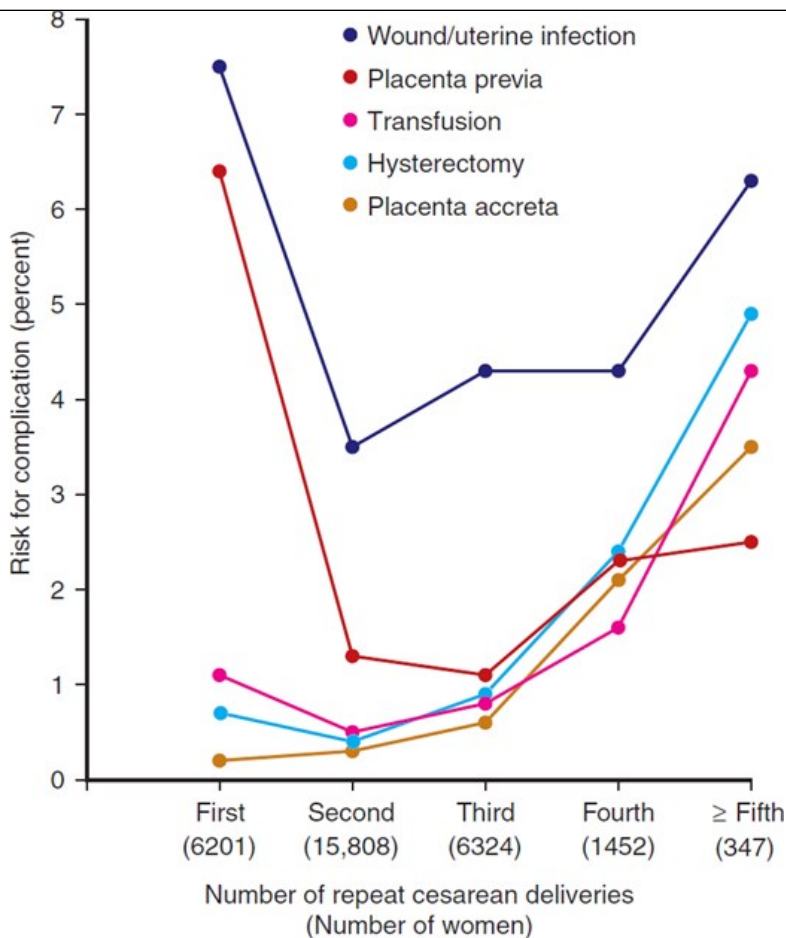
MULTIPLE REPEAT CESAREAN DELIVERIES

Because of the aforementioned concerns with TOLAC, most women in the United States undergo ERCD. This choice has several significant maternal complications, and rates of these rise in women who have multiple repeat operations. The incidences of some common complications for women with one prior transverse cesarean delivery who undergo an ERCD were shown in Table 31-2. Of note, half of cesarean hysterectomies done at Parkland Hospital are in women with one or more prior cesarean deliveries (Hernandez, 2013).

The Network addressed issues of increased morbidity in a cohort of 30,132 women who had from one to six repeat cesarean deliveries (Silver, 2006). The rates of some of the more frequent or serious complications are depicted in Figure 31-6. In addition, rates of bowel or bladder injury, admission to an intensive care unit or need for ventilator therapy, and maternal mortality, as well as operative and hospitalization length, showed significantly rising trends. Similar results have been reported by others (Nisenblat, 2006; Usta, 2005). More difficult to quantify are risks for bowel obstruction and pelvic pain from peritoneal adhesive disease, both of which increase with each successive cesarean delivery (Andolf, 2010; Mankuta, 2013).

FIGURE 31-6

Maternal-Fetal Medicine Units Network: rates of some complications with increasing number of repeat cesarean deliveries. (Data from Silver RM, Landon MB, Rouse DJ, et al: Maternal morbidity associated with multiple repeat cesarean deliveries. *Obstet Gynecol* 207:1226, 2006.)



Source: F. Gary Cunningham, Kenneth J. Laveno, Steven L. Bloom, Catherine Y. Spong, Jodi S. Dashe, Barbara L. Hoffman, Brian M. Casey, Joanne S. Sheffield. *Williams Obstetrics*, 25th Edition. Copyright © McGraw-Hill Education. All rights reserved.

Cook and colleagues (2013) from the United Kingdom Obstetric Surveillance System (UKOSS) described adverse sequelae of women with five or more cesarean deliveries. These women had significantly higher rates of morbidity. Namely, the major hemorrhage rate increased 18-fold; visceral damage, 17-fold; critical care admissions, 15-fold; and delivery <37 weeks, sixfold. Much of this morbidity was in the 18 percent who had a placenta previa or an accrete syndrome (Chap. 41, Placenta Previa).

VAGINAL BIRTH AFTER CESAREAN—2017

For providers and their patients, unfortunately, no large randomized trials have compared outcomes of women with an intent to pursue either TOLAC or ERCD. Most studies to date have compared *actual* routes of delivery rather than the *intended* route of delivery. Thus, we agree with Scott (2011) regarding a “common-sense” approach. The woman—and her partner if she wishes—are encouraged to actively participate with her provider in informed consent. Counseling should include documentation of the prior uterine incision and discussion of risks, benefits, and success rates of TOLAC or ERCD. This includes consideration of risks involving future pregnancies. Ideally, counseling begins preconceptionally and continues throughout pregnancy, with flexible options extending up to delivery. For women who desire TOLAC despite a factor that increases their specific risk, additions to the consent form are recommended by the American College of Obstetricians and Gynecologists (2017a). Bonanno and colleagues (2011) have provided such an example. Brief synopses of professional society guidelines are shown in Table 31-4. Guidelines that tend to be more conservative are shown in Table 31-5.

TABLE 31-4

Some Recommendations of Professional Societies Concerning a Trial of Labor to Attempt VBAC

	Counseling	Facilities	Other
American College of Obstetricians and Gynecologists (2017a)	Offer to most women with one prior low-transverse incision; consider for two prior low-transverse incisions	Safest with ability for immediate cesarean delivery; patients should be allowed to accept increased risk when not available	Not precluded: twins, macrosomia, prior low-vertical or unknown type of incision
Society of Obstetricians and Gynaecologists of Canada (2005)	Offer to women with one prior transverse low-segment cesarean delivery; with >1 prior CD then VBAC likely successful but increased risks	Should deliver in hospital in which timely cesarean delivery is available; approximate timeframe of 30 minutes	Oxytocin or Foley catheter induction safe, but prostaglandins should not be used; macrosomia, diabetes, postterm pregnancy, twins are not contraindications
Royal College of Obstetricians and Gynaecologists (2007)	Discuss VBAC option with women with prior low-segment cesarean delivery; decision between obstetrician and patient	Suitable delivery suite with continuous care and monitoring; immediate cesarean delivery capability	Caution with twins and macrosomia

CD = cesarean delivery; VBAC = vaginal birth after cesarean.

TABLE 31-5

Conservative Guidelines to Approach a Trial of Labor Following Cesarean Delivery

<p>Follow ACOG practice guidelines</p>
<p>Education and counseling</p> <ul style="list-style-type: none"> Preconceptionally <ul style="list-style-type: none"> Provide ACOG patient pamphlet Early during prenatal care <ul style="list-style-type: none"> Develop preliminary plan Revisit at least each trimester Be willing to alter decision Have facilities availability
<p>Risk assessment</p> <ul style="list-style-type: none"> Review previous operative note(s) Review relative and absolute contraindications Reconsider risks as pregnancy progresses Tread carefully: >1 prior transverse CD, unknown incision, twins, macrosomia
<p>Labor and delivery</p> <ul style="list-style-type: none"> Cautions for induction—unfavorable cervix, high station <ul style="list-style-type: none"> Consider AROM Avoid prostaglandins Respect oxytocin—know when to quit Beware of abnormal labor progress Respect EFM pattern abnormalities Know when to abandon a trial of labor

ACOG = American College of Obstetricians and Gynecologists; AROM = artificial rupture of membranes; CD = cesarean delivery; EFM = electronic fetal monitoring.

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