Uterine Rupture During a Trial of Labor After Previous Cesarean Delivery

Carolyn M. Zelop, MD*

KEYWORDS

• Uterine rupture • Trial of labor after previous cesarean
• Risk factors • Protective factors

Controversy surrounding a trial of labor (TOL) in women with a history of prior cesarean delivery has been dominated by the fear of uterine rupture. Although the overall risk of uterine rupture is less than 1%,[1] the potential for maternal and neonatal morbidity and even mortality remain paramount concerns for both patients and health care providers. In a study encompassing 142,075 women undergoing a TOL after previous cesarean birth, the uterine rupture–related complication rate per 1000 TOL's was 1.8 for maternal transfusion, 1.5 for fetal acidosis less than 7.0, 0.8 for genitourinary injury, 0.4 for perinatal death, and 0.02 for maternal death.[2] Before embarking on a discussion of prevalence rates of uterine rupture and variables that may modify these risks, it is important to establish a working definition. The recent National Institutes of Health (NIH) Consensus Development Conference entitled "Vaginal Birth after Cesarean: New Insights" defined uterine rupture as the complete anatomic separation of the uterine wall regardless of the presence or absence of symptoms with or without extrusion of the fetal-placental unit.[3] Although uterine dehiscence, which implies an incomplete disruption of the uterine wall with intact serosa, may be clinically relevant as a near-miss uterine rupture, the rates of the 2 entities will not be used interchangeably. However, some studies choose to report these together as disruptions of normal uterine anatomy.

Although the rates differ among various cohorts, the literature consistently reports an increased risk of uterine rupture in women undergoing a TOL compared with elective repeat cesarean delivery (ERCD). According to the NIH Consensus Statement,[3] the risk of uterine rupture for women of all gestational ages undergoing a TOL is 0.33%

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Beth Israel Deaconess Medical Center, Division of Maternal Fetal Medicine, Harvard University School of Medicine, Boston, MA 02215, USA
* Beth Israel Deaconess Medical Center, 330 Brookline, KS 338, Boston, MA 02215.
E-mail address: cmzelop@comcast.net

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compared with 0.03% for women undergoing ERCD. At term, the risk of uterine rupture is 0.78% in women undergoing TOL compared with 0.02% in those undergoing ERCD. Perhaps the most clinically relevant analyses are based on intention to deliver.[4] Spong and colleagues[5] stratified the analysis of uterine rupture among 39,117 women at term with a history of cesarean delivery by 5 subgroups that might be encountered by the clinician including (1) TOL (n = 15,323), (2) ERCD with labor (n = 2721), (3) ERCD without labor (n = 14,993), (4) indicated repeat cesarean delivery with labor (n = 1078), and (5) indicated repeat cesarean delivery without labor (n = 5002). In this study, the rate of uterine rupture in women who underwent TOL was 0.74% in contrast to those who underwent ERCD with or without labor, who sustained a rate of 0.15% and 0%, respectively. The group with indicated repeat cesarean delivery with or without labor experienced slightly higher rates of uterine rupture compared with the group with ERCD (0.28% and 0.08%, respectively).

FACTORS AFFECTING THE INTEGRITY OF THE HYSTEROTOMY SCAR

There is a paucity of data regarding wound healing of the hysterotomy scar. Various modalities including radiological and pathologic studies as well as an animal model have been used to gain insight, yet information remains sparse.[6–8] Wound healing is characterized as an initial inflammatory process with recruitment of fibroblasts and synthesis of collagen to create a scar matrix. Theoretically, remodeling of the initial uterine hysterotomy scar under the influence of growth factors, such as insulinlike growth factor 1, might favor the eventual regeneration of the myometrium.[6] Using ultrasonography to evaluate the appearance of both single- and double-layer closure of the hysterotomy, Hamar and colleagues[8] demonstrated an initial increase in the thickness of the postpartum uterus that was 5- to 6-fold at 48 hours after delivery. Although there was a gradual decrease in the uterine thickness over the 6-week course, the uterine scar thickness remained increased compared with the predelivery baseline irrespective of the mode of hysterotomy closure technique suggesting ongoing scar remodeling after the traditional postpartum period. The small sample size may have precluded the detection of an observed difference in the thickness between the closure techniques. However, magnetic resonance imaging has suggested that remodeling and restoration of the uterine zonal anatomy in a lower transverse hysterotomy lasts at least 6 months.[7]

Factors affecting the integrity of the hysterotomy scar may modify the risk of uterine rupture during a TOL after previous cesarean birth. Shipp and colleagues[9] demonstrated that postpartum fever, which could impede the healing process of the hysterotomy scar complicating the index cesarean birth, is associated with an increased risk of uterine rupture during a subsequent TOL. A short interdelivery interval that does not allow enough time for complete hysterotomy healing may be associated with an increased risk of uterine rupture during a TOL after previous cesarean.[10,11] An interdelivery interval of less than or equal to 18 months is associated with a 3-fold increased risk of uterine rupture during a subsequent TOL after previous cesarean birth.[10] The technique of prior uterine closure (single- vs double-layer suturing of the hysterotomy) has also been studied as a possible risk factor for uterine rupture. Although results have been inconsistent in the literature, the largest study to date by Bujold and colleagues[12] demonstrated an almost 3-fold increased risk of uterine rupture during TOL after previous cesarean birth when single-layer closure of the hysterotomy was used in the index pregnancy. Further analysis in this study revealed no association between uterine rupture and suture material used for hysterotomy closure. Other factors not well studied because of sample size include other aspects of surgical

technique, such as interlocking suture placement. Complicating the concept of tensile strength of the repaired hysterotomy governing the chance of uterine rupture during TOL after previous cesarean is the documentation of uterine rupture remote from the lower uterine segment.[13]

CLINICAL FACTORS THAT MODIFY THE RISK OF UTERINE RUPTURE DURING TOL

Clinical research initiated in the late 1990s, which continued into the new millennium, identified factors that increase or decrease the risk of uterine rupture during a TOL after previous cesarean. Identifying women with the least risk of uterine rupture should potentially optimize the safety of vaginal birth after cesarean (VBAC). Both antepartum and intrapartum factors should be considered.

UTERINE SCAR TYPE AND NUMBER OF PRIOR CESAREAN DELIVERIES

Most of the literature examining outcomes of TOL has focused on women with prior low transverse hysterotomy, and indeed, this cohort has become the referent group in other comparative studies.[4] In the largest study examining women with prior low vertical hysterotomy undergoing TOL after previous cesarean birth, Shipp and colleagues[14] demonstrated a 0.8% risk of symptomatic uterine rupture, which was not increased when compared with those with a prior low transverse uterine incision. This study had a power of 80% to detect an increase from 1% (as noted for low transverse incisions) to 3% risk of symptomatic uterine rupture, which has been observed in women undergoing a TOL after multiple previous cesarean births.

Recent studies have reported a range of risk of uterine rupture from 0.9% to 3.7% during a TOL after 2 prior cesareans compared with a TOL after single prior cesarean birth,[15–17] leading to some inconsistencies in the interpretation of the data. Although there is an increased risk of major maternal morbidity associated with TOL after more than 1 prior cesarean delivery, the absolute risk remains small. All 3 studies suggested a protective effect of prior vaginal delivery when undergoing a TOL after more than 1 prior cesarean birth.

DEMOGRAPHIC CHARACTERISTICS, PRIOR OBSTETRIC HISTORY, AND THE RISK OF UTERINE RUPTURE

More recently, demographic factors have been demonstrated to influence the risk of uterine rupture, and because these factors can be identified in the antepartum period, they can be used for counseling women. In a retrospective cohort study, Shipp and colleagues[18] demonstrated that increasing maternal age was associated with a greater chance of uterine rupture. In this study, women younger than 30 years undergoing a TOL after previous cesarean delivery had a 0.5% risk of uterine rupture compared with a risk of 1.4% in those aged 30 years or older. Age, in general, seems to hinder abdominal wound healing, and it also seems to affect uterine hysterotomy healing in a model controlling for other risk factors that modify the risk of uterine rupture. Any previous vaginal delivery is associated with a decreased risk of uterine rupture during a TOL after previous cesarean birth. Using a logistic regression model controlling for possible confounders such as epidural analgesia, year of birth, maternal age, birthweight, duration of labor, and use of oxytocin for augmentation or induction, Zelop and colleagues[19] demonstrated that women with a previous vaginal delivery experienced one-fifth the risk (0.2% vs 1.1%) of uterine rupture during a TOL after previous cesarean when compared with women without prior vaginal delivery.

Fetal size and maternal body mass index (BMI), defined as the weight in kilograms divided by the height in meters squared, seem to have some influence on the risk of uterine rupture during a TOL after previous cesarean birth. Birthweight is used as a proxy for estimated fetal weight in the literature when examining the risk of uterine rupture. Zelop and colleagues[20] reported no statistically increased risk of uterine rupture among women with fetuses weighing more than 4000 g compared with those weighing 4000 g or less during a TOL after previous cesarean. Caution was recommended for fetuses with birthweights less than 4250 g because the rate of rupture was 2.4% in this group of women undergoing a TOL after previous cesarean. Elkousy and colleagues[21] concluded in their analysis that women with no prior vaginal deliveries and neonatal birthweight greater than or equal to 4000 g were at an increased risk of uterine rupture with a rate of 3.6%. Increasing BMI also seems to increase the risk of uterine rupture and dehiscence. The combined risk increased from 0.9% to 2.1% when comparing women with a normal BMI undergoing a TOL after previous cesarean with morbidly obese women defined as those with a BMI greater than 40.[22]

Gestational age of the current pregnancy may influence the risk of uterine rupture. Compared with women with term pregnancies undergoing a TOL after previous cesarean birth, those laboring preterm seem to have lower rates of uterine rupture (0.34% vs 0.74%).[23] For spontaneous labor, uterine rupture during a TOL after the estimated day of delivery (EDD) seems to be similar to the risk before EDD as reported in 2 cohort studies.[24,25] If the previous cesarean delivery was preterm, the risk for uterine rupture in the subsequent TOL is minimally increased when compared with the risk in women who had previous term cesarean deliveries. In a multivariable analysis controlling for confounders, patients with a previous preterm cesarean delivery remained at an increased risk of subsequent uterine rupture during a TOL when compared with women with previous term cesarean delivery with an odds ratio of 1.6 corresponding to an absolute increased risk from 0.68% to 1.0%.[26]

LABOR MANAGEMENT AND THE RISK OF UTERINE RUPTURE

Discussion of induction and augmentation of labor after previous cesarean birth is a broad topic that is covered in depth in an article by Grivell and colleagues elsewhere in this issue. Therefore, the discussion in this article revolves around the effect of induction and augmentation on the risk of uterine rupture during a TOL after previous cesarean birth. Induction of labor with oxytocin is associated with an increased risk of uterine rupture. Zelop and colleagues[27] demonstrated an overall rate of uterine rupture of 2.3% among patients with induction of labor compared with 0.7% among women with spontaneous labor. In a logistic regression model controlling for possible confounders, induction of labor in women with prior cesarean and no other deliveries was associated with a 4.6-fold increased risk of uterine rupture. In this same model, there was a trend toward increased risk of uterine rupture associated with use of prostaglandin E_2 gel, although this difference was not statistically different. In a subsequent study to further clarify the effect of prostaglandin use, Lydon-Rochelle and colleagues[28] confirmed the increased risk of induction compared with repeated cesarean delivery and demonstrated the highest risk associated with use of prostaglandins particularly misoprostol. Landon and colleagues[29] reported a statistically significant increased risk of uterine rupture associated with induction of labor after previous cesarean delivery regardless of the method used compared with spontaneous labor after previous cesarean birth.

Variable results have been reported regarding the association of augmentation of labor and the risk of uterine rupture during a TOL after previous cesarean birth. Goetzl

and colleagues[30] demonstrated no differences in exposure to oxytocin between cases defined as women with uterine rupture who received oxytocin and controls defined as women who received oxytocin and sustained no uterine rupture. In contrast, Landon and colleagues[29] reported a 0.9% risk of uterine rupture in women receiving oxytocin for augmentation of labor compared with 0.4% in women with spontaneous labor after previous cesarean delivery. In addition, Cahill and colleagues[31] demonstrated a statistically significant 4-fold or greater increased risk of uterine rupture when maximum dosages greater than 20 mU/min of oxytocin were used for augmentation of labor during a TOL after previous cesarean birth.

PREDICTION OF UTERINE RUPTURE

Can uterine rupture be predicted in women attempting a TOL after previous cesarean birth? Ideally, the most suitable candidates for a TOL after previous cesarean have the lowest risk of uterine rupture and the highest chance of a successful vaginal delivery. Two approaches have been explored in the literature for the prediction of uterine rupture: assessment of the lower uterine segment (LUS) and prediction nomograms or multivariable models.

Rozenberg and colleagues[32] evaluated a transabdominal ultrasonographic approach to assess the thickness of the LUS in patients with a history of prior cesarean at 36to 38 weeks as a screening tool to predict the risk of intrapartum uterine rupture. Their technique performed with a full bladder seemed to measure the thinnest portion of the myometrium in the LUS. Analysis of their data demonstrated that the risk of a defective scar was related to thinning of the LUS as measured by ultrasonography. Using a cutoff of 3.5 mm, the sensitivity of the ultrasonographic measurement was 88%, with a positive predictive value of 11.8% but a negative predictive value of 99.3%. Using these data, women with an LUS greater than or equal to 3.5 mm may be considered for a TOL after previous cesarean birth. Subsequently, Bujold and colleagues[33] demonstrated that a full LUS thickness of less than 2.3 mm is associated with a higher risk of complete uterine rupture. A recent systematic review of the use of sonographic LUS thickness in predicting uterine scar defect demonstrated that although LUS thickness is a strong predictor for uterine scar disruption, no ideal cutoff has been identified.[34] More studies are required before this tool is ready for widespread clinical use because the technical aspects of its reproducibility have yet to be validated and would require large-scale monitoring similar to nuchal translucency measurement in practice.

Several multivariable models have been proposed in the literature as well. Macones and colleagues[35] investigated the use of both antepartum and early labor factors to develop a model predictive of uterine rupture. Their study using receiver operating characteristic curves, which examined such factors including prior vaginal delivery, ethnicity, maternal age, gestational age, induction of labor, and cervical dilation greater than 3 cm, failed to achieve sensitivity and specificity that are clinically useful. Grobman and colleagues[36] sought to develop a model that predicted individual specific risk for uterine rupture. They divided their data into a training set and a testing set. The logistic regression model that yielded the optimal final prediction tool failed to achieve discriminating ability necessary to predict uterine rupture that was clinically useful. Lastly, Shipp and colleagues[37] proposed an assessment tool for prediction of intrapartum uterine rupture based on factors available early in the antepartum period. Using their scoring system based on 40 symptomatic uterine ruptures and 4384 TOL's, 60% of uterine ruptures would be prevented while allowing 81% of patients a TOL. About 36 elective repeat cesarean deliveries would be performed to

prevent 1 symptomatic uterine rupture. Although this model seemed to perform well and the sample size was robust, it was not large enough to enable a validation phase to be performed. Thus, in summary, although several reasonable models have been designed to predict uterine rupture, prospective studies are required to continue to optimize their clinical utility for the satisfactory prediction of uterine rupture during a TOL after previous cesarean birth.

SUMMARY

Uterine rupture, which involves complete separation of the uterine wall, occurs in about 1% of those attempting VBAC. Because uterine rupture is one of the most significant complications of a TOL after previous cesarean, identifying those at increased risk of uterine rupture is paramount to the safety of a TOL after previous cesarean birth. It seems that both antepartum demographic characteristics and intrapartum factors modify the risk of uterine rupture. The ability to reliably predict an individual's a priori risk for intrapartum uterine rupture remains a major area of investigation.

REFERENCES

1. Fang YM, Zelop CM. Vaginal birth after cesarean: assessing maternal and perinatal risks-contemporary management. Clin Obstet Gynecol 2006;49:147–53.
2. Chauhan SP, Martin JN, Henrichs CE, et al. Maternal and perinatal complications with uterine rupture in 142,075 patients who attempted vaginal birth after cesarean delivery: a review of the literature. Am J Obstet Gynecol 2003;189: 408–17.
3. NIH Consensus Development Conference on Vaginal Birth After Cesarean: New Insights. March 8–10, 2010. Available at: http://concensus.nih.gov/2010/images/vbac/vbac_statement.pdf. Accessed August 23, 2010.
4. American College of Obstetricians and Gynecologists. Vaginal birth after previous cesarean delivery. Practice bulletin No. 115. Obstet Gynecol 2010; 116:450–63.
5. Spong CY, Landon MB, Gilbert S, et al. Risk of uterine rupture and adverse perinatal outcome at term after cesarean delivery. Obstet Gynecol 2007;110:801–7.
6. Bowers D, McKenzie D, Dutta D, et al. Growth hormone treatment after cesarean delivery in rats increases the strength of the uterine scar. Am J Obstet Gynecol 2001;185:614–7.
7. Dicle O, Kucukler C, Pinar T, et al. Magnetic resonance imaging evaluation of incision healing after cesarean sections. Eur Radiol 1997;7(1):31–4.
8. Hamar B, Saber S, Cackovic, et al. Ultrasound evaluation of the uterine scar after cesarean delivery: a randomized controlled trial of one and two layer closure. Obstet Gynecol 2007;110:808–13.
9. Shipp TD, Zelop CM, Cohen A, et al. Post-cesarean delivery fever and uterine rupture in a subsequent trial of labor. Obstet Gynecol 2003;101:136–9.
10. Shipp TD, Zelop CM, Repke JT, et al. Interdelivery interval and risk of symptomatic uterine rupture. Obstet Gynecol 2001;97:175–7.
11. Bujold E, Gauthier RJ. Risk of uterine rupture associated with an interdelivery interval between 18-24 weeks. Obstet Gynecol 2010;115(5):1003–6.
12. Bujold E, Goyet M, Marcoux S, et al. The role of uterine closure in the risk of uterine rupture. Obstet Gynecol 2010;116:43–50.
13. Buhimschi CS, Buhimschi SP, Malinow A, et al. Rupture of the uterine scar during term labour: contractility or biochemistry? BJOG 2005;112(1):38–42.

14. Shipp TD, Zelop CM, Repke JT, et al. Intrapartum uterine rupture and dehiscence in patients with prior lower uterine segment vertical and transverse incisions. Obstet Gynecol 1999;94:735–40.
15. Landon MB, Spong CY, Thom E, et al. Risk of uterine rupture with a trial of labor in women with multiple and single prior cesarean delivery. Obstet Gynec 2006; 108(1):12–20.
16. Macones GA, Cahill A, Pare E, et al. Obstetric outcomes in women with two prior cesarean deliveries: is vaginal birth after cesarean delivery a viable option? Am J Obstet Gynecol 2005;192:1223–9.
17. Caughey AB, Shipp TD, Repke JT, et al. Rate of uterine rupture during a trial of labor in women with one or two prior cesarean deliveries. Am J Obstet Gynecol 1999;181:872–6.
18. Shipp TD, Zelop CM, Repke JT, et al. The association of maternal age and symptomatic uterine rupture during a trial of labor after prior cesarean delivery. Obstet Gynecol 2002;99:585–8.
19. Zelop CM, Shipp TD, Repke JT, et al. Effect of previous vaginal delivery on the risk of uterine rupture during a subsequent trial of labor. Am J Obstet Gynecol 2000;183:1184–6.
20. Zelop CM, Shipp TD, Repke JT, et al. Outcomes of trial of labor following previous cesarean delivery among women with fetuses weighing >4000g. Am J Obstet Gynecol 2001;185(4):903–5.
21. Elkousy MA, Sammel M, Stevens E, et al. The effect of birth weight on vaginal birth after cesarean delivery success rates. Am J Obstet Gynecol 2003;188: 824–30.
22. Hibbard JU, Gilbert S, Landon MB, et al. Trial of labor or repeat cesarean delivery in women with morbid obesity and previous cesarean delivery. Obstet Gynecol 2006;108:125–33.
23. Durnwald CP, Rouse DJ, Leveno KL, et al. The maternal-fetal medicine units cesarean registry: safety and efficacy of a trial of labor in preterm pregnancy after a prior cesarean delivery. Am J Obstet Gynecol 2006;195(4):1119–26.
24. Zelop CM, Shipp TD, Cohen A, et al. Trial of labor after 40 weeks' gestation in women with prior cesarean. Obstet Gynecol 2001;97(3):391–3.
25. Coassolo KM, Stamilio DM, Pare E, et al. Safety and efficacy of vaginal birth after cesarean attempts at or beyond 40 weeks' of gestation. Obstet Gynecol 2005; 106(4):700–6.
26. Sciscione AC, Landon MB, Leveno KJ, et al. Previous preterm cesarean delivery and risk of subsequent uterine rupture. Obstet Gynecol 2008;111(3):648–53.
27. Zelop CM, Shipp TD, Repke JT, et al. Uterine rupture during induced or augmented labor in gravid women with one prior cesarean delivery. Am J Obstet Gynecol 1999;181:882–6.
28. Lydon-Rochelle M, Holt VL, Easterling TR, et al. Risk of uterine rupture during labor among women with a prior cesarean delivery. N Engl J Med 2001; 345(1):3–8.
29. Landon MB, Hauth JC, Leveno KJ, et al. Maternal and perinatal outcomes associated with a trial of labor after prior cesarean delivery. N Engl J Med 2004;351: 2581–9.
30. Goetzl L, Shipp TD, Cohen A, et al. Oxytocin dose and the risk of uterine rupture in trial of labor after cesarean. Obstet Gynecol 2001;97:381–4.
31. Cahill AG, Waterman BM, Stamilio DM, et al. Higher maximum doses oxytocin are associated with unacceptably high risk for uterine rupture in patients attempting vaginal birth after cesarean delivery. Am J Obstet Gynecol 2008;199:32.e1–5.

32. Rozenberg P, Goffinet F, Philippe HJ, et al. Ultrasonographic measurement of lower uterine segment to assess risk of defects of scarred uterus. Lancet 1996; 347:281–4.
33. Bujold E, Jastrow N, Simoneau J, et al. Prediction of complete uterine rupture by sonographic evaluation of the lower uterine segment. Am J Obstet Gynecol 2009; 201(3):320.e1–6.
34. Jastrow N, Chaillet N, Roberge S, et al. Sonographic lower uterine segment thickness and the risk of uterine scar defect: a systematic review. J Obstet Gynaecol Can 2010;32(4):321–7.
35. Macones G, Cahill AG, Stamilio AM, et al. Can uterine rupture in patients attempting vaginal birth after cesarean delivery be predicted? Am J Obstet Gynecol 2006;195:1148–52.
36. Grobman WA, Lei Y, Landon MB, et al. Prediction of uterine rupture associated with attempted vaginal birth after cesarean delivery. Am J Obstet Gynecol 2008;199:30.e1–5.
37. Shipp TD, Zelop CM, Lieberman E. Assessment of the rate of uterine rupture at the first prenatal visit: a preliminary evaluation. J Maternal Fetal Neonatal Med 2008;21(2):129–33.