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Uterine rupture

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ABSTRACT

The increasing rate of elective and indicated caesarean sections worldwide has led to new pathologies and management challenges. The number of patients undergoing trial of labor after caesarean section (TOLAC) is also increasing. Three professional societies provide detailed guidelines based on scientific evidence for the management of patients attempting vaginal birth after caesarean section (VBAC). However, they do not provide any recommendations for the actual surgical steps to be followed to minimize the risks of uterine rupture (UR) during TOLAC. Uterine scar condition, intrapartum management and maternal health status correlate to uterine scar rupture risk and provide guidance for parturient TOLAC eligibility. TOLAC and vaginal delivery success rate as reported by the largest studies is between 60% and 77%. Uterine rupture is more prevalent in VBAC-2 patients (1.59%) in contrast to VBAC-1 (0.72%). Additionally, VBAC-2 patients have higher incidence of caesarean hysterectomy 0.56% vs. 0.19% for VBAC-1. The chances of successful VBAC increase when the interpregnancy/ interdelivery interval is less than 6.3 years and less than 24 months, respectively. No difference was detected between the techniques of uterine incision closure of the previous CS and TOLAC results, although closure of the CS uterine incision in 2 layers seems to be practiced more widely. Niche or isthmocele presents another complication of CS. Secondary infertility due to niche, will eventually direct to hysteroscopic or laparoscopic repair, depending on the residual myometrial thickness (RMT) as measured by US scan. When RMT is below 3 mm or 2.5 mm surgery can be performed, to prevent any spontaneous UR in case of pregnancy. Monitoring by US scanning of hysterotomy scar after myomectomy can detect hematoma. In patients with severe postoperative pain but hemodynamically stable follow up by US scan examination can direct the management decision. In those patients with active bleeding and deterioration of hysterotomy scar edema will be an indication to surgery. There is no firm evidence regarding which type of thread, knotting or sequence of suturing is more favorable to reduce the risk of UR after VBAC or hysterotomy after myomectomy.

Keywords: Cesarean section; Hysterotomy; Niche; TOLAC; Uterine rupture; VBAC.

Introduction

Uterine rupture is defined as the continuity of the uterine muscles of varying degrees, (1). The true rupture of the uterus consists of an authentic complete laceration of the myometrium and this event has a high rate of maternal and fetal morbidity for which it can be considered as one of the most feared complications in pregnancy. In most cases, this event develops in women who have already undergone surgery on the uterus, in particular previous caesarean sections, given the increase in the number of caesarean sections and whose risk of uterine rupture is increased independently of labor. In particular, in industrialized countries the overall incidence of uterine rupture is about 1 in 4366 pregnancies (0.023%), with an incidence of 1 in 236 pregnancies (0.42%) in women who have undergone cesarean section in the past (2). In addition, it should be considered that the probability of a successful labor in women who have previously undergone a caesarean section is estimated to be between 60% and 80%, so it can be considered high (2-6).

Uterine rupture can be **primary**, when it occurs in an intact uterus or without scarring, or **secondary** if it occurs in association with a pre-existing myometrial incision, lesions or abnormalities already present (1). It can also be classified according to an anatomical criterion for which it can be defined as **complete**, if it affects all the layers of the uterine wall, or **incomplete**, also called uterine dehiscence, if there is involvement of the endometrium and myometrium but the integrity of the visceral peritoneum is respected.

Complete uterine rupture is associated with the following conditions (1):

1. Clinically significant uterine bleeding.
2. Persistent abdominal pain that increases in intensity during contractions.
3. Fetal status not reassuring, especially fetal bradycardia.
4. Loss of the level of the presented part.
5. Protrusion or expulsion of the fetus and/or placenta into the abdominal cavity.
6. Need for an emergency caesarean section.
7. Uterine repair or hysterectomy.

Incomplete uterine rupture occurs more frequently than complete rupture and tends to be generated through a dehiscence involving the previous uterine scar, rarely involving major maternal or fetal complications. It should be noted that in the literature the terms "uterine rupture" and "uterine dehiscence" are not distinct from each other and are often used interchangeably, but of course the clinical consequences are totally different. It must be considered that in the case of uterine dehiscence of the previous scar, the fetus and its appendages remain confined inside the uterus and the complications, first of all bleeding, are not clinically significant contrary to what happens in cases of complete uterine rupture. For these reasons, these two entities must be distinct, as must their management.2

From a pathophysiological point of view, uterine rupture can be classified as:

1. *Spontaneous*, resulting from myometrial contractile activity or progressive uterine distention.
2. *Traumatic*, resulting from traumas mostly of external origin (motorway accidents).
3. *Iatrogenic,* caused by drugs, obstetric or instrumental manual interventions.

Rupture can also be defined as *complicated* if it affects neighbouring organs or is accompanied by an infectious process (7).

Risk Factors

The risk factors are different, some can be identified in the patient's medical history, while others are emerging and must be identified intrapartum, they are reported in table no. 1 (7).

Antepartum Risk Factors	Intrapartum Risk Factors
One or more previous caesarean sections. Previous hysterotomy or myomectomy with opening of the uterine cavity and especially if performed laparoscopically. Uterine malformations, especially bicornuate uterus. Exposure in utero placement on Diethylstilbestrol. Maternal congenital syndromes such as S. Ehlers-Danlos.	Placentation abnormalities, such as placenta accreta. Multiparity, as it can cause a weakening of the uterine wall in toto. Incongruous obstetric/instrumental manoeuvres. Mechanical or dynamic dystocia. Abnormal fetal presentations. Incorrect uterine tonics (prostaglandinat E1). Multifetal gravity for uterine overdistention.

Table 1 Summary of risk factors for uterine rupture

Clinic

Clinically, uterine rupture can occur silently, threatens rupture, or as a full-blown rupture. Persistent abdominal pain (i.e., always present even outside of contractions and increasing in intensity during contractile activity) is the clinical aspect most related to uterine rupture. The uterus, in the *threat of rupture*, is progressively hypertonic, sometimes tetanic: in this case the pains change from mild and nuanced to frankly persistent and affecting the entire abdomen and dorsal region (8). In *full-blown uterine rupture*, on the other hand, the patient may present very agitated and suffering, tachycardia, dyspneic and complain of violent, stabbing pain, especially at the height of contraction. After full-blown rupture, uterine contractile activity ceases completely (7).

Another symptom in the presence of uterine rupture is vaginal bleeding. In severe cases, hypovolemic shock may occur (8).

On the other hand, the main fetal signs include prolonged and persistent fetal bradycardia, which is why in patients at risk of rupture such as in those who have performed a previous caesarean section, continuous fetal monitoring is recommended. The fetus, in already overt uterine ruptures, is usually expelled into the peritoneal cavity through the uterine continuous solution together with amniotic fluid and placenta and this sometimes leads to a loss of the level of the presented part and inevitably greatly increases fetal morbidity and mortality (8).

Diagnosis

There is no gold-standard test for diagnosis, which is essentially clinically based. In addition, there is not a single pathognomonic symptom of uterine rupture but a coexistence of several signs and symptoms. Ultrasonography can play a diagnostic role as it can show hemoperitoneum and free fluid in the abdominal cavity, fetal parts and its appendages expelled partially or totally into the abdominal cavity.

At the cardiotocographic level, the abnormalities described above can also be noted, especially fetal bradycardia.

Clinical management of uterine rupture

The 2004 A.C.O.G. Practical Bulletin (9) declares that, in the event of a uterine rupture, "response time is critical". There are two case-control studies

in the literature that have looked at what the time limit was to act in these cases. The first analyzes 106 cases of uterine rupture, in which, among other things, maternal anamnestic characteristics and intrapartum factors could not predict this catastrophic event. The study concludes that neonatal morbidity was significant when more than 18 minutes elapsed between the onset of prolonged deceleration and delivery (10).

In another study from 2002 (11), with 23 cases of uterine rupture analyzed, the temporal correlation described by the previous study was not confirmed and concludes that the most important factor associated with metabolic acidosis and fetal morbidity is placental or fetal extrusion and describes two severe cases of metabolic acidosis incurred despite fetal extraction occurring before 18 minutes of deep deceleration.

According to the guidelines of the Canadian Society of Obstetrics and Gynecology (12) but also according to the guidelines of ACOG and RCOG, TOLAC should only take place in a hospital where all the necessary resources can be mobilized as quickly as possible to prevent serious maternal-fetal consequences from occurring. The company also admits that in the event of a uterine rupture, it does not take more than thirty minutes for the team to be formed and the emergency laparotomy to begin.

After birth, the type of maternal treatment depends on the severity of the bleeding, the patient's clinical condition, the desire for further pregnancies, the extent and type of rupture.

In the case of good maternal hemodynamic stability, a conservative approach can be opted for, especially if there is a low transverse rupture that does not extend to the large ligament, the bumper and the uterine cervix and if the patient wishes to become pregnant. Hysterectomy, on the other hand, should be considered as the treatment of choice in case of bleeding that does not respond to medical and surgical treatment, when the site of uterine rupture is longitudinal, multifaceted, or if it affects the cervix (2, 13).

Rupture in a scarless uterus

Although it is a complication that is less likely to occur in women who have never undergone uterine surgery or in nulliparous women, uterine rupture can still occur favored by some patient's medical history and/or iatrogenic factors (2, 14).

Uterine rupture, in such cases, is mainly found in women with a history of uterine abnormalities such as bicornuate uterus, intake of diethyl stilbestrol or women suffering from maternal connective tissue diseases such as congenital syndromes such as S. Ehlers-Danlos.

Among this category of patients with scarless uteruses during pregnancy, more care should be taken if they have undergone induction and/or acceleration of labor or if they have an abnormal placentation (placenta accreta) (15).

In addition, large multiparous women, especially in combination with epidural analgesia or induction of labor with oxytocin, can also incur this complication (16).

Therefore, whenever a suspicious clinic arises, even in the absence of surgical scars, these risk factors must be taken into account in order to achieve diagnosis more efficiently and quickly.

Uterine rupture in primigravida with previous uterine surgery

In women with a history of uterine surgery, particularly in the case of myomectomies, there is an increased risk of uterine rupture among primigravids. The risk is even higher if the myomectomy surgery is performed laparoscopically rather than laparotomy. In fact, the healing of laparoscopic uterine suture depends on various factors such as the methods and instruments used to perform the incision and the achievement of accurate hemostasis. A possible explanation for the increased risk of uterine rupture with laparoscopic surgery may lie in the suturing technique, which is more difficult to perform than laparotomy (13, 15).

Among the types of fibroids, regardless of the method used, the most relevant factor is whether the removal of the myoma involves the incision of the myometrium in its entire thickness up to the uterine cavity. For this reason, there is no increased risk of uterine rupture in primigravida with a history of myomectomy for pedunculated or subserous fibroids.

A 2006 study by Serrachioli et al. evaluated the consequences on a future pregnancy after a laparoscopic myomectomy and out of 158 pregnancies analyzed there was not a single case of uterine rupture. However, many of the patients recruited (74.5%) performed an elective caesarean section, perhaps underestimating the risk of this complication in the event of labor (17). In a retrospective cohort study in 2018 (18), 469 women who underwent myomectomy were analyzed and of these 152 subsequently became pregnant: 66.4 % attempted labour, while 21.8 % chose elective caesarean section. The result of this study was that there was not a single case of uterine rupture and 90.4% of the women who attempted labor were able to have a successful vaginal delivery. However, this study was criticized because, among patients attempting labor, only 1.4% (1/73) underwent myomectomy with reaching the uterine cavity (19).

According to the Royal College Guidelines of 2015 (20) it is unclear whether women who have undergone laparoscopic or abdominal myomectomy, especially with entry into the uterine cavity, have an increased risk of uterine rupture (21-27). On the other hand, there appears to be a rare risk of uterine rupture with regard to hysteroscopy for resection of the uterine septum (28, 29). Given this uncertainty, women who have undergone such surgery should be considered to have the same risk of rupture as those with a previous caesarean section attempting trial labor and managed in the same way during labor.

Uterine rupture associated with a previous cesarean section.

TOLAC (Trial of Labor After Cesarean delivery) is defined as trial labor in a woman who has previously had a cesarean delivery, regardless of the result she will then achieve. If the woman succeeds in giving birth vaginally, then VBAC (Vaginal Birth After Cesarean Delivery) is defined.

When discussing with a woman who has previously undergone a caesarean section about her chances of successful TOLAC, it is also important to talk about the different antepartum and intrapartum predictors of uterine rupture. While TOLAC is appropriate for many patients, it is important to assess which woman may be an ideal candidate with the lowest maternal-fetal risks and the highest success rate (6, 30, 31).

Antepartum predictors of uterine rupture

Among the antepartum risk factors predictive of uterine rupture, one of the most significant is the *type of uterine incision* performed during the previous cesarean section: low transverse, low vertical, classic or unknown.

For the low transverse incision (the most frequently used technique), several large studies have reported a uterine rupture rate after TOLAC of about 0.5-0.9% (30-35).

The few studies that have evaluated TOLAC in women with a previous low vertical uterine incision have reported similar rates of vaginal delivery success compared to women with a previous low transverse uterine incision (36-38).

With regard to the T-shaped or classic incision on the body of the uterus, the incidence of uterine rupture is 4% to 9% (9).

Other times, the type of uterine incision made in the previous cesarean delivery may not be known. Although some authors have questioned the safety of offering a TOLAC under these circumstances, in two large studies the success rates of VBAC and uterine rupture were similar to those of women with prior documented low transverse uterine incision (39, 40). The absence of an association may result from the fact that most incisions are low transverse and the type of uterine scar can often be inferred based on the indication of the previous cesarean delivery. Therefore, even according to the 2010 ACOG bulletin, women with a previous cesarean section and an unknown uterine scar may be candidates for TOLAC, unless there is a high clinical suspicion of a previous bodily uterine incision such as in the case of a cesarean section performed at an extremely preterm gestational age (9).

Two other important predictors are the *suturing mode* of the uterine incision and especially the *single versus the double layer*. There are conflicting opinions in the literature. One study randomized 164 women into a single-layer closure and a double-layer group who underwent cesarean section and then trial labor and concluded that there was no difference in the risk of uterine dehiscence or uterine rupture (41), while there was an increase in uterine dehiscence but not uterine rupture between patients with a single layer of suture in another Retrospective study (42).

Among the studies noting an increase in single-layer uterine rupture versus double-layer is an observational study of 1980 patients who had an increased risk (4 times higher) with a single-layer suture compared to double-layer (43), while a retrospective study of more than 1185 patients attempting a TOLAC demonstrated a Statistically significant difference in the chance of achieving a successful vaginal birth if the time between births is less than 19 months compared to a longer time, reporting a success rate of 79% (< 19 months) and 85.5% (> 19 months), respectively (44, 45). This was confirmed by a 2001 study by Shipp et al., where for an interval between births of up to 18 months the uterine rupture rate was 2.25% (seven out of 311 patients) compared to 1.05% (22 out of 2098 patients) with an interval or greater of 19 months or more (P = 0.07) (46).

Other authors suggest that it would be better to consider an interval of more than 24 months, otherwise the risk of uterine rupture for shorter periods of time is increased by 2-3 times (OR: 2.05; 95% CI=1.41-2.96) (43, 47).

The Royal College Guidelines of 2015 speak of an increased risk of uterine rupture with an interval of less than 12 months between caesarean section and TOLAC (20).

Another antepartum factor to consider is previous *vaginal delivery*, including a previous successful VBAC, as it is the most profitable event of a TOLAC success and is also protective against uterine rupture during a trial labor (20, 48). The success of a vaginal delivery after cesarean delivery increases even more when women have had a previous VBAC (93%) rather than a vaginal delivery before cesarean delivery (85%). The chances of success increase as the number of previous vaginal deliveries increases. Mercer and his colleagues found that the rate of uterine rupture decreased after the first successful VBAC and did not increase with subsequent vaginal deliveries (0.87% risk after VBAC, 0.52% after 5 deliveries) (49).

Studies evaluating the association of *gestational age* with the success rate of VBAC have consistently demonstrated a reduction in this association in women attempting trial labor beyond 40 weeks of gestation. Gestational age at the time of vaginal delivery may also contribute to the likelihood of uterine rupture, especially this complication may be less associated in patients with early pregnancy. This factor finds its rationale in the thickness of the lower uterine segment, the latter being more resistant to rupture at an earlier gestational age than at the end of pregnancy where it is more distended and therefore much thinner. However, this should not be a good reason to induce a patient who has undergone a previous caesarean section before the term, because it is known that the rate of uterine rupture increases significantly (up to 2-3 times) in patients who undergo induction compared to those who go through spontaneous labor (20).

As for patients with twin pregnancies, if there are no other obstetric contraindications, they may be offered the possibility of trial labor after cesarean delivery because various studies, including the National Institute of Child Health and Human Development study with 186 twin pregnancies (50) and three retrospective U.S. studies (n = 535,139, n = 1850,140 and n = 25141 of twin pregnancies) reported similar success rates of VBAC in twin pregnancies (45–84%) compared to those in single pregnancies (51–53).

Many authors have investigated the relationship between *macrosomia* and the risk of uterine rupture with mixed results analyzed by the ACOG bulletin (9). Three studies reported no association (54-56) while a fourth suggested an increased risk of uterine rupture for women undergoing TOLAC who did not have a previous vaginal delivery (relative risk 2.3; $P < 0.001$) (57).However, these studies used true birth weight as data and not estimated fetal weight, limiting the applicability of these data in the prenatal decision regarding the mode of delivery (82).

In a 2013 meta-analysis (58) it was suggested that *measuring the thickness* of the *lower uterine segment* in women with a previous cesarean delivery could be used to predict the onset of a scar dehiscence or scar rupture in women undergoing VBAC. According to the study, a myometrial thickness overlying the amniotic cavity at the level of the uterine scar of 2.1–4.0 mm provides a strong negative predictive value for the onset of uterine dehiscence or rupture during VBAC, while a myometrial thickness value between 0.6 and 2.0 mm provides a strong positive prediction for the occurrence of the

previous complications listed. However, the study was unable to define an ideal thickness that could be used in clinical practice. This meta-analysis provides a basis for further future studies; however, it lacks a standardized measurement method.

Intrapartum predictive factors

During labor there are a number of signs and symptoms that should be seen as suspicious for uterine rupture and, among the signs, the most specific and sensitive is undoubtedly fetal **bradycardia** or more generally cardiotocographic changes (10, 59-61). For this reason, continuous cardiotocographic monitoring of labour in women with a previous caesarean section is absolutely recommended, while invasive monitoring is not indicated (9).

In a 2007 study that analyzed 26 cases of uterine rupture compared to controls that successfully completed a VBAC, the most common signs of this occurrence were mild and severe variable decelerations. The conclusions of this study indicated that such decelerations, especially in the presence of persistent abdominal pain, may be predictive factors of uterine rupture in patients attempting VBAC (62).

The patient may therefore present, when the uterine rupture has already occurred, **abdominal pain**, metrorrhagia, loss of the level of the presented part. Pain that persists both before and after contraction is the symptom most correlated with uterine rupture. Surely it is not the single symptom that must lead us to the diagnosis of uterine rupture but the overall picture, also taking into account the antepartum risk factors listed above, which must lead us to the diagnosis of uterine rupture as quickly as possible, avoiding serious maternal-fetal consequences.

Induction and acceleration of labor

Although induction and enhancement of labor are not contraindicated in women with prior cesarean section, there remains considerable disagreement about their use among clinicians. According to the Royal College Guidelines' 2015 TOLAC induction or enhancement of labor is associated with a 2- to 3 -fold increased risk of uterine rupture and an approximately 1.5-fold increased risk of cesarean delivery compared to spontaneous labor. On the other hand, induction of labor with mechanical methods (amniorhexis or Foley catheter) is associated with a lower risk of scar rupture than induction with prostaglandins (20).

As for oxytocin, its administration in labor for induction or acceleration of delivery appears to be safe according to a meta-analysis conducted on 11417 labor labors and 6147 elective cesarean sections (63). It would seem plausible to assume that uterine rupture would occur more likely if oxytocin is used for labor with adequate uterine activity than when uterine activity is absent or inadequate. In addition, a case-control study with approximately 800 patients analyzed and 272 patients receiving oxytocin, had the following results: the use of a superior oxytocin dosage at 20 mU/min leads to an increase in the risk of uterine rupture of about 4-fold or more (21-30 mU/min: hazard ratio [HR] 3.92, 95% confidence interval [CI] (64, 65). Therefore, it remains plausible to assume that oxytocin is used, especially when the contractions are short and ineffective, and that a dosage below 20 mU/min is used.

In one of the studies by the National Institute of Child Health and Human Development, induction with prostaglandins (30) compared with induction

without prostaglandins (e.g., intracervical amnion or Foley catheter) was associated with a higher risk of uterine rupture (87 per 10,000 [0.87%] versus 29 per 10,000 [0.29%]) as well as a higher rate of uterine rupture. perinatal death from uterine rupture (11.2 per 10,000 [0.11%] versus 4.5 per 10,000 [0.045%]). Therefore, particular care should be taken with the use of prostaglandins and, if they are to be used, the total exposure dose should be limited or another method of induction, such as an intracervical Foley catheter (66) should be considered.

Misoprostol (prostaglandin E1) and the use of prostaglandins in general, should be avoided in women with previous uterine scars, because statistically it has a high incidence of uterine hyperstimulation and therefore, of risk of uterine rupture. According to various studies, the risk increases by up to 16 times (38).

Two retrospective studies have suggested that low-dose prostaglandin E2 is a safe option for induction of labor in women undergoing VBAC, without an appreciable increase in rates of uterine rupture or maternal and perinatal mortality compared to women undergoing spontaneous VBAC (67, 68). However, a Cochrane review suggested that there is insufficient evidence from randomized controlled trials to determine the method with the lowest risk of uterine rupture by induction of labor with a prior cesarean delivery (69).

Uterine rupture associated with more than one previous cesarean section.

According to the 2010 ACOG bulletin, there are studies in the literature that describe the risks and benefits of a TOLAC in women with more than one cesarean section and report a risk of uterine rupture between 0.9% and 3.7% (9).

In fact, in a prospective multicenter study by Landon et al. in 2006, there was no increased risk of uterine rupture (0.9% vs. 0.7%) in women with a previous cesarean section (16,915 cases analyzed) compared to multiple previous cesarean deliveries (analyzed 975 cases) and concludes that VBAC may be a valid option for this category of patients as well (47).

In contrast, another retrospective study by Macones et al. in 2005, which analyzed 20,175 women with a previous cesarean section and 3,970 with two previous cesarean sections, showed a risk of uterine rupture that increased from 0.9% to 1.8%, respectively (70).

ACOG concludes that vaginal delivery after two previous caesarean sections should remain an option for women without other risk factors, especially if the incision type of previous caesareans was low transverse and if there have been previous vaginal deliveries. On the other hand, there are few data on the risk of complications of TOLAC for women with more than two previous caesarean sections.

According to the Royal College Guidelines of 2015, women who have had two or more previous caesarean sections may be offered VBAC after consultation with a senior obstetrician, and labour should be conducted at a centre with appropriate expertise where an emergency caesarean section can be switched to as soon as possible (20).

In conclusion, according to a systematic review, women with two previous cesarean sections who are considering VBAC should be informed about the success rate (71.1%), the uterine rupture rate

(1.36%), and maternal morbidity comparable to the iterative caesarean section option (71).

Management of future pregnancies after a uterine rupture

If the site of rupture is limited to the lower uterine segment, the rate of repeated rupture or suture dehiscence in labor is 6% (72). If the scar includes the upper segment of the uterus, the rate of repeated rupture is reported to be 32% (72, 73). In a more recent study from 2015, this rate was estimated at 15% (74).

Given these high recurrence rates, it is recommended that women who have had a previous uterine rupture perform a cesarean delivery in the future pregnancy. In addition, since spontaneous labor is unpredictable and may occur before 39 weeks of gestation, the times suggested by ACOG for iterative caesarean section are between 36 0/7 and 37 0/7 weeks of gestation, but can be individualized according to the clinical situation of the individual patient (75).

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