

## VBAC: antenatal predictors of success

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**Summary.** To determine antenatal factors that may predict successful vaginal birth after Caesarean section (VBAC), to develop a relevant antenatal scoring system and a nomogram for prediction of vaginal birth after caesarean delivery. A non recurring indication for previous Caesarean section (CS), such as breech presentation or foetal distress, is associated with a much higher successful VBAC rate than recurrent indications, such as cephalopelvic disproportion (CPD). Prior vaginal deliveries are excellent prognostic indicators of successful VBAC, especially if the vaginal delivery follows the prior CS. A low vertical uterine incision does not seem to adversely affect VBAC success rates as compared to a low transverse incision. Maternal obesity and diabetes mellitus adversely affect VBAC outcomes. Foetal macrosomia does not appear to be a contraindication to VBAC, as success rates exceeding 50% are achieved and uterine rupture rates are not increased. An interpregnancy interval of <24 months is not associated with a decreased success of VBAC. Success rates decrease when interval increases. Twin gestation does not preclude VBAC. Post-dates pregnancies may deliver successfully by VBAC in greater than two-thirds of cases. There are few absolute contraindications to attempted VBAC. Attempted VBAC will be successful in the majority of attempted cases. ([www.actabiomedica.it](http://www.actabiomedica.it))

**Key words:** vaginal birth after Caesarean, predictors of success, antenatal, TOL, success rates

### 1. Introduction

Before 1970s, the phrase "once a Caesarean, always a Caesarean" dictated obstetrics practice, in fact Caesarean section (CS) rates steadily increased throughout the twentieth century. Repeating a CS came to account in almost 40% of all CS. This has implications not only at an economic level, but also in terms of maternal and neonatal morbidity. Studies have demonstrated that neonates of mothers who undergo elective repeat CS can be at greater risk of respiratory morbidity. Maternal complications associated with elective repeat CS include placenta accrete, visceral injury, intensive care unit admission, hysterectomy, blood transfusion, and a longer duration of

hospital stay. In 1981, vaginal birth after CS, was recognized as a safe and acceptable option after a previous low transverse Caesarean delivery (1), though vaginal birth after caesarean (VBAC) is not without its own risks, which include uterine rupture, endometritis, blood transfusion. Since that time, encouraging women to attempt VBAC has been one of the strategies used in an attempt to reduce Caesarean delivery rates. Increasing experience with VBAC has caused a gradual easing of selection criteria for trial of labour (TOL), reflected in the clinical practice guidelines. In 1988, ACOG published 'Guidelines for vaginal delivery after a previous caesarean birth' endorsing vaginal birth after Caesarean delivery (VBAC)-TOL as it became clear that this procedure was safe and did

not appeared to be associated with appreciable excess perinatal morbidity, compared with elective CS. Subsequently, first in 2007 and then in 2015, Royal College of Obstetricians and Gynaecologists (RCOG) published new Guidelines for VBAC that planned VBAC is a clinically safe choice for most women with a single previous lower segment caesarean delivery (2). This guideline provides evidence-based recommendations on best practice for the antenatal and intrapartum management of women undergoing planned VBAC. There are predictive factors that can prenatally determine a patient's probability of successful vaginal delivery and these are summarized in the following sections. Trial of labour after CS is defined as an attempt at vaginal delivery in women with a previous caesarean section (3). A successful trial of labour after caesarean section (TOLAC) is defined as spontaneous or instrumental (assisted by vacuum or low forceps) delivery to a woman undergoing TOLAC. An unsuccessful TOLAC is defined as failure to achieve a vaginal birth after caesarean section in women undergoing a TOLAC and the delivery ending by emergency CS.

## 2. Antenatal factor associated VBAC

### 2.1 Factors associated with previous obstetrical history

#### 2.1.1 Indication for previous CS

Several studies (4, 5), were conducted to evaluate the influence of previous CS on VBAC success. The indications of previous CS were divided into recurrent and non-recurrent group. Recurrent indication for a caesarean delivery is defined as poor labour progress, secondary arrest, prolonged second stage, failed induction of labour and macrosomic baby. Whilst non-recurrent indications include foetal distress, malpresentation such as transverse or oblique lie, breech presentation, severe preeclampsia, placenta previa, and abruption placenta. Successful rates for women whose first caesarean delivery is performed for a nonrecurring indication (breech, non-reassuring foetal well-being) are similar to vaginal delivery rates among nulliparous women (6). Prior operative delivery for cephalopelvic disproportion (CPD)/failure to progress is associated with success rates ranging from 50% to 67% compared

to prior CS for breech presentation, which is associated high success rate of 89%. In a large multicentre study, VBAC were significantly lower following CS for CPD than for breech or foetal distress (7). Nevertheless, about two-thirds of women with a history of CS for CPD will achieve a successful vaginal delivery. Women with non-recurrent indications were statistically more likely to have successful trial of labour compared to those with recurrent indications. This could be due to the element of cephalon-pelvic disproportion, which reduces the likelihood of vaginal birth. Hence, they concluded that indication of previous CS is an important predictor of success of trial of labour (8).

#### 2.1.2 Birth weight after CS

Women who underwent CS for CPD may often be counselled to consider elective repeat CS if the estimated foetal weight in the current pregnancy is larger than that of the pregnancy that required CS. A birthweight of 4kg or more is associated with an increased risk of uterine rupture, unsuccessful VBAC, shoulder dystocia, and third- and fourth degree perineal laceration. For women with no prior vaginal delivery undergoing VBAC labour when neonatal birthweight is 4kg or higher, the VBAC success rate is reported as less than 50%. However, third trimester ultrasound is a poor predictor of macrosomia in decision making regarding VBAC (2). Nonetheless, 60% to 70% of women who attempt VBAC with macrosomic foetus are successful (9). Birthweight difference between first pregnancy (delivered by caesarean) and second pregnancy with attempted VBAC clearly influences successful rates. Concluding, pregnancy estimated foetal weight (EFW) of less than 3.5 kg at 36 weeks has a higher rate of VBAC (10).

#### 2.1.3 Cervical dilatation achieved before prior CS

Maximal cervical dilatations achieved prior to CS for CPD or for arrest disorder may be prognostic of future vaginal delivery rates. The arrest in the 'first stage' corresponding to 9 cm or less, and the arrest in the 'second stage' corresponding to full dilatation. A history of the arrest in the second stage is associated with a higher chance of VBAC, rather than the arrest

in the first stage, that is associated with 65% of success of VBAC. Women should not be discouraged from attempting VBAC solely based on the cervical dilatation achieved prior to CS in the previous pregnancy.

#### *2.1.4 History of failed trial of operative vaginal delivery before prior CS*

Those women that had had an emergency caesarean delivery in their first pregnancy have a lower VBAC success rate. Even though successful VBAC appears more likely among women with previous caesarean for dystocia at 8 cm or more compared with women with previous caesarean for dystocia at less than 8 cm. Several studies have shown that failed operative vaginal delivery resulting in CS is not an absolute contraindication to VBAC, in fact in a prospective cohort study (11) VBAC was successful in about 80%, in those women who had CS in the second stage of labour. The success rate for VBAC was high in women who had a prior CS due to an unsuccessful instrumental delivery.

#### *2.1.5 Number of previous CS*

Women with a history of two previous low transverse CS remain candidates for TOL. There is conflicting evidence regarding any increased risk of uterine rupture with TOL after more than one prior CS, but this factor does not seem to impact negatively on vaginal birth rates. Several studies have shown similar rates of VBAC success with two previous caesarean birth (VBAC success rate of 62-75%) and single prior CS, but it must be underlined that more than half of the women two previous caesarean deliveries had also had a previous vaginal birth and 40% had had a previous VBAC (2). Women who have undergone laparoscopic or abdominal myomectomy, particularly where the uterine cavity has been breached, are at increased risk of uterine rupture, while uterine rupture after hysteroscopic resection of uterine septum is considered a rare complication. These women should be considered to have delivery risks at least equivalent to those of VBAC and managed similarly in labour (2).

#### *2.1.6 Effect of prior vaginal deliveries*

Prior vaginal delivery, including prior successful VBAC, is the strongest predictor of a successful TOL and is protective against uterine rupture following TOL (12). The success increases when women had a prior VBAC (93%) rather than a vaginal delivery prior to the caesarean birth (85%). A history of vaginal delivery in addition to a CS would appear to be a positive indicator of success in subsequent TOL. The chance of success increases with the increasing number of prior vaginal deliveries. Mercer and 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) (13). The possible explanation for this is multiparous women will develop efficient uterine contractions in labour and will have less problem with cephalopelvic disproportion (CPD) (14). This suggests that a previous successful VBAC (15, 16) is the single best predictor of successful VBAC than a vaginal birth before the original CS (2, 17, 18).

#### *2.1.7 Type of previous CS scar*

The type of scar depends on the type of cut in the uterus: Low transverse: a side-to-side cut made across the lower, thinner part of the uterus. This is the most common type of incision and carries the least chance of future rupture. Low vertical: an up-and-down cut made in the lower, thinner part of the uterus. This type of incision carries a higher risk of rupture than a low transverse incision. High vertical: an up-and-down cut made in the upper part of the uterus. This is sometimes done for very preterm caesarean deliveries. It has the highest risk of rupture. There is insufficient evidence to support the safety of VBAC in women with previous inverted T or J incision, low vertical incision or significant inadvertent uterine extension at the time of primary caesarean. The risk of uterine rupture with classical incision or inverted T incisions is high as 12%. RCOG recommend that VBAC is contraindicated in women with previous classical caesarean delivery (2). The type of previous incision may not always be known, especially if the operation was performed in a different country. Although in several

previous studies, it has been shown that there are no statistically significant differences between the group of women with unknown scar types and the group with known low segment incisions, caution should be exercised in these women and decisions should be made case by case.

#### *2.1.8 Interpregnancy interval*

Interpregnancy interval was defined as time in months between caesarean in first pregnancy and the start of amenorrhea in next ongoing pregnancy. In women with one prior CS and no history of vaginal delivery, an interpregnancy interval of <2 years is non-associated with a reduced success rate of trial of labour after CS. The success rate is lower in intervals of >2 years. No association between adverse outcomes and interpregnancy interval was found (19). Short interpregnancy intervals are a risk factor for uterine rupture during TOLs. The incidence of rupture increases when inter-delivery interval of less than 18 months.

#### *2.1.9 Uterine closure technique*

Since the early 1990s, single-layer closure of the uterus has been frequently used by many obstetricians, but patients had two-layer closure of the uterine wall during their primary CS. A single-layer uterine closure technique is commonly used because it is associated with a shorter operating time and a short-term complication. It is possible that a single, continuous suture technique does not precisely approximate the tissues together because decidua can be included in the scar. Pathophysiology involved in the association of the single-layer closure technique and subsequent uterine rupture is not clear enough. Probably uterine rupture is thought to result from a biomechanical process, in which there is an imbalance between the tensile strength of the scar that maintains its integrity and the forces causing disruption (20). Several authors concluded that there were no statistically significant differences in maternal or foetal mortality in either group, single-layer or two-layer uterine closure (15).

#### *2.1.10 Presence of Müllerian anomalies*

Women with Müllerian duct anomalies according to the classification ESHRE/ESGE (21) such as, class I: dysmorphic uterus class III: dysfused uterus, class IV: unilaterally formed uterus, class V: aplastic/dysplastic uterus have significantly higher rates of CS mainly caused by foetal malpresentation. The outcome of VBAC in women with uterine malformations has been poorly studied. Foetal malpresentation is the major indication for primary and repeated CS in women with MA. Instead patients with Müllerian anomalies and foetal cephalic presentation who presents with spontaneous labour have an excellent prognosis for a successful VBAC; these patients have a significantly lower rate of failure to progress in the first stage of labour (22). The VBAC success rate is 37.6% for women with Müllerian anomalies and 50.7% for those with a normal uterus ( $P < .0009$ ). Therefore, the presence of an isolated maternal Müllerian anomaly has not been thought to constitute a contraindication to VBAC (23). Women with a uterine anomaly should be counselled that, based on the small amount of data available on their relatively rare condition, their risk of uterine rupture is low, but they may have an increased risk of failed TOLAC.

### *2.2 Factors associated with previous medical history*

Maternal demographics factors such as race, age, BMI, and insurance status have been demonstrated to impact the success of TOL. Younger women had highest success rate. Maternal age of 40 years or more is an independent risk factor for stillbirth and unsuccessful VBAC. In a multicentre study of 14,529 term pregnancies undergoing TOL, Caucasian women had an overall 78% success rate compared with 70% in non-Caucasian women such as African, American, Hispanic and other women. Married women, smokers, and those with private insurance all had a greater likelihood of successful TOL.

#### *2.2.1 Maternal obesity*

Maternal BMI is classified as underweight (<19.8 kg/m<sup>2</sup>), normal (19.8-24.9 kg/m<sup>2</sup>), overweight (25-29.9 kg/m<sup>2</sup>), or obese (≥30 kg/m<sup>2</sup>).

Durnwald et al. was seen that VBAC success had decreased in obese (54.6%) but not overweight (65.5%) women compared women of normal BMI (70.5%). Women with a normal BMI had higher rates of VBAC success than overweight women. To determine whether change in weight between pregnancies impacts whose BMI classifications changed, they had evaluated women whose BMI classification changed before the second pregnancy. When overweight women lost weight achieving a normal BMI before the second pregnancy, there was no significant improvement in rates of successful vaginal delivery during a subsequent trial of labour. However, women of normal BMI before the first pregnancy who became overweight (BMI >25 kg/m<sup>2</sup>) before the second pregnancy had a significant reduction in VBAC success compared with those women whose BMI remained normal between pregnancies. It is possible that adiposity accrued when a woman was overweight may not decrease enough to increase her likelihood of VBAC success comparable to those women who have always had a normal BMI. This adiposity may be disproportionately distributed in the pelvis and may alter a woman's pelvimetry, thus increasing the likelihood of dystocia. Increasing pre-gravidic BMI and weight gain between pregnancies reduce VBAC success. In the other study, Gupta S. et al., in a prospective observational study included 100 women with previous CS in the study group and 100 primigravidas in the control group. Various predictors of success were analysed including pre-pregnancy BMI. These support that there is a highly significant relation between BMI and success of trial of labour after previous caesarean delivery (19). Hence, maternal obesity may be a negative predictor of successful vaginal delivery (2, 15, 16, 24, 25). Women with increased BMI clearly experience decreased VBAC success rates.

### 2.2.2 Diabetes mellitus

Diabetic pregnancies are at increased risk for Caesarean delivery secondary to failed induction of labour, arrest of labour, foetal intolerance of labour, and foetal macrosomia (estimated foetal weight >4000 g). Diabetes complicates 2% to 3% of pregnancies. Several studies have been conducted and these data show that diabetes mellitus is associated with a reduced chance of

successful vaginal delivery, both in comparison to non-diabetic women attempting VBAC, and diabetic women without uterine scars undergoing a TOL. However, reported success rates suggest that attempting VBAC in a select population of women with diabetes mellitus remains a reasonable option (6, 26, 27, 28).

## 2.3 Factors associated with current pregnancy

### 2.3.1 Macrosomia

Foetal macrosomia is a difficult diagnosis to make. There was a 'U'-shaped relationship between birthweight and the error of ultrasound estimation of foetal weight, in which the error in birthweight estimation increases for both low and high birthweight foetuses. In fact, for foetus greater than 4500g, the sensitivity and specificity of ultrasound decreases. Hence, third trimester ultrasound is a poor predictor of macrosomia on decision making regarding VBAC. In relation to VBAC labour, birthweight of 4 kg or more is associated with an increased risk of uterine rupture and unsuccessful VBAC. In women with no prior vaginal delivery undergoing VBAC when there is a suspicion of macrosomia, the VBAC success rate was less than 50% (2). Society of Obstetricians and Gynaecologists of Canada (SOGC) states that labour and vaginal delivery are not contraindicated with estimated foetal weights of up to 5000g, in absence of maternal diabetes. Suspected foetal macrosomia is not a contraindication to a TOL after CS.

### 2.3.2 Twin pregnancy

Women with twin gestation and one previous low transverse scar caesarean section are candidates for TOLAC. Moreover, two analyses of large populations found that women with twin gestations had a similar likelihood of achieving VBAC as women with singleton gestations as well as outcomes are similar to singletons (29).

### 2.3.3 Breech presentation

Women with a prior caesarean who are carrying a breech in the current pregnancy have similar rates of

successful breech versions as mothers without a uterine scar. A mother with a prior caesarean birth can elect to have a version for breech this time to avoid a caesarean. External cephalic version for breech presentation is not contraindicated in women with a prior low-transverse uterine incision who are candidates for external cephalic version and TOLAC. Moreover, the likelihood of successful external cephalic version has been reported to be similar in women with and without a prior caesarean delivery.

#### *2.3.4 Post-dates pregnancy*

Studies evaluating the association of gestational age with VBAC outcomes have consistently demonstrated decreased VBAC rates in women who undertake TOLAC beyond 40 weeks of gestation. Although the likelihood of success may be lower in more advanced gestations, gestational age greater than 40 weeks alone should not preclude TOLAC (24). A logistic regression analysis indicated that gestational age >40 weeks was an independent predictor of caesarean section (30). Trial of Labour for VBAC is a reasonable course of action if labour begins spontaneously after the due date, because the risk of uterine rupture is significantly higher with induction of labour. Hence, plans to pursue VBAC need not to be changed simply because the due date has passed. The NICE induction of labour guidelines recommend induction of labour from 41 weeks, as this reduces perinatal mortality without an increase in caesarean delivery rates, but a few data recommend whether this approach is equally valid in women with previous caesarean delivery. Thus, likelihood of successful VBAC on clinical and cervical assessment at the time to admission.

#### *2.3.5 Preterm VBAC*

Whereas postdates have been associated with a no statistically significant decrease in VBAC success, prematurity has been associated with an increase in VBAC success rate. Some studies, including NICHHD study, show that VBAC success rates for preterm and term pregnancies were similar. Perinatal outcomes were similar with preterm VBAC and preterm elective repeat CS (ERCS) as well as the rates of uterine

rupture and dehiscence were significantly lower in preterm compared with the term VBAC (31).

#### *2.4 Labour status and cervical examination*

Labour status and cervical examination on admission influence VBAC success. Those women who were admitted after rupture of membrane at active first stage of labour and having occipito-anterior position had a higher chance of vaginal delivery than those with occipito-posterior and occipito-transverse position, or unknown position. Presence of meconium stained liquor and labour stay lasting more than four hours after admission were associated with high failure rate of VBAC. The stronger factor determining success was cervical dilatation at admission. Those who were admitted with cervical diameter greater than 3 cm (active first stage of labour) had a strong likelihood of vaginal delivery than those admitted at cervical diameter of less than or equal to 3 cm (latent first stage of labour). Hence a favourable initial pelvic examination, consisting of cervical dilation >1 cm, cervical effacement >50% or station -1 or lower. Women who laboured spontaneously, had higher percentage of successful VBAC than those who underwent induction of labour (2, 9, 14, 32). Oxytocin augmentation had lower rate of successful VBAC rather than any intervention and may be associated with uterine rupture. Favourable Bishop's score on admission was the strongest and most significant predictor for successful vaginal birth after caesarean section and the chances of vaginal delivery after previous caesarean section improve as the Bishop's score at the time of admission increase (8). Therefore, the chance of VBAC for an individual varies based on demographic and obstetric characteristics.

#### *2.5 The role of vaginal birth after caesarean delivery prediction models*

Several pre-admission and admission-based multivariate models have been published to predict the individualised likelihood of VBAC success. Several studies have been conducted about the association between second trimester cervical length and VBAC. Furthermore, studies have been conducted to understand the role of ultrasonographic assessment of myometrial scar

thickness to predict VBAC success and uterine scar rupture. Moreover, predictive models have been created to predict the likelihood of a successful trial of labour after caesarean delivery. The probability that a woman attempting TOLAC will achieve VBAC depends on her individual combination of factors. Several investigators have attempted to create scoring systems to assist in the prediction of VBAC, but most have had methodologic limitations and have not been used widely. However, one model was specifically developed for women undergoing TOLAC at term with one prior low-transverse caesarean delivery incision, singleton pregnancy, and cephalic foetal presentation. This model uses information that is available at the first prenatal visit to generate the predicted probability that a VBAC will be achieved if TOLAC is undertaken. Predicted probability for VBAC is based on a multivariable logistic regression model that includes maternal age, BMI, race, prior vaginal delivery, history of a VBAC, Bishop's score and indication for prior caesarean delivery (15). Prediction of TOLAC success at the time of admission was highly dependent on the initial cervical examination (33, 34). This model, as well as one that provides the probability of VBAC after TOLAC using information that is not available until the admission for delivery, may have utility for patient education and counselling for those considering TOLAC at term. Although such a calculator may provide more specific information about the chance of VBAC, which can be used by health care providers and their patients to further the process of shared decision making, no prediction model for VBAC has been shown to result in improved patient outcomes. By using a proposed mean score of 4 out of 7, the scoring system had a sensitivity of 81%, specificity of 52.3% and a positive predictive value of 84.6%. Grobman and colleagues (35) as early as 2007 created a simple nomogram using factors available at the first prenatal visit. These predictive nomogram incorporates six variables including history of successful VBAC, value not included in the other models because according to some authors it is highly probable that these women would reattempt VBAC regardless of counselling. The investigators concluded that the nomogram was accurate and discriminating, and was a potentially useful tool for patient-specific rates of success and that the

MFMU VBAC prediction model validated in women with one prior caesarean delivery also accurately predicts the likelihood of successful TOLAC in women with two prior caesarean deliveries (36).

### ***2.6 The role of vaginal birth after caesarean delivery second trimester cervical length***

Several studies have provided evidence that cervical length and its changes begin in the midtrimester. It can be established sonographically and it has relevance for pregnancy outcomes, but does not significantly improve the clinical value of a previously developed validated VBAC prediction model. Women have been undergoing transvaginal ultrasound between 18 and 24 weeks. A cut off of Cervical Length (CL) of 45 mm has been established and more women with CL < 45 mm had successful VBAC compared to women with long CL. Prior vaginal delivery and CL < 45mm were both significant predictor of VBAC. Hence, shorter midtrimester CL is associated with a greater chance of vaginal birth after TOLAC (36, 37).

### ***2.7 Sonographic assessment of lower uterine segment thickness***

Three layers of the lower uterine segment (LUS) can be identified on ultrasound: the chorion amniotic membrane with decidualized endometrium, the middle muscular layer, and the uterovesical peritoneal reflection juxtaposed with muscularis and mucosa of the bladder. Full thickness is defined as the distance between the bladder wall and the amniotic cavity, while myometrial thickness is defined as the minimum thickness overlying the amniotic cavity at the level of the uterine scar. The measurement of LUS thickness antenatally in women with a previous caesarean delivery, could be used to predict the occurrence of a uterine defect, scar dehiscence or scar rupture, in women undergoing VBAC. Uterine scar dehiscence is defined as a loss of continuity of the myometrial layer without the complete rupture of the LUS, also called uterine 'window'. Uterine rupture is defined as a complete separation of the uterine scar resulting in a communication between the uterine and peritoneal cavities (38). Several studies were conducted to evaluate the

reliability of bidimensional and tridimensional ultrasonographic measurement of the thickness of LUS in pregnant women by transabdominal and transvaginal approaches LUS measurement by transabdominal approach must be performed with the women with full bladder, placing one cursor at the urine-bladder interface and the other at the decidua-amniotic fluid interface. Transvaginal approach measuring the LUS muscular layer, one cursor must be positioned at the bladder-muscular interface and the other at the muscular-decidua interface. Secondly, a volumetric acquisition must be performed for a tridimensional reconstruction. Finally, the authors conclude that Transvaginal approach is more reliable the entire LUS thickness measured compared to transabdominal approach (39). A myometrial thickness cut-off of 2.1–4.0 mm provided a strong negative value for the occurrence of a uterine defect during VBAC, whereas a myometrial thickness cut-off between 0.5 and 2.0 mm provided a strong positive predictive value for the occurrence of a uterine defect (2, 38, 39). However, there is not an ideal LUS thickness cut-off value to be used in clinical practice, but these researches support the use of antenatal LUS measurement in the prediction of a uterine defect in women undergoing VBAC. Therefore, based on the evidence, the thickness of LUS measured by transabdominal and transvaginal sonography can successfully predict the risk of scar rupture and remain the gold standard. But several studies confirm that this is not only viable predictor of rupture because composition of the scar tissue may also play a significant role in the occurrence of scar dehiscence. Magnetic resonance (MR) is another imaging modality that has a well-established role in studying the female pelvis, especially at high field strengths. MR with diffusion tensor imaging (MR-DTI) and fibre tracking reconstruction is a novel non-invasive imaging technique that could characterise tissue morphology by measuring the amount of random diffusion of water molecules throughout the tissue and is known to have the best soft tissue contrast resolution. Fiocchi et al. shows that the majority of the uteri with a Caesarean scar have altered orientation of fibers in the anterior isthmus compared to non-scarred myometrium. A significant difference between the two methods, transvaginal-ultrasound and 3t-MR, was found in

the measurement of the myometrial thickness at the scar level. We suggest that 3T-MR could provide a more accurate and reliable measurement than TVUS, as the spatial resolution of the image is much higher. Upstream of the scar, TVUS measurements reported a significantly thinner myometrial layer compared to 3T-MR. Hence, MRI can be used to predict scar dehiscence and rupture (40, 41). However, the quantitative data of MRI added to morphological evaluation could help the gynaecologist predict later complications of CS, and the identification of those women who could attempt VBAC (41).

## Conclusion

It has been demonstrated that women who undergo successful VBAC have lower short-term and long-term morbidity. Conversely, women who are unsuccessful following TOLAC have the highest morbidity. For this reason, Trial of labour after CS should be considered in women who have no contraindications that are relatively few, classical or T-shaped uterine incision after appropriate discussion. Identifying the best candidates using factors available to the obstetrician can increase VBAC success rate and minimize maternal morbidity. Multiple previous CS, Müllerian anomalies, maternal obesity, maternal diabetes and a short interdelivery interval are negative predictors of successful VBAC, while a non-recurrent indication for previous caesarean section, one prior vaginal birth and a spontaneous labour are positive predictor of successful VBAC. So, concluding is important individualize the risk estimation for each patient in order to make the VBAC a safe choice.

**Conflict of interest:** Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article

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