

**UNIVERSITY RESEARCH DOCTORATE (PhD) THESIS**

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**EFFECT OF HIGH BODY MASS INDEX, INCREASED WEIGHT GAIN  
AND SINGLE- VERSUS-DOUBLE LAYER UTERINE INCISION  
CLOSURE ON SUCCESS OF VAGINAL BIRTH AFTER CESAREAN  
DELIVERY**

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DEPARTMENT OF OBSTETRICS AND GYNECOLOGY  
DEBRECEN 2008**

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## I. INTRODUCTION

Cesarean section is the most frequently performed abdominal operation in present days although its indication has changed a lot in the past 100 years. While the operation historically has been performed largely to protect the health of the mother, more recently the health of the fetus has played a larger role in decisions to go to surgery. Before the 1970s, *Cragin's* dictum „once a cesarean, always a cesarean” guided obstetric practice in the United States and worldwide, as well. In the 1970s the overall cesarean section rate was about 5% in the world. As techniques such as a low transverse scar, that increased the safety of cesarean delivery were used more often, new features of fetal monitoring and ultrasound diagnostics were introduced and medico-legal pressures on physicians increased, indication for cesarean birth were liberalized. After declining for many years in the 1990s the cesarean rate peaked at 28% in 2006, the highest percentage ever reported in the USA. During the last three decades several efforts were made in order to stop this drastically increasing tendency. Vaginal birth after Cesarean (VBAC) has been successfully practiced since the late 1950s. Large multicenter trials have shown that the average success rate is between 60% and 80% in appropriate candidates, with decreased hospital stays and complication rates in the VBAC group. In the past decade the popularity of VBAC has vanished due to the extended discussion that has turned toward adverse maternal and neonatal outcome related to uterine rupture during trial of labor after a previous cesarean. Although we are still trying to identify which factors are associated with VBAC success, there is little information available regarding obesity.

Excessive weight gain and obesity have an increasing relevance in obstetrics. WHO now accepts a body-mass index (BMI) of 25 kg/m<sup>2</sup> or higher as abnormal; the overweight category is classified as obese when the BMI is 30 kg/m<sup>2</sup> or more. The risks of diabetes, hypertension, dyslipidaemia and coronary heart disease increase from a BMI about 21 kg/m<sup>2</sup>, thereby reducing life expectancy and greatly increasing the health and societal economic burden. At present at least 1.1 billion adults are overweight in the world including 312 million who are obese. Thus, it is clear that obesity is of special concern for women who are pregnant or who plan to become pregnant. Overweight and obesity have long been known to complicate pregnancy and are associated with increased risk for pregnancy-induced hypertension, preeclampsia and gestational diabetes, as well as anesthesia-related risks, should the woman undergo surgery. Among these women the incidence of cesarean delivery increases while VBAC success decreases.

Although the effectiveness and success of VBAC can not be questioned, there is still no randomized controlled trial conducted about maternal and perinatal outcome on VBAC vs. elective repeat cesarean delivery. More information is available in the literature about risks and side effects of VBAC, but there is a paucity of reports on the management of subsequent pregnancy among obese women with a prior cesarean delivery.

## **II. OBJECTIVES**

Using a chart and logbook review on labor and delivery from January 1, 1996, to December 31, 2000 at the Department of Obstetrics, Gynecology and Reproductive Science at the Mount Sinai Medical Center (New York, USA) I analyzed the VBAC cases with regard to the followings:

1. Does excessive weight gain during pregnancy and high body-mass index effect on success of vaginal birth after Cesarean delivery?
2. How does a previous successful VBAC affect on trial of labor in the subsequent pregnancy?
3. Does the one- or two-layer uterine incision closure affect uterine rupture rate in the subsequent pregnancy during VBAC?

## **II. MATERIALS AND METHODS**

A chart review using International Classification of Diseases, 9th Revision (ICD-9) codes “VBAC” and “non-primary C-section” and review of logbooks on labor and delivery from January 1, 1996, to December 31, 2000, identified patients attempting VBAC at Mount Sinai Medical Center, a tertiary care referral center.

We identified 1,741 patients from ICD-9 codes. An additional 184 cases were identified from the logbooks. Thus, a total of 1925 patients were identified for possible inclusion. Exclusion criteria included multiple gestation, more than one previous cesarean delivery, previous uterine scar other than low transverse, malpresentation in the current

pregnancy, presence of an intrauterine fetal demise, delivery at less than 36 weeks of gestation (36 0/7 weeks), and incomplete information for a patient. Using these criteria, 709 patients were excluded. In addition, only 3 patients were excluded because their prepregnancy weight data were not in their charts. Height was documented for all patients. After excluding these patients, the total number available for analysis was 1213. Patients were divided into the following groups: underweight (BMI<19.8), normal weight (BMI 19.8–26), overweight (BMI 26.1–29), and obese (BMI>29) based on the categories described by the Institute of Medicine. Each patient was assigned to a BMI group based on her prepregnancy weight. Excessive weight gain was defined as a weight gain of more than 40 lb, based on the maximum amount of weight gain for underweight patients suggested by the Institute of Medicine. Pregnancy weight gain was defined as the difference between the prepregnancy weight (data provided by the patient) and the weight at the last prenatal visit. Variables of interest included diabetes, previous successful VBAC, previous successful normal spontaneous vaginal delivery, history of gestational or pregestational diabetes, birth weight, labor induction, and the presence of a recurrent indication for cesarean delivery. Nonrecurrent indications for cesarean delivery included malpresentation, nonreassuring fetal heart tracing, elective primary cesarean delivery, macrosomia, placenta previa, placental abruption, cord prolapse and active herpes simplex virus infection. Recurring indications included cephalo-pelvic disproportion and failure to progress (dilatation and/or descent). Complications included maternal chronic medical conditions, intrauterine growth restriction, preeclampsia/eclampsia, oligo/polyhydramnios, preterm labor, and placenta previa. The majority of inductions were performed with prostaglandins.

Until 1999, misoprostol was regularly used for induction at the institution in previously scarred uteri. Oxytocin was the other commonly used induction agent. Birth weight was categorized as either 4,000 grams or more or less than 4,000 grams. Uterine rupture was defined as a symptomatic, complete separation of the previous uterine scar, with extrusion of fetal parts into the peritoneal cavity.

2. In the second study I tried to analyze whether a history of a previous successful vaginal birth after cesarean delivery has an affect on a subsequent VBAC attempt. Patient selection, inclusion and exclusion criteria were the same as mentioned above.

3. Due to the large attention paid by medical and lay literature on potentially serious maternal and fetal morbidity and mortality following uterine rupture, I was eager to know the incidence

of uterine rupture in our population. I also analyzed the connection between uterine rupture and single- vs. double-layer closure of the uterine incision.

Statistical analysis was performed with  $\chi^2$  or Fisher exact tests for the dichotomous variables. The Student *t* test was used for continuous variables. Analysis of variance in means was performed with analysis of variance testing. Univariate and multivariable logistic regression analyses were then performed to evaluate predictors of VBAC success. Finally, linear regression determination of a Pearson correlation coefficient was performed to examine the relationship between BMI and VBAC success.

These studies were approved by the Mount Sinai Institutional Review Board.

#### **IV. RESULTS AND DISCUSSION**

1. In the first study I identified 1213 patients who met inclusion criteria. The percentage of patients within the BMI categories of less than 19.8, 19.8-26.0, 26.1-29.0, and greater than 29.0 were 13.2%, 58.9%, 11.3%, and 16.6%, respectively. Our patients were similar in their gestational age of delivery, indication for the previous cesarean delivery, percentage with a previous successful VBAC, and percentage undergoing induction. Some notable, yet expected, differences were that the overweight and obese patients were more likely to have gestational or pregestational diabetes (16.0% and 20.0% versus 4.0% and 6.0% in the underweight and normal weight groups, respectively,  $P < 0.001$ ), and the birth weights of their infants were greater than those in the normal weight and underweight patients.

Overall, the VBAC success rate was 77.2%. The VBAC success rates for each BMI category, from less than 19.8 to greater than 29.0 were 83.1%, 79.9%, 69.3%, and 68.2%, respectively,  $P < 0.001$ . The prepregnancy BMI was similar in those who succeeded or failed at VBAC ( $24.1 \pm 5.2$  and  $25.8 \pm 5.6$ , respectively,  $P = 0.71$ ). However, the BMI at the time of the delivery was significantly higher in those who failed VBAC ( $31 \pm 5.9$ ) than in those who were successful ( $29.0 \pm 4.9$ ,  $P < 0.001$ ). When controlling for previous normal spontaneous vaginal delivery, previous VBAC, indication for previous cesarean delivery, birth weight, and diabetes, those patients with a BMI greater than 29 were still almost 50% less likely to have VBAC success than their underweight counterparts (odds ratio [OR] 0.53, 95% confidence interval [CI] 0.29–0.98,  $P = 0.043$ ).

With respect to pregnancy weight gain, the VBAC success rate was 79.1% for those who gained less than 40 lb and 66.8% for those who gained more than 40 lb during the pregnancy,  $P<0.001$ . Patients who gained more than 40 lb were almost 40% less likely to be successful at VBAC than those who gained less than that amount (OR 0.63, 95% CI 0.42–0.97,  $P=0.034$ ). A history of a previous normal spontaneous vaginal delivery (OR 2.28, 95% CI 1.51–4.52,  $P=0.018$ ) or a previous VBAC (OR 6.32, 95% CI 3.46–11.55,  $P<0.001$ ) were the 2 factors predictive of success for those women who gained more than 40 lb. Those who were successful at VBAC gained significantly less weight than those who failed VBAC ( $29 \pm 10.1$  lb and  $31.4 \pm 12.7$  lb, respectively,  $P<0.005$ ). There were fewer patients who gained more than 40 lb in the successful VBAC group (13.6%) than in the failed VBAC group (22.7%,  $P<0.001$ ). Although there were more uterine ruptures in the group that gained more than 40 lb (2.1% versus 1.5%), this difference was not statistically significant,  $P=0.515$ .

Although an inverse association was noted with BMI and VBAC success, when the 4 BMI categories were included in a multivariable regression analysis that controlled for excessive weight gain, we found that it was the weight gain specifically that decreased VBAC success (OR 0.65, 95% CI 0.42 – 0.98,  $P=0.042$ ). Also, those patients whose prepregnancy BMI was greater than 29 showed a trend toward decreased VBAC success (OR 0.54, 95% CI 2.93–1.01,  $P=0.053$ ).

Our data show that obese patients and those who gain more than 40 lb during the pregnancy are less likely to have VBAC success. For the first time we looked at patients who had excessive weight gain during the pregnancy. We have demonstrated that an inversely proportional relationship exists between VBAC success rates and prepregnancy BMI. However, those in the obese category had a 68.2% success rate, even although they are 50% less likely to succeed when compared with underweight patients. Similarly, patients who gained more than 40 lb in the pregnancy had a 66.8% VBAC success rate, although they were almost 40% less likely than those who gained a normal amount of weight to be successful. When the weight gain during the pregnancy was evaluated in conjunction with the pregnancy BMI, it was actually the weight gain that made patients less likely to have VBAC success. However, when comparing the success rates of those who gained more than 40 lb, or of obese patients, with the traditionally quoted VBAC success rate of 60–80%, they are within an acceptable range.

Given the known risks associated with attempting VBAC, patient selection to optimize VBAC success and minimize complications becomes of paramount importance. Although obese candidates may succeed, they do so with longer labors, increased complication rates,

and a baseline increased risk for cesarean. Obesity is not a contraindication for VBAC, but obese patients need appropriate counseling to understand the risks of attempting a vaginal trial after previous cesarean.

2 A patient who has had a previous VBAC is regarded differently when she attempts a second VBAC from someone without this history. The commonly held notions are that she is more likely to be successful and less likely to rupture her uterus. Others come to the opposite conclusion and say that these patients are less likely to succeed because they are more likely to rupture since the scar has been labored before. Neither of these views has been supported (or refuted) by the current literature.

The purpose of this part of my work was to identify factors associated with successful VBAC and, specifically, to evaluate VBAC outcomes in patients with a previous successful VBAC. We identified 1216 patients who met inclusion criteria. Overall, the VBAC success rate was 77.1% (938/1216). Of those patients with a history of one or more previous successful VBAC attempts, 94.6% (318/336) had a subsequent successful VBAC. This is significantly higher than the 70.5% (620/880) VBAC success rate for those patients without a history of prior successful VBAC ( $P < 0.001$ ). For those patients with a previous successful normal spontaneous vaginal delivery, 87.8% had a successful VBAC, whereas only 75.6% were successful without this history ( $P = 0.001$ ). Patients with a history of previous VBAC were 7 times more likely to have a subsequent VBAC success (OR 7.40, 95% 4.51–12.16;  $P < 0.001$ ) than those who did not.

The overall uterine rupture rate was 1.56%. There was no significant difference in the rate of uterine rupture in the previous VBAC group compared with those without this history, 0.60% versus 1.93%, respectively ( $P = 0.093$ ). However, the uterine rupture rate was nearly 10 times higher in the unsuccessful VBAC group than in the successful VBAC group (5.4% vs 0.5%;  $P < 0.001$ ). This is likely because once uterine rupture was suspected the patients were taken immediately for cesarean delivery. In this series there were no fetal deaths noted once a uterine rupture had occurred.

Our study sought to determine which factors in the maternal history would make VBAC success more likely and found that a history of a previous VBAC made it 7 times more likely to have a successful VBAC. Most experts agree that an important benefit of VBAC is elimination of the need for major surgery. It allows patients wanting large families to have multiple deliveries without the potential for multiple repeat cesareans. Women planning further pregnancies avoid the risks of placenta accreta, increased chances of uterine rupture,

and the morbidity related to multiple abdominal surgeries that repeated cesarean deliveries can bring. The incidence of postpartum infection, need for transfusion, maternal length of stay, and cost are all significantly reduced with VBAC. However, when elective repeat cesarean delivery was compared with cesarean delivery after failed trial of labor, the patients who failed attempted VBAC had the highest morbidities.

Recently, the risks of VBAC to the fetus have been readdressed. One large retrospective trial looking at over 20,000 women with a second delivery after cesarean delivery showed an 11-fold increase in fetal mortality once the uterus ruptured. Although the absolute number was 5 fetuses (or 5.5% of all uterine ruptures), the question of acceptable risk thresholds arose.

Our study evaluated those patients who have had a successful VBAC in an attempt to determine those factors that increase the likelihood of this outcome. We found that a history of a previous VBAC makes a patient 7 times more likely to repeat that success in a future attempt. This outcome was better than that for patients who had just had a previous normal spontaneous vaginal delivery alone. However, when all of the variables were controlled for in the logistic regression model, a history of a previous successful normal spontaneous vaginal delivery no longer significantly influenced future VBAC outcome. An analysis of the data showed that once a patient had a recurrent indication for cesarean delivery, the history of a previous normal spontaneous vaginal delivery no longer led to VBAC success. Induction of labor also had no effect on VBAC outcome. A birth weight of more than 4,000 grams also significantly impacted VBAC success and was independent of the presence of gestational or pregestational diabetes.

With the risks and benefits of vaginal birth after cesarean delivery being debated in both the scientific and the lay literature, we have attempted to re-evaluate VBAC outcomes by looking for factors to prognosticate success. Not all women with a previous low-transverse cesarean delivery make good candidates for VBAC. Identifying which women will be successful can help to decrease perinatal morbidity and mortality. Our data clearly shows that women who have had a previous successful VBAC, those who had a previous cesarean delivery for a nonrecurring indication, and those whose fetuses weighed less than 4,000 grams at delivery are more likely to have successful VBAC attempts. Furthermore, although a history of a previous spontaneous vaginal delivery was a strong indicator for VBAC success, the opposite effect of having a recurrent indication for cesarean delivery weighed more strongly on VBAC outcome. These findings should aid the physician in counseling patients who are considering VBAC.

3. The purpose of this part of my investigation was to evaluate whether single- as opposed to double-layer closure of the uterine scar is associated with an increased risk of uterine rupture in the subsequent pregnancy. Uterine rupture was defined as complete separation of the previous uterine scar, with extrusion of fetal parts into the peritoneal cavity. Single-layer closure was defined as one continuous, locked layer of the lower segment incision. With a double-layer closure, the initial layer was closed in a running, locked fashion and the second layer was a continuous, imbricating layer.

We identified 948 patients who met the inclusion criteria. Of those, 913 patients had a double-layer closure and 35 had a single-layer closure of the previous uterine incision. Although there was a difference in the rates of induction in the two groups, 28.6% in the single-layer group versus 45.0% in the double-layer group, this did not reach statistical significance,  $P=0.06$ . The only difference amongst the two groups, aside from uterine rupture rates, was the time interval to subsequent delivery. The single-layer group waited an average of  $26.4\pm 14.7$  months between deliveries while the double-layer group had an interval of  $38.6\pm 22.2$  months,  $P=0.001$ .

Of those patients with a single-layer closure, 8.6% (3/35) had a uterine rupture compared to 1.3% (12/913) in the double-layer closure group ( $P=0.015$ ). Although the single-layer group had a shorter interval to delivery, when time interval was controlled for in a logistic regression model, uterine rupture remained significantly elevated in the single-layer group (OR 7.20, 95% CI 1.81–28.62,  $P=0.005$ ). Overall, the uterine rupture rate was 1.6%. When combining the effects of a previous VBAC, previous NSVD, induction, birth weight  $\geq 40000$  g, body mass index BMI $>29$  and a time interval to delivery of  $>19$  months in a logistic regression model, those patients with a single-layer closure were now eight times more likely to have uterine rupture (OR 8.01, 95% CI 1.96–32.79,  $P=0.004$ ).

Uterine rupture is a serious and potentially fatal complication of attempting a VBAC delivery. Because of the potential morbidities of uterine rupture, recent literature has sought to identify those patients likely to have VBAC success. Some authorities have evaluated the number of layers used to close the uterine incision both to decrease the likelihood for uterine rupture and to improve VBAC success. Traditionally, uterine incision closure has been described in two layers with No. 0 or No. 1 absorbable suture. Changes in practice patterns followed, and single-layer uterine closure became commonplace.

Our study showed that uterine rupture was more likely in patients whose uteri were closed with one layer. Our rate appears higher than the commonly quoted rates of 0.2 to 1.5%. We hypothesize that the high uterine rupture rate is secondary to the routine use of

misoprostol for induction of labor before 1999. This finding persisted when controlling for previous VBAC, induction, birth weight >4000 grams, delivery interval >19 months, and BMI>29. In order to satisfactorily answer the question of number of layers and type of suture ideal for closing the uterine scar to optimally decrease the rate of uterine rupture in the subsequent pregnancy, a randomized controlled trial looking at all these variables must be undertaken.

## V. SUMMARY

Cesarean section is one of the most frequently performed abdominal operations nowadays. As techniques such as low transverse scar, that increased the safety of cesarean delivery were used more often, new features of fetal monitoring and ultrasound diagnostics were introduced and medico-legal pressures on physicians increased, indications for cesarean birth were liberalized. After declining for many years in the 1990s the cesarean rate peaked at 30,3% in 2005, the highest percentage ever reported in the USA. In the past three decades a lot of efforts have been made both on national and international levels in order to stop this tendency. VBAC is an ideal and safe method in decreasing high cesarean section rates, but unfortunately the popularity of this method has been drastically dropped down due to the reason of publications on uterine ruptures.

Excessive weight gain and obesity have an increasing relevance in obstetrics. As the modernized nations' fastest growing epidemic obesity is having devastating effects on multiple fronts: it exacerbates existing illnesses, increases the risk of developing others, and poses a severe health threat for generations to come. Overweight and obesity have long been known to complicate pregnancy and are associated with increased risk for pregnancy-induced hypertension, preeclampsia and gestational diabetes, as well as anesthesia-related risks, should the woman undergo surgery. Among these women the incidence of cesarean delivery increases while VBAC success decreases.

In my study I emphasized that obese patients and those who gain more than 40 lb during the pregnancy are less likely to have VBAC success. I have demonstrated that an inversely proportional relationship exists between VBAC success rates and prepregnancy BMI. We also found that a history of a previous VBAC makes a patient 7 times more likely to repeat that success in a future attempt. The data clearly shows that women who have had a previous successful VBAC, those who had a previous cesarean delivery for a nonrecurring indication, and those whose fetuses weighed less than 4,000 grams at delivery are more likely to have successful VBAC attempts. I also showed that uterine rupture is much more likely to happen in patients whose wound was closed in a single-layer fashion during the previous operation.

Given the known risks associated with attempting VBAC, patient selection to optimize VBAC success and minimize complications becomes of paramount importance. Although obese candidates may succeed, they do so with longer labors, increased complication rates, and a baseline increased risk for cesarean. Obesity is not a contraindication for VBAC, but obese patients need appropriate counseling to understand the risks of attempting a vaginal trial after previous cesarean.

### **List of original publications related to the dissertation**

Gyamfi C, **Juhasz G**, Gyamfi P, Blumenfeld Y, Stone JL.  
Single- versus double-layer uterine incision closure and uterine rupture.  
*J Matern Fetal Neonatal Med* 2006;19:639-43.

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**Juhasz G**, Gyamfi C, Tocce K, Stone JL. BMI and excessive weight gain affect VBAC  
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