Effect of Birth Weight on Adverse Obstetric Outcomes in Vaginal Birth After Cesarean Delivery

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OBJECTIVE: To estimate the association between neonatal birth weight and adverse obstetric outcomes in women attempting vaginal birth after cesarean.

METHODS: We reviewed the medical records of all women undergoing a trial of labor after a prior low transverse cesarean delivery in our institution between 1987 and 2004. Patients were categorized according to birth weight (less than 3,500 g [group 1, reference], 3,500–3,999 g [group 2], and 4,000 g or more [group 3]) and prior vaginal delivery. The rates of failed trial of labor, uterine rupture, shoulder dystocia, and third- and fourth-degree perineal laceration were compared among groups. Multivariable logistic regressions were performed to adjust for potential confounding factors.

RESULTS: Of 2,586 women, 1,519 (59%), 798 (31%), and 269 (10%) were included in groups 1, 2, and 3, respectively. Birth weight was directly correlated to the rate of failed trial of labor (19%, 28% ,and 38% for groups 1, 2, and 3, respectively; $P<.01$), uterine rupture (0.9%, 1.8%, and 2.6%; $P<.05$), shoulder dystocia (0.3%, 1.6%, and 7.8%; $P<.01$), and third- and fourth-degree perineal laceration (5%, 7%, and 12%; $P<.01$). After adjustment for confounding variables, birth weight of 4,000 g or more remained associated with uterine rupture (odds ratio [OR] 2.62, 95% confidence interval [CI] 1.001–6.85), failed trial of labor (OR 2.47, 95% CI 1.82–3.34), shoulder dystocia (OR 25.13, 95% CI 9.31–67.86), and third- and fourth-degree perineal laceration (OR 2.64, 95% CI 1.66–4.19).

CONCLUSION: Birth weight and specifically macrosomia are linked with failed trial of labor, uterine rupture, shoulder dystocia, and third- and fourth-degree perineal laceration in women who underwent prior cesarean delivery. Estimated fetal weight should be included in the decision-making process for all women contemplating a trial of labor after cesarean delivery.

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LEVEL OF EVIDENCE: II

The rate of cesarean delivery has continued to increase worldwide in recent decades,[1] reaching 25.6% in Canada in 2005, whereas the rates of vaginal birth after cesarean (VBAC) have steadily decreased.[1,2] Current trends are partially attributed to concerns about the safety of VBAC, including the risk of uterine rupture as well as potential maternal and neonatal morbidities related to failed trial of labor.[3,4] However, successful trial of labor has been associated with lower rates of maternal and neonatal morbidities when compared with cesarean delivery.[5,6] Therefore, it is important to improve the selection of women with better chances of successful VBAC and low risk of adverse outcomes, including uterine rupture.

Fetal macrosomia has been linked with several adverse obstetric outcomes, such as emergency cesarean, first and second stages of labor dystocia, shoulder dystocia, and perineal laceration.[7] Few trials have evaluated these outcomes in women with prior cesarean. Because labor dystocia is a risk factor for uterine rupture,[8,9] it is likely that uterine rupture could also be increased with fetal macrosomia.

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We aimed to estimate the relationship between neonatal birth weight and adverse obstetric outcomes, namely, rates of failed trial of labor, uterine rupture, shoulder dystocia, and third- and fourth-degree perineal laceration in patients undergoing VBAC.

MATERIALS AND METHODS

This retrospective cohort study comprised patients with a history of previous cesarean delivery who were admitted to Sainte-Justine Hospital between January 1987 and December 2004 to undergo a trial of labor. Estimated fetal weight was not performed routinely in our center, and there were no changes in the local or national recommendations for VBAC management during this period. Part of this database was investigated in the past for publication.[10] Medical records were reviewed by two independent observers who collected demographic data, medical and obstetric history, complications and outcomes of the current pregnancy, and neonatal birth weight. The inclusion criteria were singleton pregnancies 24 weeks or more of gestation at delivery in patients with one or more previous low transverse cesarean deliveries. Women with prior classic, J-shape, or T-inverted incision or prior transmural myomectomy were excluded. The study population was categorized into three groups according to neonatal birth weight of the offspring: less than 3,500 g (group 1, used as reference), 3,500–3,999 g (group 2), and 4,000 g or more (group 3). This classification into three groups was predetermined and based on several factors: 1) It allowed evaluation of the dose-response effect, 2) it provided a better estimate of risk for women in the intermediate category, and 3) it took into account the relative accuracy of sonographically estimated fetal weight.

The following adverse obstetric outcomes were compared among these groups: 1) failed trial of labor; 2) symptomatic uterine rupture, defined as complete separation of the uterine scar, resulting in communication between the uterine and peritoneal cavities necessitating emergency cesarean or postpartum laparotomy; 3) third- and fourth-degree perineal laceration; and 4) shoulder dystocia, defined as prolonged head-to-body delivery time reported by the attending obstetrician associated with additional obstetric maneuvers (such as the McRoberts position, corkscrew, or delivery of the posterior arm). Analyses were subdivided according to women with and without previous vaginal delivery.[11,12]

The rates of adverse outcomes in groups 2 and 3 were compared with the reference group by the χ^2 test and univariable logistic regression. Multivariable logistic regression analyses with and without stepwise regression were performed to control for potential confounding factors. The following covariates were included in the model for uterine rupture: prior uterine closure, interdelivery interval (defined as categorical covariates: less than 18 months, 18–24 months, and greater than 24 months), labor induction, prior vaginal delivery, maternal age (aged less than 35 years compared with aged 35 years or more), epidural anesthesia, and gestational age of 41 weeks or more. Covariates in the model for failed trial of labor were maternal age, prior vaginal delivery, previous cesarean for recurrent indications, and labor induction. Covariates in the model for shoulder dystocia were maternal age, prior vaginal delivery, operative vaginal delivery, and labor induction. Covariates in the model for third- and fourth-degree perineal laceration were maternal age, prior vaginal delivery, and operative vaginal delivery. Linear regression analyses were performed to evaluate association between years of delivery and uterine rupture or failed trial of labor. Statistical analyses were performed with SPSS 16.0 (SPSS Inc., Chicago, IL). $P<.05$ was designated to indicate statistical significance. Institutional review board approval was obtained from the Ethic and Scientific Committee of Sainte-Justine Hospital Research Center.

RESULTS

Between January 1987 and December 2004, 2,586 women underwent a trial of labor, and the overall rate of successful VBAC was 76.1%. Of them, 1,519 (59%) delivered a neonate with a birth weight of less than 3,500 g (group 1, reference), 798 (31%) with a birth weight of 3,500–3,999 g (group 2), and 269 (10%) with a birth weight of 4,000 g or more (group 3). Table 1 reports the demographic characteristics of the different groups. Birth weight of 4,000 g or more was associated with higher rates of oxytocin and epidural anesthesia use, two interventions that could be secondary to prolonged labor and dystocia. In our population, induction of labor was performed in 28% and oxytocin was used in 58% of women. Neither induction of labor ($P=.98$) nor oxytocin ($P=.34$) was associated with uterine rupture. Prostaglandins have been used only in 20 women, with one of them (5%) ending her delivery with a uterine rupture. Linear regression analyses showed no association between years of delivery and uterine rupture or failed trial of labor ($P=.46$ and $P=.24$, respectively). Birth weight was directly correlated with the rate of failed trial of labor, uterine rupture, shoulder dystocia, and third- and fourth-degree perineal laceration in women with or without previous vaginal delivery, except for uter-

Table 1. Demographic Characteristics According to the Different Birth Weight Groups

	Group 1: Less Than 3,500 g (n=1,519)	Group 2: 3,500–3,999 g (n=798)	Group 3: 4,000 g or More (n=269)	*P*
Age (y)	31 (28–34)	31 (29–34)	32 (28–34)	NS
Gestational age at delivery (wk)	39.0 (37.7–40.0)	40.0 (39.1–40.7)	40.3 (39.6–41.0)	<.01
Birth weight (g)	3,115 (2,790–3,315)	3,705 (3,604–3,835)	4,195 (4,073–4,363)	<.01
Diabetes*	178 (11.7)	94 (11.8)	37 (13.8)	NS
More than one cesarean delivery	75 (4.9)	21 (2.6)	8 (3.0)	.02
Prior vaginal birth	486 (32)	220 (27.6)	81 (30.1)	NS
Prior single-layer closure	362 (23.8)	222 (27.8)	81 (30.1)	.02
Interdelivery interval (mo)	42.0 (26.5–66.4)	38.6 (25.4–59.8)	36.4 (25.5–61.2)	.02
Operative vaginal delivery	178 (11.7)	98 (12.3)	34 (12.6)	NS
Oxytocin	812 (53.5)	492 (61.7)	190 (70.6)	<.01
Labor induction	404 (26.6)	223 (27.9)	107 (39.8)	<.01
Prostaglandins	11 (0.7)	8 (1.0)	1 (0.4)	NS
Epidural anesthesia	946 (62.3)	565 (70.9)	209 (77.7)	<.01

NS, not significant.
Data are median (interquartile range) or n (%) unless otherwise specified.
Medians were compared by using Kruskal-Wallis test, and proportions were compared by using Pearson χ^2 test.
* Preexisting or gestational diabetes.

ine rupture in women with previous vaginal delivery (Fig. 1). Women with fetal macrosomia and no previous vaginal delivery combined had a rate of uterine rupture that reached 3.2% (6 of 188). After adjustment for confounding variables, birth weight of 4,000 g or more remained associated with all adverse obstetric outcomes, whereas birth weight between 3,500 and 3,999 g stayed linked with failed trial of labor and shoulder dystocia (Table 2). Of 618 failed trials of labor, the majority were performed in the active phase of labor, including 402 (65%) for labor dystocia. Cervical dilatation at the time of cesarean delivery

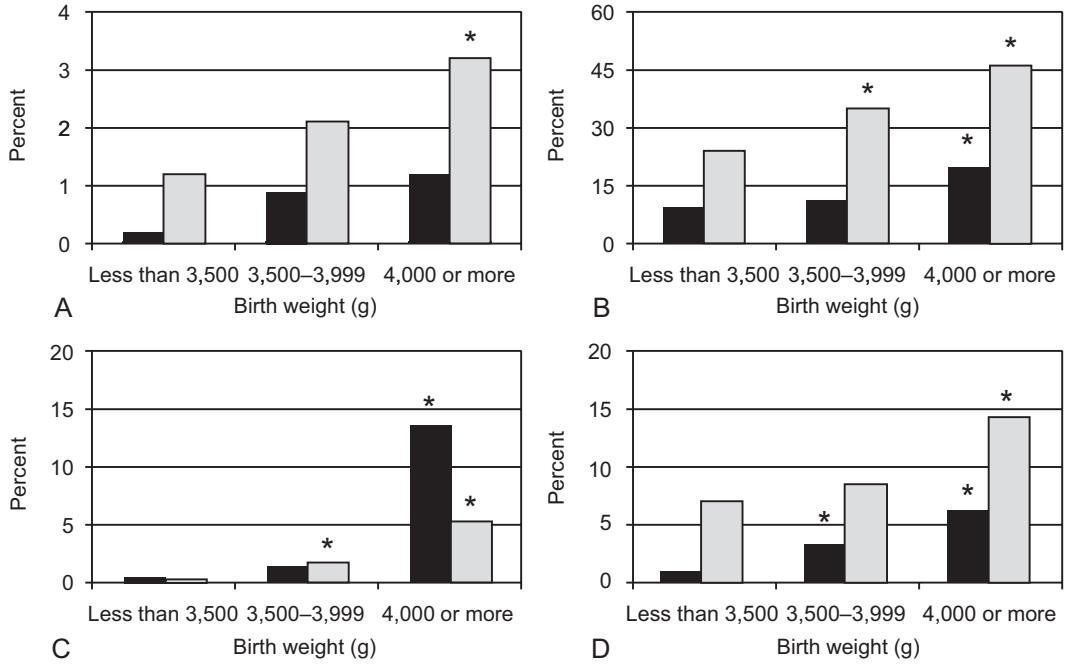

Fig. 1. Rates of adverse obstetric outcomes according to birth weight and previous vaginal delivery. Women with no previous vaginal delivery (*gray*) and fetal macrosomia were more likely to experience uterine rupture **(A)**, failed trial of labor **(B)**, shoulder dystocia **(C)**, and third- or fourth-degree perineal laceration **(D)**. Women with previous vaginal delivery (*black*) and fetal macrosomia have a significantly higher rate of all outcomes except uterine rupture. *P<.05.
Jastrow. Fetal Macrosomia and VBAC. Obstet Gynecol 2010.

Table 2. Association Between Obstetric Outcomes and Birth Weights

Outcome	n (%)	*P*	Unadjusted Odds Ratio	95% CI	Adjusted Odds Ratio*	95% CI*
Uterine rupture						
Less than 3,500 g	13 (0.9)	Ref	1.00	—	1.00	—
3,500–3,999 g	14 (1.8)	.07	2.01	0.94–4.29	1.86	0.86–4.03
4,000 g or more	7 (2.6)	.02	2.99	1.18–7.57	2.62	1.001–6.85
Failed trial of labor						
Less than 3,500 g	290 (19.1)	Ref	1.00	—	1.00	—
3,500–3,999 g	225 (28.2)	<.01	1.66	1.36–2.03	1.58	1.27–1.97
4,000 g or more	103 (38.3)	<.01	2.63	1.99–3.47	2.47	1.82–3.34
Shoulder dystocia						
Less than 3,500 g	5 (0.3)	Ref	1.00	—	1.00	—
3,500–3,999 g	13 (1.6)	<.01	4.87	1.73–13.71	5.21	1.85–14.70
4,000 g or more	21 (7.8)	<.01	24.80	9.26–66.36	25.13	9.31–67.86
Third- and fourth-degree perineal laceration						
Less than 3,500 g	74 (5.0)	Ref	1.00	—	1.00	—
3,500–3,999 g	56 (7.0)	<.05	1.42	1.00–2.05	1.41	0.97–2.04
4,000 g or more	32 (11.9)	<.01	2.55	1.65–3.94	2.64	1.66–4.19

CI, confidence interval; Ref, reference.

* Odds ratios and 95% CIs were adjusted for the following variables: uterine rupture—prior uterine closure, interdelivery interval, labor induction, prior vaginal birth, maternal age, gestational age greater than 41 weeks, epidural anesthesia; failed trial of labor—maternal age, prior vaginal birth, indication of previous caesarean delivery, labor induction; shoulder dystocia—maternal age, prior vaginal birth, operative vaginal delivery, labor induction; third- and fourth-degree perineal laceration—maternal age, prior vaginal birth, operative vaginal delivery.

was available for 477 (77%). Women with macrosomic fetuses were more likely to have a cesarean delivery in the second stage of labor (9%) compared with women in the two other groups (3% and 5%, respectively; $P<.01$). We repeated the logistic regression analyses for uterine rupture using a stepwise regression approach. In this scenario, only three factors remained associated with uterine rupture: a prior single-layer closure (odds ratio [OR] 8.1, 95% confidence interval [CI] 3.7–17.9), an interdelivery interval of less than 18 months (OR 2.8, 95% CI 1.2–6.3), and a birth weight of 4,000 g or more (OR 2.7, 95% CI 1.1–6.9). An interdelivery interval between 18 and 24 months did not remain a significant factor for uterine rupture (OR 1.2, 95% CI 0.4–3.3).

DISCUSSION

We observed a positive association between birth weight and adverse obstetric outcomes, such as uterine rupture, shoulder dystocia, third- and fourth-degree perineal laceration, and failed trial of labor, in women who underwent previous cesarean delivery. More specifically, we found that the risk of adverse outcomes was significantly higher in women with no previous history of vaginal delivery, including a 3.2% rate of uterine rupture associated with fetal macrosomia. Because macrosomia accounts for approximately 10% of all pregnancies,[2] these findings are important, as they will help obstetricians and women to better assess the risk of adverse obstetric events when they deliberate over the mode of delivery after a previous cesarean delivery.

Several authors investigated the risk of uterine rupture for women with fetal macrosomia.[9,13–21] In 1984, Phelan et al[14] reported one (0.7%) symptomatic uterine rupture among 140 women with macrosomic children and concluded that trial of labor was an acceptable option. Although most studies did not demonstrate a significant association between birth weight and uterine rupture, the crude rate was usually higher in women with fetal macrosomia.[13,14,16,19,20] Like us, Elkousy et al[19] noted a high rate of uterine rupture (3.2%) in women with fetal macrosomia and no previous vaginal delivery combined. When all these studies, including the current work, were combined, we discerned that women with a macrosomic infant had a higher risk of uterine rupture (pooled OR 1.52, 95% CI 1.09–2.11; Table 3). Only three cohorts, including ours, have been investigated for the rate of uterine rupture in women with no previous vaginal delivery.[19,20] In this subgroup, 43 uterine ruptures (3.0%) were observed in 1,403 women with fetal macrosomia, compared with 132 (1.4%) in 9,493 women with smaller neonates. Only two trials have assessed the rate of uterine rupture in parous women, with 6 (1.2%) occurring in 512 women with fetal macrosomia compared with 24 (0.6%) in 3,887 women with small neonates.[19] Globally, these data

Table 3. Studies Reporting the Association Between Macrosomia and Uterine Rupture

Authors (Year)	Type of Study	Uterine Rupture in Neonates of 4,000 g or More	Uterine Rupture in Neonates Less Than 4,000 g	Odds Ratio (95% CI)
Aboulfalah et al (2000)[16]	Cohort	4/297	9/1,242	1.87 (0.57–6.12)
Algert et al (2008)[17]	Cohort	4/1,441	35/8,715	0.69 (0.24–1.95)
Elkousy et al (2003)[19]	Cohort	5/431	21/3,181	1.77 (0.66–4.71)
Flamm and Goings (1989)[13]	Cohort	1/310	2/1,475	2.46 (0.22–27.16)
Macones et al (2006)	Case–control	21/99	112/699	1.41 (0,84–2.388)
Nguyen et al (1992)[18]	Cohort	0/26	4/216	0.89 (0.05–17.01)
Zelop et al (2001)[20]	Cohort	6/365	23/2,384	1.72 (0.69–4.24)
Current study	Cohort	7/269	28/2,317	2.18 (0.94–5.05)
Pooled odds ratio*		48/3,229	179/20,230	1.52 (1.09–2.11)*

CI, confidence interval.
* Random effects using the DerSimonnian and Laird model, $P<.001$.

indicate that fetal macrosomia is associated with uterine rupture, and the lack of significance in previous studies was probably because of insufficient power to show any effect. Additionally, we confirmed the link between macrosomia and heightened risk of other adverse obstetric outcomes. Regarding VBAC success rates, our results are consistent with those of previous works, which suggested that the likelihood of successful VBAC decreased with increasing birth weight.[9,13,14,19,20] As postulated by other authors,[20] this may be attributed to true dystocia but could also be partially explained by a lower threshold for repeat cesarean delivery in women with suspected fetal macrosomia. We did not find other studies that reported the risk of shoulder dystocia or third- and fourth-degree perineal laceration for women with previous cesarean delivery. We made similar observations, as in women without previous cesarean delivery.[2]

Current recommendations of the American College of Obstetricians and Gynecologists[22] and the Society of Obstetricians and Gynaecologists of Canada[23] state that fetal macrosomia should not be a contraindication for a trial of labor although it is associated with a lower likelihood of successful VBAC. Based on our data, we believe that women with a previous cesarean delivery and an estimated fetal weight of 4,000 g or more should be informed about their higher risks of uterine rupture and other adverse outcomes. Such women with no previous vaginal delivery should be told about the high risk (1.6–3.2%) of uterine rupture.[19,20]

Several limitations of our study need to be considered. First, this was a retrospective study, leading to potential information bias. This was limited by completeness of the data, the absence of loss to follow-up, and a uniform team of obstetric caregivers. Second, because the investigation was performed in a single tertiary care center, the external validity could be questioned. Another limitation of the present work is the use of birth weight instead of estimated fetal weight. It is well known that sonographic accuracy declines as fetal weight increases toward 4,000 g,[24,25] with some studies reporting errors in excess of 20% of actual birth weight.[26] A recent review of birth weight prediction[27] established that the posttest probability of detecting a macrosomic fetus with sonographic estimation was variable among different trials, ranging between 15% and 79%. However, recent publications suggest that macrosomia detection could be improved by measuring the fetal nutrition score, determined from a qualitative assessment of the amount of subcutaneous tissue present at three locations (face, ribs, and buttocks) on antenatal three-dimensional ultrasonography, which was shown to be strongly correlated with birth weight.[28] One could also consider that the number of uterine ruptures (n=34) observed was small, but the results were similar to previous reports. Finally, our study was limited because other factors believed to modify the risk of uterine rupture, such as sonographic lower uterine segment thickness,[29,30] were not taken into account in the risk evaluation. In this regard, we believe that future investigations should group the ultrasonographic estimation of fetal weight and lower uterine segment thickness. Combination of these two sonographic evaluations could lead to better estimates of the risk of uterine rupture and adverse obstetric outcomes in women with previous cesarean delivery.

In conclusion, macrosomia is associated with higher rates of adverse outcomes, including uterine rupture, shoulder dystocia, third- and fourth-degree perineal laceration, and failed trial of labor. Furthermore, our data indicate that women without a history of vaginal delivery present high risks of uterine rup-

ture. These findings should be considered by obstetricians when counseling women with a suspected macrosomic fetus about the mode of delivery after a previous cesarean delivery.

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