



## Pregnancy after bariatric surgery is not associated with adverse perinatal outcome

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### KEY WORDS

Bariatric surgery  
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**Objective:** The purpose of this study was to investigate the pregnancy outcome of patients after bariatric surgery.

**Study design:** A population-based study was performed that compared all pregnancies of patients with and without previous obesity operations between the years 1988 and 2002. Stratified analyses with the Mantel-Haenszel technique and a multiple logistic regression model were performed to control for confounders.

**Results:** Of the 159,210 deliveries that were performed during the study period, 298 deliveries were to patients after bariatric operations. No significant differences regarding obstetric characteristics or pregnancy outcome were noted between the open ( $n = 159$ ) and laparoscopic procedures ( $n = 139$ ). With the use of a multivariable analysis, the following conditions were associated significantly with a previous bariatric operation: previous cesarean delivery (odds ratios, 1.4; 95% confidence interval, 1.1-2.0;  $P = .024$ ), fertility treatments (odds ratios, 2.3; 95% confidence interval, 1.6-3.8;  $P < .001$ ), premature rupture of membranes (odds ratios, 1.9; 95% confidence interval, 1.3-2.7;  $P = .001$ ), labor induction (odds ratios, 2.1; 95% confidence interval, 1.6-2.7;  $P < .001$ ), fetal macrosomia (birth weight,  $> 4$  kg; odds ratios, 2.1; 95% confidence interval, 1.4-3.0;  $P < .001$ ), and obesity (odds ratios, 8.8; 95% confidence interval, 6.1-12.9;  $P < .001$ ). No significant differences were noted between the groups regarding other pregnancy complications such as placental abruption, placenta previa, labor dystocia, or perinatal complications (such as meconium-stained amniotic fluid, perinatal mortality, congenital malformations and low Apgar scores at 1 and 5 minutes). However, there were higher rates of cesarean delivery among the bariatric operation group (25.2% vs 12.2%; odds ratios, 2.4; 95% confidence interval, 1.9-3.1;  $P < .001$ ). When controlled for possible confounders (such as previous cesarean delivery, obesity, fertility treatments, premature rupture of membranes, labor induction, diabetes mellitus, hypertensive disorders and fetal macrosomia) by the Mantel-Haenszel technique, the correlation between previous bariatric surgery and cesarean delivery remained significant.

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**Conclusion:** Previous bariatric surgery, although an independent risk factor for cesarean delivery, is not associated with adverse perinatal outcome.

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Obesity, defined as a body mass index (BMI) of  $\geq 30$  kg/m<sup>2</sup>, is now recognized as a major disease in the western world.<sup>1-3</sup> In the United States, >18% of women meet obesity criteria, and the prevalence of morbid obesity (defined as a BMI of  $>40$  kg/m<sup>2</sup> or a BMI of  $>35$  kg/m<sup>2</sup> with obesity comorbidity) is increasing steadily among women in the reproductive age, assuming epidemic proportions.<sup>1-5</sup> These women have higher rates of associated medical problems such as diabetes mellitus, hypertensive disorders, coronary heart disease, and stroke. Obesity has become the second leading cause of death in the West.<sup>4</sup>

Pregnancy outcome of obese women in general has been shown to be worse than that of women of normal BMI.<sup>6-8</sup> The literature reports increased incidence of the following complications: gestational diabetes mellitus, gestational hypertension and preeclampsia, fetal macrosomia, cesarean deliveries, and anesthesia-related complications.<sup>6-8</sup>

The 1991 National Institute of Health Consensus Developmental Conference concluded that bariatric surgery is the only effective treatment for morbidly obese patients.<sup>9</sup> Bariatric operations are performed predominantly among women.<sup>10</sup> Few studies have addressed pregnancy outcome after obesity surgery.<sup>11-16</sup> The present study was designed to investigate the outcome of pregnancy and delivery in these patients, because this group of patients is growing and undoubtedly will be part of the daily practice of many obstetricians in the near future.

## Material and methods

A population-based study that compared all pregnancies of patients with and without a history of bariatric surgery was performed. Deliveries occurred during the years 1988 to 2002 in the Soroka University Medical Center. This is the sole hospital in the Negev, the southern part of Israel, and serves the entire obstetric population. Thus, the study represents nonselective data.

Patients had all forms of bariatric surgery performed, including restrictive and malabsorptive procedures that were performed in open or laparoscopic technique. Another comparison was performed regarding obstetric characteristics and pregnancy outcome between the open and laparoscopic procedures. Data were collected from the perinatal database that consists of information that is collected directly after delivery by an obstetrician.

Skilled medical secretaries examine the information routinely before entering it into the database. Coding is done after an assessment is made of the medical prenatal care records and the routine hospital documents.

The following clinical characteristics were analyzed: maternal age, gravidity, parity, previous bariatric surgery, gestational age, and birth weight. The following obstetric risk factors were examined: obesity (BMI,  $\geq 30$  kg/m<sup>2</sup>), previous cesarean delivery, fertility treatments, twin pregnancy, intrauterine growth restriction (IUGR), hypertensive disorders,<sup>17,18</sup> gestational diabetes mellitus,<sup>19</sup> hydramnios, oligohydramnios, and premature rupture of membranes (PROM). The following pregnancy and labor characteristics were assessed: labor induction and failed induction, placental abruption, placenta previa, malpresentation, non-reassuring fetal heart rate patterns, dystocia during the first or second stages of labor, meconium-stained amniotic fluid, instrumental delivery or cesarean delivery, Apgar score at 1 and 5 minutes  $<7$ , perinatal death, congenital malformations, maternal anemia, and gastrointestinal obstruction. All patients after 1 low transverse cesarean delivery are entitled to vaginal birth after cesarean delivery in our medical center.

Statistical analysis was performed with the SPSS software package (SPSS, Inc, Chicago, Ill). Statistical significance was ascertained with the chi-squared test for differences in qualitative variables and the *t*-test for differences in continuous variables. Stratified analysis, with the Mantel-Haenszel technique, was done to assess the association between previous bariatric surgery and the risk for cesarean delivery and to obtain the weighted odds ratio, while controlling for confounding variables. A multivariable logistic regression model was constructed to find independent risk factors that were associated with previous bariatric surgery. Odds ratios (ORs) and their 95 % confidence interval (CI) were computed. Probability values of  $<.05$  were considered statistically significant.

## Results

During the study period, there were 159,210 deliveries, of which 298 deliveries (0.2%) occurred in patients with previous bariatric surgery. Clinical characteristics of these 2 groups are shown in Table I. Patients with a history of bariatric surgery tended to be older and of lower birth-order (gravidity and parity). Although there were

**Table I** Clinical characteristics of patients with and without previous bariatric surgery

Characteristic	Bariatric surgery (n=298)	No bariatric surgery (n=158,912)	P value
Maternal age (y)*	29.1 ± 5.7	28.3 ± 5.9	.026
Gravidity (n)*	3.6 ± 2.5	3.9 ± 2.9	.043
Parity (n)*	3.1 ± 2.2	3.5 ± 2.6	.008
Gestational age (wk)*	39.2 ± 2.1	39.1 ± 2.3	.362
Birth weight (g)*	3231.9 ± 622.8	3153.5 ± 568.9	.017
Macrosomia: Birth weight, >4 kg (n)	28 (9.4%)	7,268 (4.6%)	<.001
Fetal gender			
Male	146 (49.0%)	81,348 (51.2%)	
Female	152 (51.0%)	77,552 (48.8%)	.448
Obesity: BMI, ≥30 kg/m <sup>2</sup> (n)	32 (10.7%)	1,910 (1.2%)	<.001

\*Data are expressed as means ± SD.

**Table II** Obstetric risk factors of pregnancies with and without previous bariatric surgery

Characteristic (n)	Bariatric surgery (n=298)	No bariatric surgery (n=158,912)	P value
Previous cesarean delivery	46 (15.4%)	16,755 (10.5%)	.006
Fertility treatment	20 (6.7%)	3,582 (2.3%)	<.001
Twin pregnancy	8 (2.7%)	4,877 (3.1%)	.701
IUGR	15 (5.0%)	3,148 (2.0%)	<.001
Mild preeclampsia	14 (4.7%)	5,603 (3.5%)	.273
Severe preeclampsia	3 (1.0%)	1,847 (1.2%)	.802
Chronic hypertension	16 (5.4%)	2,776 (1.7%)	<.001
Gestational diabetes mellitus A	28 (9.4%)	8,009 (5.0%)	.001
Diabetes mellitus (B-R)	2 (0.7%)	1,919 (1.2%)	.397
Hydramnios	18 (6.0%)	6,533 (4.1%)	.094
Oligohydramnios	6 (2.0%)	3,352 (2.1%)	.908
PROM	31 (10.4%)	9,029 (5.7%)	<.001

no significant differences between the groups regarding gestational age, birth weight was significantly higher among the bariatric surgery group. Moreover, there were higher rates of fetal macrosomia (birth weight, ≥ 4 kg) and obesity among patients after obesity surgery compared with the comparison group. The association between bariatric operations and macrosomia remained statistically significant even after obesity was controlled for with the Mantel-Haenszel technique (4 obese patients after bariatric surgery had fetal macrosomia vs 24 nonobese patients after bariatric surgery; weighted OR, 2.1; 95% CI, 1.4-3.0; *P*<.001).

**Table III** Pregnancy and labor complications in pregnancies with and without bariatric surgery

Characteristic (n)	Bariatric surgery (n=298)	No bariatric surgery (n=158,912)	P value
Labor induction	71 (23.8%)	17,363 (10.9%)	<.001
Failed induction	5 (1.7%)	596 (0.4%)	<.001
Placental abruption	2 (0.7%)	1,237 (0.8%)	.833
Placenta previa	1 (0.3%)	654 (0.4%)	.838
Malpresentation	23 (7.7%)	9,836 (6.2%)	.274
Nonreassuring fetal heart rate pattern	10 (3.4%)	4,737 (3.0%)	.704
Dystocia			
1st Stage	8 (2.7%)	2,978 (1.9%)	.303
2nd Stage	2 (0.7%)	2,722 (1.7%)	.166
Meconium-stained amniotic fluid	46 (15.4%)	25,581 (16.1%)	.756
Cesarean delivery	75 (25.2%)	19,341 (12.2%)	<.001
Perinatal death	1 (0.3%)	2,353 (1.5%)	.102
Apgar score <7			
1 Minute	16 (5.5%)	6,933 (4.5%)	.411
5 Minute	3 (1.0%)	954 (0.6%)	.371
Congenital malformations	15 (5.0%)	6,333 (4.0%)	.355
Anemia (hemoglobin, <10 g/d)	63 (26.8%)	31,080 (26.4%)	.885
Packed-cells transfusion	10 (3.4%)	2,560 (1.6%)	.017
Gastrointestinal obstruction	0	4 (0.0%)	.931

Obstetric risk factors are shown in Table II. There were higher rates of previous cesarean delivery, fertility treatments, IUGR, hypertensive disorders, diabetes mellitus, and PROM in the bariatric surgery group compared with the rest of the population.

Patients with a history of bariatric surgery were more likely to have labor induction (OR, 2.6; 95% CI, 1.9-3.3; *P*<.001) and cesarean delivery (OR, 2.4; 95% CI, 1.9-3.1; *P*<.001) than patients with no such history (Table III). No significant differences were noted between the groups regarding pregnancy complications (such as placental abruption, placenta previa, or labor dystocia) or regarding perinatal complications (such as meconium-stained amniotic fluid, perinatal mortality rates, and low Apgar scores at 1 and 5 minutes).

A comparison between open bariatric surgeries (n = 159) and laparoscopic procedures (n = 139) is presented in Table IV. No significant differences regarding obstetric characteristics or pregnancy outcome were noted between the open and laparoscopic operations.

With the use of a multivariable analysis, previous cesarean delivery, fertility treatments, fetal macrosomia, PROM, obesity, and labor induction were associated significantly with previous obesity surgery (Table V).

**Table IV** A comparison between open and laparoscopic operations for obesity

Characteristic (n)	Open surgery (n = 159)	Laparoscopic surgery (n = 139)	P value
Macrosomia (birth weight, > 4 kg)	14 (8.8%)	14 (10.1%)	.708
Obesity (BMI, $\geq 30$ kg/m <sup>2</sup> )	19 (11.9%)	13 (9.4%)	.470
Previous cesarean delivery	26 (16.4%)	20 (14.4%)	.640
Fertility treatment	12 (7.5%)	8 (5.8%)	.537
IUGR	6 (3.8%)	9 (6.5%)	.287
Chronic hypertension	7 (4.4%)	9 (6.5%)	.429
Gestational diabetes mellitus A	13 (8.2%)	15 (10.8%)	.440
Diabetes mellitus (B-R)	2 (1.3%)	0	.185
PROM	18 (11.3%)	13 (9.4%)	.579
Labor induction	33 (20.8%)	38 (27.3%)	.183
Failed induction	2 (1.3%)	3 (2.2%)	.546
Cesarean delivery	38 (23.9%)	37 (26.6%)	.589
Perinatal death	0	1 (0.7%)	.284
Apgar 5-minute score, < 7	1 (0.6%)	2 (1.5%)	.460
Congenital malformation	6 (3.8%)	9 (6.5%)	.425
Packed-cells transfusion	7 (4.4%)	3 (2.2%)	.283

**Table V** Multiple logistic regression of factors associated with bariatric surgeries

Characteristic	OR	95% CI	P value
Previous cesarean delivery	1.4	1.1-2.0	.024
Fertility treatments	2.3	1.6-3.8	<.001
IUGR	1.4	0.9-2.1	.063
PROM	1.9	1.3-2.7	.001
Labor induction	2.1	1.6-2.7	<.001
Hypertensive disorder	1.4	0.9-1.9	.176
Diabetes mellitus	1.3	0.9-1.8	.234
Obesity (BMI, $\geq 30$ kg/m <sup>2</sup> )	8.8	6.1-12.9	<.001
Macrosomia (birth weight, > 4 kg)	2.1	1.4-3.0	<.001

When controlling for possible confounders such as previous cesarean delivery, fertility treatments, PROM, labor induction, diabetes mellitus, hypertensive disorders, obesity, and fetal macrosomia, with the Mantel-Haenszel technique, the association between bariatric surgery and the use of cesarean as a mode of delivery remained significant (Table VI).

## Comment

The major finding of our population-based study was that previous bariatric surgery was not associated with adverse perinatal outcome. Perinatal death, congenital malformations, and Apgar scores are similar in patients with and without a history of previous bariatric surgery.

**Table VI** The association between previous bariatric surgery and the risk for cesarean deliver

Variable in analysis	OR	95% CI	P value
Crude OR for cesarean delivery	2.4	1.9-3.1	<.001
ORs for cesarean delivery			
Adjusted for:			
Previous cesarean delivery	2.4	1.8-3.2	<.001
Fertility treatments	2.2	1.7-2.8	<.001
PROM	2.4	1.8-3.1	<.001
Induction of labor	2.3	1.8-3.0	<.001
Diabetes mellitus	2.4	1.8-3.0	<.001
Hypertensive disorders	2.3	1.8-3.0	<.001
Obesity (BM, $\geq 30$ kg/m <sup>2</sup> )	2.2	1.7-3.0	<.001
Birth weight, > 4 kg	2.4	1.9-3.1	<.001

ORs and 95% CIs are given for the crude and the Mantel-Haenszel-adjusted ORs.

This is in accordance with a recent publication by Martin et al,<sup>11</sup> who evaluated 23 pregnancies in 20 patients after adjustable gastric banding and concluded that women who conceived soon after adjustable gastric bypass had uncomplicated pregnancies. Likewise, other studies reported that pregnancies after bariatric surgery were uncomplicated and well tolerated by the mothers.<sup>12-14</sup> However, those pregnancies were found to be associated with an increased risk of anemia because of iron, folate, and vitamin B<sub>12</sub> deficiencies.<sup>15</sup>

Unlike our results, several case reports described a number of complications in pregnancies after bariatric operations. Such complications included gastrointestinal bleeding,<sup>20</sup> IUGR,<sup>21</sup> and fetal malformations.<sup>22,23</sup> Our results are reassuring for the morbidly obese population who intend to undergo bariatric surgery because we found that pregnancy outcome is not affected negatively by these operations. Of note, in the group of patients who had undergone some form of bariatric surgery, approximately 11% of patients remained obese, which is a failure rate that is comparable to that reported by others.<sup>5,11</sup> The failure rate of bariatric surgery varies according to the type of surgery that is performed, the definition used to determine failure, and the length of follow-up. In this study, no significant difference was noted when we compared the obesity rate after open and laparoscopic procedures.

The present study, to the best of our knowledge, includes the largest number of pregnancies after bariatric surgeries (n = 298). Other studies varied from single case reports<sup>20-23</sup> to <100 patients.<sup>11-16</sup> In addition, our study design differed extensively from most other studies that investigated pregnancy outcome after obesity operations. Although the latter were mostly descriptive, giving detailed characteristics of the bariatric surgery group, we performed a population-based study, which enabled us to describe independent risk factors that

are associated with a previous obesity surgery. Patients after bariatric surgery tended to have higher rates of previous fertility treatments, cesarean delivery, fetal macrosomia, PROM, and labor induction. No significant differences were noted between the open and the laparoscopic operations. Although in the univariate analysis these pregnancies were associated with higher rates of diabetes mellitus and hypertensive disorders, these risk factors lost their significance in the multivariate analysis, excluding independent associations. Indeed, diabetes mellitus and hypertensive disorders were shown to be associated with morbid obesity,<sup>4</sup> not with previous obesity operation surgery. Weight loss undoubtedly decreases the risk of pregnancy complications.<sup>11</sup>

Interestingly, in our study, even after controlling for confounders (such as previous cesarean delivery, obesity, fertility treatments, and fetal macrosomia), we found that bariatric surgery was an independent risk factor for cesarean delivery. Because there is not a known physiologic reason for performing more cesarean deliveries among patients who have had bariatric surgery, it is difficult to ascribe the increased use of cesarean delivery in patients with previous bariatric surgery to anything but caregiver bias. Many obstetricians are reluctant to operate on women with previous intra-abdominal surgery because of the increased risk of complications.

Worldwide cesarean delivery birth rate has quadrupled in <2 decades.<sup>24-26</sup> Cesarean delivery is the most frequently performed major operation in the United States, where approximately 1 million such operations are performed annually.<sup>24</sup> The involvement of anesthesia and laparotomy increases the risk for maternal morbidity.<sup>27</sup> Therefore, it is appropriate to view the widely growing rate of cesarean delivery as an impending obstetric hazard. Because the prevalence of morbid obesity is increasing among women in the reproductive age<sup>1-3</sup> and because of the fact that bariatric surgery is the only effective treatment for morbidly obese patients,<sup>9</sup> we certainly shall see an increasing percentage of pregnancies after obesity operations. Because of the significant, independent association between a previous bariatric surgery and cesarean delivery, the obstetricians must reconsider their attitudes towards this trend. An objective evaluation of the benefits and risks of the performance of cesarean delivery in these patients is needed to make an informed recommendation regarding the preferred mode of delivery in this growing group of patients.

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