Pregnancy and delivery outcomes after abdominal vs. laparoscopic myomectomy: an evaluation of an American population database

Perrine Ginod, M.D., Ph.D.,[a,b] Ahmad Badeghiesh, M.D., M.P.H.,[c] Haitham Baghlaf, M.D., M.P.H.,[d] and Michael H. Dahan, M.D., Ph.D.[a]

[a] Department of Obstetrics and Gynecology, Division of Reproductive Endocrinology and Infertility, McGill University, Montréal, Québec, Canada; [b] Service de Gynécologie-Obstétrique et Assistance Médicale à la Procréation, CHU Dijon Bourgogne, Dijon, France; [c] Division of Gynecology and Obstetrics, King Abdulaziz University, Rabigh Branch, Rabigh, Saudi Arabia; and [d] Department of Obstetrics and Gynecology, University of Tabuk, Tabuk, Saudi Arabia

Objective: To evaluate population characteristics and obstetric complications after abdominal myomectomy vs. laparoscopic myomectomy.

Design: Retrospective cohort study.

Patient(s): A total of 13,868 and 338 pregnancies after abdominal or laparoscopic myomectomy, respectively.

Exposure: Obstetrics outcomes following abdominal and laparoscopic myomectomy were collected.

Main Outcome Measure(s): Obstetric outcomes after abdominal or laparoscopic myomectomies were collected using hospital discharges from 2004 to 2014 inclusively, and adjusted using multiple and binomial logistic regression in different models for age, obesity, chronic hypertension, and pregestational diabetes mellitus. Pregnancy, delivery, and neonatal outcomes were analyzed.

Result(s): Abdominal myomectomy were characterized by younger patients, lower rates of Caucasian, chronic hypertension, pregestational diabetes, active smoking, illicit drug use, and higher rates of previous cesarean delivery, and multiple gestations when compared with laparoscopic myomectomy. Pregnant women with laparoscopic myomectomy had decreased rates of pregnancy-induced hypertension (adjusted risk ratios [aRR], 0.12; 95% confidence intervals [CI], 0.006–0.24]), gestational hypertension (aRR, 0.24; 95% CI, 0.08–0.76), pre-eclampsia (aRR, 0.18; 95% CI, 0.07–0.48), and pre-eclampsia or eclampsia superimposed on chronic hypertension (aRR, 0.03; 95% CI, 0.005–0.3), gestational diabetes mellitus (aRR, 0.14; 95% CI, 0.06–0.34), preterm premature rupture of membranes (aRR, 0.14; 95% CI, 0.02–0.96), preterm delivery (aRR, 0.36; 95% CI, 0.23–0.55), and cesarean delivery (aRR, 0.01; 95% CI, 0.007–0.01) and small for gestational age (aRR, 0.15; 95% CI, 0.005–0.04), compared with abdominal myomectomy group. Laparoscopic myomectomy group had a higher rate of spontaneous (aRR, 35.57; 95% CI, 22.53–62.66), and operative vaginal delivery (aRR, 10.2; 95% CI, 8.3–12.56), uterine rupture (aRR, 6.1; 95% CI, 3.2–11.63), postpartum hemorrhage (aRR, 3.54; 95% CI, 2.62–4.8), hysterectomy (aRR, 7.74; 95% CI, 5.27–11.4), transfusion (aRR, 3.34; 95% CI, 2.54–4.4), pulmonary embolism (aRR, 7.44; 95% CI, 2.44–22.71), disseminated intravascular coagulation (aRR, 2.77; 95% CI, 1.47–5.21), maternal infection (aRR, 1.66; 95% CI, 1.1–2.5), death (aRR, 2.04; 95% CI, 1.31–3.2), and intrauterine fetal death (aRR, 2.99; 95% CI, 1.72–5.2) compared with the abdominal myomectomy group.

Conclusion(s): Women who had a previous abdominal myomectomy have underlying risk factors for hypertension disorders of pregnancy and gestational diabetes. Women who underwent laparoscopic myomectomies have higher risks of bleeding, uterine rupture, resultant complications, and death, and should be monitored as high-risk patients, like abdominal myomectomies. (Fertil Steril® 2025;123:164–72. ©2024 by American Society for Reproductive Medicine.)

El resumen está disponible en Español al final del artículo.

Key Words: Obstetric complications, open myomectomy, mode of delivery, cesarean section, uterine rupture

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Correspondence: Perrine Ginod, M.D., Ph.D., Service de Gynécologie-Obstétrique et Assistance Médicale à la Procréation, CHU Dijon Bourgogne, Dijon, France (E-mail: perrine.ginod@gmail.com).

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Uterine myomas are the most common benign tumors and are estimated to affect 20%–40% of women during their reproductive years (1) and between 2% and 11% of pregnant women (2–4). Moreover, pregnancies in women with fibroids have been found to have an elevated risk for adverse outcomes such as placental abnormalities, fetal malpresentation, preterm premature rupture of membranes, preterm birth, cesarean delivery (CD), postpartum hemorrhage, and fetal growth restriction (2, 5–7) compared with control pregnancies in women without fibroids. If several consensus statements and guidelines agree that myomectomy is indicated in patients with submucosal fibroids who desire pregnancy, little evidence suggests the benefits of myomectomy for intramural fibroids. This surgery might be discussed with the patient, particularly in patients with unexplained infertility otherwise (8, 9). Laparoscopic myomectomy is the recommended surgical approach when feasible, being less invasive than abdominal resection, reducing blood loss, postoperative pain, and hospital stays (10–12). Most of the previous research on surgical myomectomies has come from clinical studies, evaluating reproductive outcomes and not obstetric outcomes after a specific surgical approach, or a specific type of fibroid removed. Recent evidence has suggested that abdominal myomectomy is associated with a higher rate of intrauterine adhesions as compared with minimally invasive surgery (13).

Studies in the literature suggest previous myomectomy procedures are associated with a greater risk of complications during pregnancy and delivery, such as uterine rupture, abnormal placentation, and intrauterine growth restriction (7, 14). However, no study extensively evaluated the possibility of different obstetric risks linked to the type of surgical approach performed for myomectomy before conception, except for preterm delivery, cesarean, and uterine rupture rate. To further understand discrepancies between these two populations, we used a large nationwide database to investigate the demographic characteristics and maternal, pregnancy, delivery, and neonatal outcomes, in women with previous myomectomy, according to the type of surgery performed: laparoscopic myomectomy and abdominal myomectomy.

MATERIALS AND METHODS

We conducted a retrospective study based on population data gathered from the Healthcare Cost and Utilization Project Nationwide Inpatient Sample (HCUP-NIS) database, spanning a period of 11 years from 2004 to 2014. Healthcare Cost and Utilization Project Nationwide Inpatient Sample is the largest database of its kind in the United States; encompassing inpatient stays reported by hospitals in 48 states and the District of Columbia. Each year, the database of hospital discharge International Classification of Diseases, 9th Revision, (ICD-9) clinical modification provides information on seven million inpatient stays, detailing patient characteristics, diagnoses, and procedures. The dataset is representative of 20% of all admissions to US hospitals and covers over 96% of the American population in terms of geographical representation, with a shift to ICD-10 coding in 2015, excluding subsequent data from inclusion.

Exposures

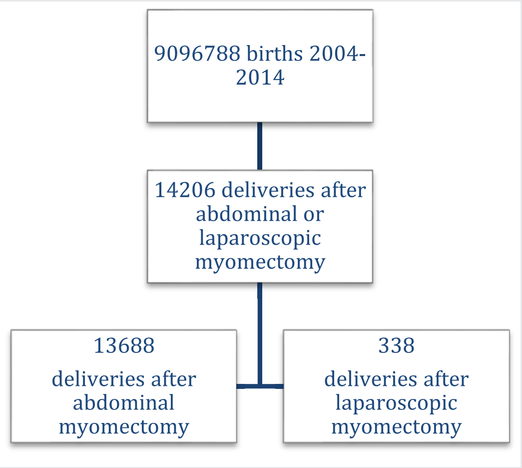
We included all patients from inpatient delivery outcomes from the HCUP-NIS database with a previous abdominal or laparoscopic myomectomy coded in their file. As for this, we were able to include all the outpatient procedures for myomectomies. We used the ICD-9-clinical modification codes for delivery-related discharge diagnoses (650.xx, 677.xx, and 651.xx–676.xx where the fifth digit is 0. 1 or 2), and birth-related procedural diagnoses (72.x, 73.x, and 74.0–74.2), in combination with the ICD-9 diagnostic codes 218.1, 218.2, and 218.9 for myomas, and abdominal or laparoscopic procedure codes 68.29 and 68.19. As the surgical procedures are also reported in the file through the Current Procedural Terminology code, we also crossed the delivery and birth-related procedural diagnostic codes with the Current Procedural Terminology codes 58140, 58145, and 58146 for abdominal myomectomy, and 58545 and 58546 for abdominal myomectomy.

A total of 9,096,788 births took place between 2004 and 2014 included in the HCUP-NIS database. Of these women, 14,206 delivered after a previous myomectomy, 13,688 after abdominal myomectomy, and 338 after laparoscopic myomectomy (Fig. 1).

Outcomes

Pregnancy, delivery, and neonatal outcomes of all women in the study population were the major outcomes of interest. Pregnancy outcomes included pregnancy-induced hypertension, gestational hypertension, pre-eclampsia, eclampsia, pre-eclampsia and eclampsia superimposed hypertension, gestational diabetes mellitus, and placenta previa (definitions detailed in Supplemental Table 1, available online). Delivery

FIGURE 1



Cohort selection.

Ginod. Outcomes after intramural myomectomy. Fertil Steril 2025.

outcomes included preterm premature rupture of membranes, preterm delivery, cesarean section, operative vaginal delivery, spontaneous vaginal delivery, maternal infection, chorioamnionitis, hysterectomy, postpartum hemorrhage, wound complications, maternal death, transfusion, maternal infection, deep vein thrombosis, pulmonary embolism, venous thromboembolism and disseminated intravascular coagulation (Supplemental Table 1). Neonatal outcomes included small for gestational age, intrauterine fetal death, and congenital anomalies (Supplemental Table 1).

Covariates

Baseline clinical characteristics included the following: maternal age, race, income, insurance type, obesity (body mass index [BMI] >30 kg/m^2), previous cesarean section, multiple gestations, tobacco smoking, illicit drug use, pre-existing hypertension, pre-existing diabetes, pre-existing thyroid disease, and use of assisted reproductive technology were also collected in the database at the time of delivery. As we cannot link the different admissions on a single individual, we included all births, and some can result in the same individual delivering two or more pregnancies after an abdominal myomectomy or a laparoscopic myomectomy.

Statistical analysis

Chi-squared tests were employed to compare baseline characteristics between abdominal and laparoscopic myomectomy cases. Subsequently, as we used categorical variables, log-binomial logistic regression analysis was performed to investigate the relationships between surgery type, pregnancy, and delivery outcomes in women who had undergone myomectomy, as the prevalence exceeded 10% for some covariates. Crude risk ratios and 95% confidence intervals (CIs) were estimated. Then three different adjusted models were performed with an a priori hypothesis of the covariates used. Model 1 is adjusted for age only, model 2 is adjusted for age and BMI grouping for obesity, and model 3 is adjusted for age, BMI grouping for obesity, presence of chronic hypertension, and pregestational diabetes mellitus or not.

We also performed a multivariate logistic regression analysis, and odds ratio (OR) and 95% CIs were estimated using two different models. We adjusted for potential confounding effects, including maternal demographic factors, pre-existing clinical characteristics, and concurrent conditions identified with a significance level of $P<.05$ in the Chi-squared tests, in the baseline characteristics of the patients in the two models: the pregnancy outcomes were adjusted for age, race, plan type, income quartiles, drug use, smoking, previous cesarean section, chronic hypertension, thyroid disease, multivariate gestation, and pregestational diabetes mellitus. The delivery and neonatal outcomes were adjusted for age, race, plan type, income quartiles, drug use, smoking, previous cesarean section, chronic hypertension, thyroid disease, multivariate gestation, pregestational diabetes mellitus, pregnancy-induced hypertension, and gestational diabetes mellitus. Model B was adjusted as model A but with adjunction of two confounding factors: year of delivery and BMI grouping for obesity.

Hence, we can compare the statistical significance between the models and their variations. All analyses were conducted using SPSS 23.0 software (IBM Corporation, Chicago, USA). This study used exclusively publicly accessible, anonymized data; therefore, according to articles 2.2 and 2.4 of the Tri-Council Policy Statement (2010), Institutional Review Board approval was not required.

RESULTS

Pregnant women who underwent previous laparoscopic myomectomy were more likely to be older than 35 years of age, White ($P<.001$), with a lower household income ($P<.001$), and less likely to be Black, Hispanic or Asian, and to have private insurance compared with abdominal myomectomy group ($P<.001$). Patients with previous laparoscopic myomectomy were also more likely to smoke ($P<.001$) or use recreational drugs ($P=.001$) during the pregnancy. Pregnant women who underwent previous laparoscopic myomectomy were associated with a higher likelihood of having chronic hypertension ($P<.0001$), pregestational diabetes mellitus ($P<.0001$), and thyroid disease ($P=.033$). Pregnant women after previous abdominal myomectomy were more likely to have had a previous caesarian section ($P<.001$) and multiple gestation for the current pregnancy ($P=.02$). There was no significant difference between the two groups for the use of in vitro fertilization (IVF) (, $P=.61$) (Table 1).

Pregnant women after laparoscopic myomectomy as compared with abdominal myomectomy, in log-binomial logistic regression, had decreased rates of pregnancy-induced hypertension (adjusted risk ratios [aRR], 0.12; 95% CI, 0.006–0.24), gestational hypertension (aRR, 0.24; 95% CI, 0.08–0.76), pre-eclampsia (aRR, 0.18; 95% CI, 0.07–0.48), and pre-eclampsia or eclampsia superimposed on chronic hypertension (aRR, 0.03; 95% CI, 0.005–0.3), gestational diabetes mellitus (aRR, 0.14; 95% CI, 0.06–0.34), preterm premature rupture of membranes (aRR, 0.14; 95% CI, 0.02–0.96), preterm delivery (aRR, 0.36; 95% CI, 0.23–0.55), and CD (aRR, 0.01; 95% CI, 0.007–0.01) (Figs. 2 and 3, Supplemental Table 2).

The laparoscopic myomectomy group had a higher rate of spontaneous vaginal delivery (aRR, 35.57; 95% CI, 22.53–62.66), operative vaginal deliveries (aRR, 10.2; 95% CI, 8.3–12.56), uterine rupture (aRR, 6.1; 95% CI, 3.2–11.63), postpartum hemorrhage (aRR, 3.54; 95% CI, 2.62–4.8), hysterectomy (aRR, 7.74; 95% CI, 5.27–11.4), transfusion (aRR, 3.34; 95% CI, 2.54–4.4), deep venous thrombosis (aRR, 5.25; 95% CI, 1.8–15.31), pulmonary embolism (aRR, 7.44; 95% CI, 2.44–22.71), venous thromboembolism (aRR, 6.04; 95% CI, 2.85–12.8), disseminated intravascular coagulation (aRR, 2.77; 95% CI, 1.47–5.21), maternal infection (aRR, 1.66; 95% CI, 1.1–2.5), and maternal death (aRR, 2.04; 95% CI, 1.31–3.2), when compared with abdominal myomectomy in the log-binomial logistic regression model (Figs. 2 and 3 and Supplemental Table 2).

There were no differences between the two groups for placenta previa, placenta abruptio, chorioamnionitis, and

TABLE 1

Maternal characteristics of pregnant women after abdominal or laparoscopic myomectomy.

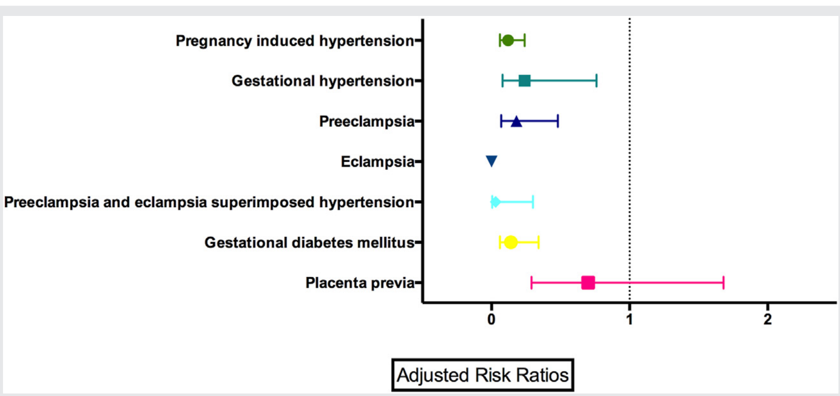
Characteristics	Pregnancy after abdominal myomectomy N = 13,868 (%)	Pregnancy after laparoscopic myomectomy N = 338 (%)	*P* value
Age (y)			
<25	1,704 (12.3)	65 (19.2)	.0001
25–34	6,695 (48.3)	110 (32.5)	
≥35	5,468 (39.4)	163 (48.2)	
Race			
White	5,391 (44.5)	157 (58.8)	.0001
Black	2,652 (21.9)	41 (15.4)	
Hispanic	2,678 (22.1)	38 (14.2)	
Asian and Pacific	745 (6.2)	<11[a]	
Native American	61 (0.5)	<11[a]	
Other	577 (4.8)	14 (5.2)	
Income quartiles			
<39,000	2,103 (23.0)	60 (30.6)	.0001
$39,000–$47,999	1,995 (21.8)	59 (30.1)	
$48,000–$62,999	2,316 (25.3)	34 (17.3)	
$63,000 or more	2,726 (29.8)	43 (21.9)	
Plan type			
Medicare	95 (0.7)	35 (10.4)	.0001
Medicaid	4,026 (29.1)	101 (30.0)	
Private including HMO	9,028 (65.2)	176 (52.2)	
Self-pay	341 (2.5)	15 (4.5)	
No charge	355 (2.6)	<11[a]	
Other	95 (0.7)	35 (10.4)	
Obesity	972 (7.0)	22 (6.5)	.72
Previous cesarean section	4,739 (34.2)	33 (9.8)	.0001
Smoking during pregnancy	389 (2.8)	38 (11.2)	.0001
Chronic hypertension	780 (5.6)	87 (25.7)	.0001
Pregestational diabetes mellitus	242 (1.7)	28 (8.3)	.0001
Thyroid disease	576 (4.2)	22 (6.5)	.033
Drug use	107 (0.8)	<11[a]	.008
Human immunodeficiency virus	14 (0.1)	<11[a]	.66
IVF	68 (0.5)	<11[a]	.61
Multiple gestations	501 (3.6)	<11[a]	.02

Note: HMO = health maintenance organization; IVF = in vitro fertilization.

[a] When 10 or fewer subjects are present, the investigators were required to list it as <11 to preserve patient anonymity.

Ginod. Outcomes after intramural myomectomy. Fertil Steril 2025.

FIGURE 2



Pregnancy outcomes after laparoscopic myomectomy vs. abdominal myomectomy, using log-binomial regression model 3, adjusted risk ratios and 95% confidence interval.

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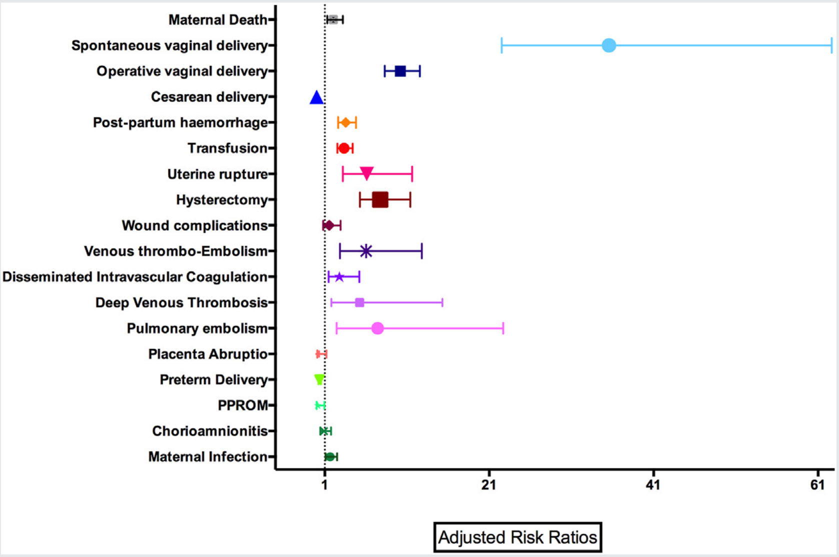
FIGURE 3



Delivery outcomes after laparoscopic myomectomy vs. abdominal myomectomy (using log-binomial regression, adjusted risk ratios, and 95% confidence interval). PPROM = preterm premature rupture of membranes.

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wound complications when using the log-binomial regression (Figs. 2 and 3 and Supplemental Table 2). When using the multivariate logistic regression model, the same results were found significant except for preterm premature rupture of membranes, maternal infection, deep venous thrombosis, and pulmonary embolism, which were not significant, whereas wound complications were. When using the same multivariate logistic regression, with adjunction of the year of delivery and presence of obesity (model B), our significant results stayed unchanged except for gestational hypertension, which became nonsignificant (adjusted odds ratio [aOR], 0.14; 95% CI, 0.2–1.0) (Supplemental Table 3).

There were significantly more neonates born small for gestational age after abdominal myomectomy (aRR, 0.15; 95% CI, 0.005–0.04) with both logistic regression types used (Supplemental Tables 2 and 3). More intrauterine fetal death after laparoscopic myomectomy (aRR, 2.99; 95% CI, 1.72–5.2) was found with the log-binomial logistic regression use, whereas it remained nonsignificant with the multivariate logistic regression model (Supplemental Tables 2 and 3). No differences were found for congenital anomalies regardless of the confounders or statistical analysis method used (Supplemental Tables 2 and 3).

DISCUSSION

Overall, we observed that pregnant women with previous abdominal myomectomy and laparoscopic myomectomy are completely different populations, with dissimilar risk factors and unlike pregnancy and delivery outcomes. We noted a completely different management mode of delivery postmyomectomy. Laparoscopic myomectomy patients delivered at almost 85% vaginally, with increased risks of uterine rupture and its related complications, whereas 98% of abdominal myomectomy patients delivered through cesarean section.

In the years 2004–2014, our results showed that 2.4% of pregnant women had a previous myomectomy through laparoscopy and 97.6% through the abdominal route. Data from the State of California evaluating the racial and socioeconomic outcomes of myomectomies, from the same study period (2005–2012) reported that 3.67% of women underwent laparoscopic myomectomy and 96.33% abdominal myomectomy, indicating that laparoscopic myomectomy was not the standardized procedure by the time of the study (15), and were similar to the rates seen in our study.

There were no differences in obesity rates (BMI >30 kg/m^2), and a low representation of obese patients with 7% and 6.5% in abdominal vs. laparoscopic myomectomy groups, respectively. In the United States, the 2011–2014 National Health and Nutrition Examination Survey data indicate that the prevalence of obesity in women aged 20–39 years is ≥34.4% (16). Most likely, our findings are linked with a combination of a lower rate of myomectomy performed in morbidly obese patients, and a lower percentage of conception in obese patients postmyomectomy, either spontaneously or with IVF use, obesity itself being an infertility risk factor (17, 18).

The distribution of race was different among women with prior abdominal myomectomy compared with those with prior laparoscopic myomectomy. Indeed, Whites, Native Americans, and Other ethnicities underwent the larger proportion of laparoscopic myomectomy before pregnancy, whereas Blacks, Hispanics, and Asians were found more likely to undergo abdominal myomectomies before pregnancy. This is concordant with the literature on the American population (19, 20). Dallas et al. (15) reported for the State of California during the same studied period, that White and Other ethnicities underwent a larger proportion of laparoscopic myomectomy, whereas Asian, Hispanic, and Black women were twice as likely to undergo an abdominal myomectomy. These disparities were adjusted for in our multivariate analysis.

Patients in the laparoscopic myomectomy group had lower household incomes ($P<.001$) and were less likely to have private insurance compared with the abdominal myomectomy group ($P<.001$). This result is discordant with previous literature showing a higher likelihood of laparoscopic procedures in patients with private insurance (21–23). In the laparoscopic myomectomy group, we found more active smoking ($P<.001$), use of recreational drugs ($P=.001$) during the pregnancy, and higher rates of chronic disease prepregnancy including, chronic hypertension ($P<.0001$), pregestational diabetes mellitus ($P<.0001$), and thyroid disease ($P=.033$). We adjusted for these differences between the groups in our multivariate logistic analysis.

As certain covariates have a high prevalence in our population, we used two different types of logistic regression, to be able to compare the effects estimates. We also used three different adjusted models in the log-binomial analysis to detect any changes between the confounders.

In the log-binomial regression, the crude risk ratios were not significant for preterm premature rupture of membranes, and pre-eclampsia and eclampsia superimposed on chronic hypertension, and became significant with the three models, respectively, adjusted for age (model 1), age and presence of obesity (model 2), and age and presence of obesity, chronic hypertension, and pregestational diabetes mellitus (model 3). Inversely, the crude and aRR were significant for wound complications for models 1 and 2 but became nonsignificant with the model 3 adjustment. In the multivariate logistic regression models, all factors remained significant regardless of whether adjustments were made for the year of delivery and the presence of obesity, except for gestational hypertension, which became nonsignificant.

When comparing the two types of logistic regression, the deep venous thrombosis and pulmonary embolism were at the margin to significance with the multivariate logistic regression and are significant with the three adjusted models of log-binomial regression, and only one became nonsignificant: wound complications. Moreover, maternal infections and intrauterine fetal death also became significant with the log-binomial regression use. Indeed, maternal infections likely increase with postpartum hemorrhage, hysterectomy, and thrombo-embolic complications, found in the postlaparoscopic myomectomy group.

Women with a history of previous abdominal myomectomy may have underlying risk factors for hypertensive disorders of pregnancy and gestational diabetes mellitus. One possible underlying risk factor linked with hypertensive disorders of pregnancy could be the local ischemia induced in the myometrium bed by the stitches and the remodeling of the vascularization in this area, which could impair placental invasion in scared uteri. For gestational diabetes mellitus, we can only hypothesize the same co-risk with insulin resistance. Additional research is needed to investigate whether pregnant women with a history of a previous abdominal myomectomy can benefit from additional screening or intervention during pregnancy (i.e., medication to reduce pre-eclampsia and early gestational diabetes mellitus screening).

We found more multiple gestations ($P=.02$) after abdominal myomectomy, whereas no significant difference in pregnancies was derived from IVF ($P=.61$) between the two groups. This might be linked to the increased proportion of Black women in the abdominal myomectomy group; this ethnicity is known to have higher rates of spontaneous multiple pregnancies (24). Multiple pregnancies in scarred uteri raise concerns about the potential increase in rupture risk. However, uterine rupture was increased in the laparoscopic myomectomy group, when controlling for rates of multiple gestations and when not controlling for confounding effects including multiple gestations.

Pregnant women after abdominal myomectomy had significantly more preterm premature rupture of membranes and preterm deliveries than after laparoscopic myomectomy. Preterm delivery is a well-described adverse obstetric outcome in pregnant patients with untreated fibroids, and their numbers and locations increase this risk (2, 6, 14, 25). However, there is limited data comparing this specific outcome according to the surgical approach performed during prepregnancy. Two randomized controlled trials (26, 27) compared preterm deliveries after abdominal myomectomy and laparoscopic myomectomy, with a very low number of cases (n = 65 and 66 and n = 68 and 68, respectively), and did not find any significant differences between the groups. Indeed, Metwally et al. (28) in a recent meta-analysis pooled these two randomized controlled trials and were unable to conclude if laparoscopic myomectomy reduces preterm deliveries or not (OR 0.70. 95% CI, 0.11–4.29; participants = 177; studies = 2; $I^2 = 0\%$) . A retrospective cohort study found a higher risk of preterm deliveries after a previous myomectomy (removal of ≥ 1 leiomyoma, measuring ≥ 20 mm or multiple leiomyomas whatever the size by hysteroscopy, laparoscopy, or laparotomy with or without persistent leiomyomas) and included 301 (1.5%) patients with leiomyomatous uterus (154 un-operated women and 147 operated women) and 19866 nonuterine control pregnancies. Preterm deliveries were significantly higher for un-operated leiomyomatous uterus (aOR, 2.7; 95% CI, 1.6–4.6) and operated women (aOR, 2.3; 95% CI, 1.3–3.9) when compared with the nonleiomyomatous uterus group (29).

However, different routes of surgery may also lead to different management of pregnancy and delivery. Indeed, the increase in preterm deliveries found in the abdominal myomectomy group may also be iatrogenic. Obstetricians might have planned preterm cesarean section because of the prior abdominal myomectomy to reduce the risks of uterine rupture.

We highlighted higher rates of hypertensive disorders of pregnancy and gestational diabetes mellitus after abdominal myomectomy than laparoscopic myomectomy, even after adjusting for prepregnancy diabetes, and chronic hypertension, which were higher in the laparoscopic myomectomy group. To our knowledge, these obstetric complications postmyomectomy are studied in a large cohort for the first time according to the surgical approach and likely represent differences in the two populations. We can also hypothesize that the healing process is different between the two techniques and that the abdominal myomectomy procedure might have a more detrimental effect on the deep myometrium and the endometrium, (through the generation of scar tissue and suboptimal vascularization) and could impair placentation leading to an increase in hypertensive disorders of pregnancy.

As for the increased rate of uterine rupture and resultant complications seen in laparoscopic myomectomy as compared with abdominal myomectomy, this is likely related to allowing women to labor and deliver vaginally with scared uteri. Although rates of maternal death, uterine rupture, intrauterine fetal death, and maternal infections were increased in laparoscopic myomectomy, they were rare, and this increase needs to be confirmed in further studies. However, transfusions were vastly increased in laparoscopic myomectomy as compared with abdominal myomectomy and are likely related to undiagnosed ruptures and/or atony of the uterus in this group.

Our results did not find any increase in the risk of placenta previa, or abruptio, when comparing the two groups. We found that abdominal myomectomy patients delivered by cesarean section in 97.8% of cases, whereas vaginal delivery was successful in 84% of patients after laparoscopic myomectomy, often with operative vaginal deliveries (41%).

We described a rate of 16% for cesarean section after laparoscopic myomectomy, whereas the literature reports 50%–80% of CD (30, 31) in this group. However, we highlighted a significantly higher rate of postpartum hemorrhage, transfusions, hysterectomy, venous thrombo-embolism, disseminated intravascular coagulation, and possibly uterine rupture and maternal death after laparoscopic myomectomy.

The main finding in our study seems to be that patients after laparoscopic myomectomy are commonly directed to vaginal delivery, with higher risks of hemorrhage related to delivery complications when compared with abdominal myomectomy patients. Obstetricians need to improve patient selection for vaginal delivery attempts after laparoscopic myomectomy, to prevent uterine rupture or hemorrhage. No matter the surgical approach, pregnancies after abdominal myomectomy or laparoscopic myomectomy should be monitored identically, according to the risks potentially passed on by the number/size of fibroids or cavity effraction.

These vaginal delivery attempts after myomectomies, whatever the surgical approach, necessitate close surveillance during each stage of labor, with resultant interventions if needed. Increased use of postpartum uterotonics, if needed based on close surveillance of uterine atonie, should be undertaken in laparoscopic myomectomy subjects.

Future research should also strive to obtain large data sets with detailed information on both the fibroids type and numbers removed, the type of surgery performed, and information on previous surgical treatment for this gynecologic condition. There is also an urgent need for a comparison of obstetric, delivery, and neonatal outcomes between the type of surgery and pregnant to fibroid women without prior myomectomy. Further studies accessing the causes of hemorrhage and resultant complications in laparoscopic myomectomy should be studied, which may be related to inherent difficulties in uterine contractions, or undetected uterine ruptures, leading to lower morbidity in delivery after surgical myomectomies.

Although this observational study has many strengths, including its large sample size, the comparison between two surgical approaches for myomectomy, and the ability to adjust for confounders, we must also recognize its limitations. The utilization of an administrative database can reduce the precision and uniformity of data coding by multiple diverse individuals. Consequently, a comprehensive account of pregnancies in women with prior abdominal myomectomy or laparoscopic myomectomy may not be entirely encompassed. This limitation in coding accuracy and its ability to capture perinatal conditions and complications is already known (32), leading to data entry errors, missing data bias, misclassification bias, and observer bias.

Our analysis of the HCUP database was confined to data up until 2014, using ICD-9 codes. Then, a shift to ICD-10 coding occurred in 2015, rendering the datasets from these two periods incompatible for direct comparison, to avoid a temporal bias.

We were not able to adjust on: the parity and the number of pregnancies after a myomectomy by the same woman, the presence of a prior preterm delivery and its etiology, the fibroid sub-phenotype, and were unaware of the presence of residual myomas at delivery, which may mediate their association with the pregnancy outcomes. We could adjust for BMI grouping only (obesity classification). The limited access to usual covariables in the HCUP database and the retrospective characteristic of the study bring major limitations with risks of unknown confounding bias, and our results must be interpreted with caution.

We cannot discriminate between elective vs. emergency cesarean sections and the failure rate of vaginal delivery in each group. The maternal mortality rate, the risk of uterine rupture, and the wound complication rate are based on a small number of subjects in the laparoscopic myomectomy groups and should be further studied before conclusions can be drawn.

Despite these limitations, having access to such a large data repository allows a comprehensive assessment of the differences in population characteristics at the time of delivery and on obstetric and delivery risks of pregnancy post abdominal and laparoscopic myomectomy. The uniqueness of this study is the extensive reporting of pregnancy and delivery outcomes for such a large surgical cohort.

CONCLUSION

This study aimed to describe the population and the complications of pregnancies and deliveries after surgical myomectomy by abdominal and laparoscopic routes. The results of this study cannot be used to compare the two techniques to prioritize one over another for clinical practice based on pregnancy complications. Abdominal myomectomy patients have increased risks of hypertensive disorders of pregnancy and gestational diabetes mellitus, whereas laparoscopic myomectomy patients have higher risks of hemorrhage and related complications.

Although many women post laparoscopic myomectomy undergoes successful uncomplicated vaginal deliveries. Consideration should be given to better patient selection to prevent hemorrhage, related complications, and possibly increased postpartum use of uterotonics in deliveries after laparoscopic myomectomy. Patients should be informed of the specific delivery risks of both modes of delivery and closer management of vaginal delivery attempts should be performed, to reduce the morbidity of these patients.

CRediT Authorship Contribution Statement

Perrine Ginod: Conceptualization, Methodology, Visualization, Writing – original draft. **Ahmad Badeghiesh:** Methodology, Formal analysis, Software, Data curation. **Haitham Baghlaf:** Supervision, Methodology, Conceptualization. **Michael H. Dahan:** Writing – review & editing, Validation, Supervision, Project administration.

Declaration of Interests

P.G. has nothing to disclose. A.B. has nothing to disclose. H.B. has nothing to disclose. M.H.D. has nothing to disclose.

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Resultados del embarazo y el parto después de una miomectomía abdominal o laparoscópica: evaluación de una base de datos de población estadounidense.

Objetivo: Evaluar las características de la población y las complicaciones obstétricas después de una miomectomía abdominal vs. una miomectomía laparoscópica.

Diseño: Estudio de cohorte retrospectivo.

Entorno: Datos de la muestra nacional de pacientes hospitalizados del Proyecto de Utilización y Costos de Atención Médica (HCUP-NIS) representativos de más del 20 % de todas las admisiones hospitalarias en los Estados Unidos.

Paciente(s): Un total de 13.868 y 338 embarazos después de miomectomía abdominal o laparoscópica, respectivamente

Intervención (es): Ninguna.

Principales medidas de resultados: Los resultados obstétricos después de miomectomías abdominales o laparoscópicas se recopilaron utilizando altas hospitalarias desde 2004 hasta 2014 inclusive, y se ajustaron mediante regresión logística múltiple y binomial en diferentes modelos para edad, obesidad, hipertensión crónica y diabetes mellitus pregestacional. Se analizaron los resultados del embarazo, el parto y el neonato.

Resultado(s): La miomectomía abdominal se caracterizó por pacientes más jóvenes, tasas más bajas de hipertensión crónica en caucásicos, diabetes pregestacional, tabaquismo activo, uso de drogas ilícitas y tasas más altas de cesáreas previas y gestaciones múltiples en comparación con la miomectomía laparoscópica. Las mujeres embarazadas con miomectomía laparoscópica tuvieron tasas reducidas de hipertensión inducida por el embarazo (cociente de riesgos ajustado [aRR], 0,12; intervalo de confianza del 95% [IC], 0,006-0,24]), hipertensión gestacional (aRR, 0,24; IC del 95%, 0,08-0,76), preeclampsia (aRR, 0,18; IC del 95%, 0,07-0,48) y preeclampsia o eclampsia superpuesta a hipertensión crónica (aRR, 0,03; IC del 95%, 0,005-0,3), diabetes mellitus gestacional (aRR, 0,14; IC del 95%, 0,06-0,34), rotura prematura de membranas (aRR, 0,14; IC del 95%, 0,02-0,96), parto prematuro (aRR, 0,36; IC del 95 %, 0,23–0,55) y parto por cesárea (aRR, 0,01; IC del 95 %, 0,007–0,01) y pequeño para la edad gestacional (aRR, 0,15; IC del 95 %, 0,005–0,04), en comparación con el grupo de miomectomía abdominal. El grupo de miomectomía laparoscópica tuvo una tasa más alta de parto vaginal espontáneo (RRa, 35,57; IC del 95 %, 22,53-62,66) y quirúrgico (aRR, 10,2; IC del 95 %, 8,3-12,56), rotura uterina (aRR, 6,1; IC del 95 %, 3,2-11,63), hemorragia posparto (aRR, 3,54; IC del 95 %, 2,62-4,8), histerectomía (aRR, 7,74; IC del 95 %, 5,27-11,4), transfusión (aRR, 3,34; IC del 95 %, 2,54-4,4), embolia pulmonar (aRR, 7,44; IC del 95 %, 2,44-2,71), coagulación intravascular diseminada (aRR, 2,77; IC del 95 %, 1,47–5,21), infección materna (aRR, 1,66; IC del 95 %, 1,1–2,5), muerte (aRR, 2,04; IC del 95 %, 1,31–3,2) y muerte fetal intrauterina (aRRa, 2,99; IC del 95 %, 1,72–5,2) en comparación con el grupo de miomectomía abdominal

Conclusión(es): Las mujeres que se han sometido a una miomectomía abdominal previa tienen factores de riesgo subyacentes de trastornos hipertensivos del embarazo y diabetes gestacional. Las mujeres que se han sometido a miomectomías laparoscópicas tienen mayores riesgos de sangrado, ruptura uterina, complicaciones resultantes y muerte, y deben ser monitorizadas como pacientes de alto riesgo, al igual que las que se sometieron a miomectomías abdominales.