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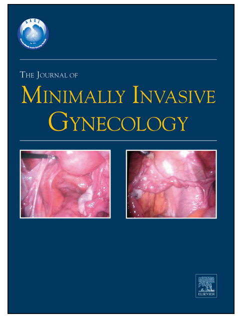

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Pregnancy Outcomes and Risk Factors for Uterine Rupture after Laparoscopic Myomectomy: A Single-center Experience and Literature Review

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Abstract

Study Objective: To evaluate pregnancy outcomes following laparoscopic myomectomy (LSM), focusing on the risk of uterine rupture

Design: Retrospective cohort study (Canadian Task Force classification III)

Setting: University hospital

Patients: Of 676 women who visited the obstetrics department for a definite pregnancy following LSM performed at the same center between 1994 and 2012, only the 523 women who had follow up through the end of pregnancy were included.

Interventions: All patients underwent LSM and their medical charts were retrospectively reviewed.

Measurements and Main Results: Multiple myomas were removed in 35.2% of cases, intramural-type lesions occurred in 46.5% of cases, and mean myoma diameter was 4.9 cm. Pregnancy outcomes after LSM were as follows: there were 400 (76.5%) full-term deliveries and 100 (19.1%) vaginal deliveries, with other adverse outcomes being no different than the general population. The mean interval between LSM and pregnancy was 14 months, and only 3 (0.6%) cases of uterine rupture occurred during pregnancy. In analysis, by reviewing the published cases of uterine rupture, we found that the mean diameter, myoma number and type, and rate of uterine suture were similar between the ruptured cases and our entire cases of LSM.

Conclusion: LSM can be safely applied in women of reproductive age who want to become pregnant. Uterine rupture occurs in rare cases regardless of myoma features, but further large-scale studies are required to ascertain the detailed effects of various surgical techniques.

Key words: laparoscopic myomectomy; uterine rupture; pregnancy outcome

Introduction

Uterine leiomyomas are the most common pelvic tumors in women and thus the most common diagnosis preceding hysterectomies in the United States (1). Approximately 12% to 25% of reproductive-age women are clinically diagnosed with uterine myomas, and approximately 80% of surgically excised uteri contain myomas (2). Laparoscopic myomectomy (LSM) has been broadly implemented as a uterine-preserving modality since Semm et al. first described it in 1979 (3). In the past decade, minimally invasive surgical techniques have dramatically improved, and a laparoscopic approach has been widely applied in a variety of gynecologic indications (4). However, LSM is still considered technically challenging, mainly because of issues regarding hemostasis during myoma excision and suturing of uterine defects with sufficient tensile strength. Nevertheless, numerous studies published to date comparing the surgical outcomes of LSM and abdominal myomectomy (AM) have indicated that LSM is as safe as, and even more beneficial than, AM in terms of reducing operative blood loss, postoperative pain, hospital stays, and recovery time (5, 6).

However, the effect of LSM on subsequent pregnancies has not been fully evaluated. In one comparative study of LSM and AM, the authors stated that perinatal outcomes were similar between LSM and AM cases based on findings that both groups had high success rates (93% versus 95% in women who attempted vaginal delivery) of vaginal delivery with no cases of uterine rupture (7). More recently, however, a meta-analysis of 56 articles published from 1970 to 2013 regarding myomectomy showed a trend toward an increased occurrence of uterine rupture following LSM (1.2%) versus AM (0.4%) (8). In 3,685 pregnancies, the authors found 29 cases of uterine rupture: 24 after LSM, three after AM, one after hysteroscopic myomectomy, and one after an unknown mode of myomectomy. Thus, the controversy has remained unresolved because major LSM-related complications in subsequent pregnancies, such as uterine rupture, are rare. In addition, data from large cohorts are limited, and most papers on the subject are case studies, which cannot be used to calculate the incidence of adverse events per number of procedures performed.

Despite such difficulties, it remains important to evaluate the effect of LSM on pregnancy because the demand for minimally invasive surgeries among gynecologic patients is increasing, and most women with symptomatic myomas are in their 20s through 40s, which are prime reproductive years. In the present study, we investigated pregnancy outcomes following LSM and detailed our experiences with rare cases of uterine rupture.

Methods

We performed a retrospective review of medical records of all consecutive patients who underwent LSM at Cheil General Hospital and Women's Healthcare Center between August 1994 and December 2012 and later had a definite pregnancy, defined as a visible gestational sac on sonography. Regardless of the surgical indication and combined surgery performed, patients were included if all surgical specimens were benign and uterine leiomyomas were laparoscopically excised. We excluded cases of conversion to laparotomy as well as hysteroscopic myomectomy. Regarding pregnancy, only cases of first pregnancies after LSM were included, and data were obtained only from women who were followed until the end of their pregnancy.

Data were collected on the patients' demographic characteristics, pathology results, and LSM surgical findings, including the number, type, and location of the myomas. According to the International Federation of Gynecology and Obstetrics (FIGO) classification system (9), myomas were categorized as intramural (FIGO types 3, 4), subserosal (including pedunculated, FIGO types 5-7), or intraligamentary (defined as myomas originating in the base of the broad ligament, FIGO types 8) and their locations were described as on either the anterior or posterior uterine wall and as either fundus or elsewhere, such as the low uterine segment or intraligament. Obstetric outcomes were also evaluated, and data collected included the time interval between myomectomy and pregnancy, conception method, delivery mode, and obstetric complications.

Additionally, we attempted to identify all published cases of uterine rupture following LSM via electronic searches of PubMed and Google Scholar using the search terms: uterine myoma, myomectomy, and uterine rupture. The clinical characteristics were thoroughly reviewed, and data collected included patients' demographic characteristics, myoma types, locations and diameters of the largest myoma, suturing techniques, times to pregnancy, and gestational ages at uterine rupture.

Cheil General Hospital and Women's Healthcare Center is one of the largest institutions in Korea specializing in obstetrics and gynecology, and LSM was performed by more than 20 surgeons during the lengthy study period. However, all surgeons followed the institutional standard for LSM: after injection of vasopressin into the myoma surface, an incision was made through the uterine wall using monopolar electro-surgical scissors; the myoma was extracted by blunt dissection, and bleeding was coagulated with bipolar diathermy via a four-port system. Depending on its depth and length, the defect was closed with one or two intracorporeal suture layers using 0-polyglactin in an interrupted or continuous manner. If the endometrial cavity was exposed, a three-layer suture was performed.

This study was approved by the institutional review board of the Cheil General Hospital and Women's Healthcare Center, which waived the requirement for informed consent. Continuous variables were described as the mean ± standard deviation with 95% confidence interval or median and range calculated with the SPSS 20.0 statistical software package.

Results

We identified a total of 676 women who had a pregnancy after LSM. Of the 676 patients, 153 women were lost to follow-up or had an ongoing pregnancy at the time of data collection. The other 523 women who were followed until the ends of their pregnancies were included in the present study. The mean age of the patients was 31.7 years, and most (91.6%) were nulliparous (Table 1). One myoma was removed in 64.8% of cases and multiple myomas were removed in 35.2% of cases. The mean diameter of the largest myoma removed was 4.9 cm (range, 1–15 cm). Approximately half (50.7%) of the myomas were subserosal, and the other half (46.5%) were intramural. Most (83.6%) myomas were located in the fundus rather than the low segment of the uterus, and the distribution of myomas in either the anterior or posterior uterine wall was nearly even. After myoma excision, uterine suturing was performed in 67.1% of cases, and no-suture methods, such as bipolar hemo-coagulation or endoscopic loop ligation, were used in 31.5% of cases. LSM demonstrated tolerable surgical outcomes for estimated blood loss, operative time, and duration of hospital stay.

The mean interval between LSM and pregnancy was 14 months. Thirteen percent of the pregnancies ended in miscarriages, 10.3% in preterm deliveries, and 76.7% in full-term deliveries. Vaginal delivery occurred in only 100 women (19.1%), and only 27 (8.8%) of the 307 women with intramural myomas delivered vaginally. The rates of obstetric complications, whether clearly related to LSM or not, are presented in Table 2. Uterine rupture occurred in three cases (0.6%), and placental abnormalities, such as placenta accreta and placenta previa, were observed in 22 (4.2%) cases.

The details of the cases with uterine rupture are described in Table 3 and depicted in Figure 1. All three cases of uterine rupture occurred in pregnancy without labor in nulliparous women who had a single myoma. In one case (Pt 1), the patient visited our outpatient clinic for prenatal care at 11 weeks' gestation, following an unremarkable prenatal course. She underwent an emergency cesarean section at a gestational age of 37 weeks due to abdominal pain, and a fundal rupture of 7 cm was found, but no risk factors were seen except for excessive use of bipolar diathermy during LSM. The second patient (Pt 2) visited our clinic at 8 weeks' gestation and, had a twin pregnancy and a history of two myomectomies: AM due to multiple myomas, including a fundal myoma six years earlier, and LSM due to a subserosal myoma six months earlier. During follow-up, the routine prenatal evaluation was unremarkable, but the patient underwent an emergency cesarean section at a gestational age of 32 weeks due to abdominal pain. A fundal rupture of 7 cm with hemoperitoneum was found, but the two fetuses survived. In the third case (Pt 3), an emergency laparotomy was performed because of abdominal pain at 21 weeks of gestation. A uterine rupture of 5 cm was found on the LSM scar, and the placenta suggested placenta accreta. Because of massive hemorrhage, a total hysterectomy was performed, resulting in fetal death.

The 21 articles (10-30) published regarding uterine rupture following LSM describe a total of 34 events. The results of reviewing cases of uterine rupture from the published reports with the present study are shown in Table 4. The median age was 32 years and the rate of multiparous women was 6.3% (one of 14 cases with eligible data). Women with uterine ruptures had no unique characteristics related to the features of uterine myomas. Myoma size was 4 cm (ranges 1.2-11 cm in 30 cases with eligible data) and most ruptures (90.6%) occurred when a single myoma had been removed. In cases of uterine rupture, myomas were subserosal or pedunculated in 52.8% of cases and located in the posterior uterine wall in 47.1% of cases, similar to women in the present study (50.7% and 46.1%, respectively). Uterine defects were sutured in 63.3%, and the median time to pregnancy was 12 months. The majority of the ruptured cases (91.7%) occurred before the onset of labor, and the time of rupture ranged widely from 17 to 40 weeks' gestation.

Discussion

Through approximately 20 years of experience, we demonstrate that LSM can be safely performed in women of reproductive age with acceptable surgical and obstetrical outcomes. Among 523 pregnancies, only three (0.6%) cases of uterine rupture occurred. We found no association between patient characteristics or clinical features of myomas and uterine rupture.

In a recent systemic review (6), the authors analyzed nine randomized controlled trials (RCTs) comparing the outcomes of LSM and AM regarding perioperative variables, reproductive outcomes, and myoma recurrence, and concluded that LSM is an acceptable alternative to an abdominal approach and has some clear advantages. Complication rates were similar between the two groups, and the most common complications were minor for both LSM and AM, such as postoperative fever and infection. However, the obstetric outcomes following myomectomy were not clearly assessed because of limited data. Nonetheless, they are worthy of attention because some complications in pregnancy (e.g., uterine rupture) can increase mortality rates in both the mother and fetus.

Despite the heterogeneity of methodologies in the published studies, it has been suggested that, compared to AM, LSM is associated with an increased rate of cesarean delivery and of uterine rupture. In a recent meta-analysis (8) of 56 articles comprising 2,017 pregnancies following LSM and 705 pregnancies following AM, the likelihood of an elective cesarean section was significantly increased following LSM versus AM, although the study lacked detailed information as to the indication for cesarean delivery, of which association with myomectomy might be ambiguous (e.g., breech presentation or placental anomaly). However, the authors found that the rate of successful vaginal delivery was as high as 93% following LSM and 88% following AM among women who attempted vaginal birth. Because the meta-analysis included not only prospective studies, but also case reports and retrospective studies, the two RCTs (31, 32) reported to date are worthy of attention. Palomba et al. (31) showed that the rate of cesarean delivery was 72% in 32 pregnancies after LSM versus 64% in 22 pregnancies after mini-laparotomic myomectomy, which was not significantly different. In the other RCT (32), a cesarean section was performed in 65% of cases (13 of 30 pregnancies) after LSM and in 78% of cases (21 of 33 pregnancies) after AM, with no cases of uterine rupture. These findings are consistent with our data, which show a cesarean delivery rate of 67%.

In the present study, uterine rupture occurred in three patients (0.6%) despite use of the same LSM procedures as those of the RCT for uterine incision with a monopolar device, electrocoagulation with bipolar current, and suturing in one or two layers in an interrupted or continuous manner using intracorporeal knots. In fact, given the low incidence of uterine rupture, the number of pregnancies in the two RCTs is insufficiently large. The prevalence of uterine rupture is estimated to be approximately 1% even in women with a history of cesarean section requiring a full-thickness incision in the uterine wall, suggesting a higher risk of rupture from cesarean section than from LSM (33). In their meta-analysis, Claeys et al. (8) reported that the risk of uterine rupture during labor and delivery was low (0.75 %), but was higher after LSM (1.2%) than after AM (0.4%). Although the difference in the meta-analysis was not statistically significant, we suggest that a large cohort study using a homogenous population should be performed based on the findings.

Due to its rarity, no study has examined the risk factors for uterine rupture after LSM based on experience. An Italian multicenter trial (14) with a large prospective LSM cohort found that myoma size (>5 cm), number (>3), and type (intraligamentous) were significantly linked to an increased risk of major complications. However, those complications mainly consisted of intraoperative or perioperative surgical complications, such as hemorrhage and bowel injury, with only one case of uterine rupture in pregnancy. Therefore, it is questionable whether those risk factors can also predict uterine rupture in pregnancy. Other authors have indicated various potentially related factors, such as myoma types, endometrial cavity exposure, use of sutures, intramural hematomas, indentations, postoperative infection, and uterine fistulas, based on their experiences (34). According to expert opinions, a cesarean section is recommended if more than 50% of the myometrium has been disrupted because the myometrium, not the endometrium, is responsible for uterine integrity (35). However, our data show that approximately half of these cases were of the subserosal or pedunculated type in women both with and without ruptures, and endometrial cavity exposure was identified in only 20% of the events.

In most articles on LSM, the surgical techniques used are largely heterogeneous, and numerous confounding factors (e.g., multiple pregnancies) are implicated in the occurrence of adverse obstetric outcomes. Consequently, conflicting results have been published on the role of sutures and electrocoagulation in uterine rupture. In a review article, the authors recommended applying sutures even in pedunculated or subserosal myomas because uterine ruptures have reportedly followed LSMs performed using only electrosurgery (34). However, our results showed that uterine defects were sutured in cases of rupture at a rate similar to that of the entire cases after LSM in the present study. During a relatively long study period of 10 years, our three cases of rupture occurred in recent years (between 2011 and 2012) after the surgeons' over 100 cases of LSMs since their first LSM performed at our institution. This implies that cases of uterine rupture were not related to the surgeons' learning curve.

In addition, the time between surgery and pregnancy varied by up to eight years, and the median time tended to be longer in cases of uterine rupture. Therefore, we reasoned that there might be no absolutely safe time interval between LSM and pregnancy. Our findings from a literature review showed that the rate of uterine rupture during labor was very low (8.3%), and most ruptures, including our three cases, occurred without labor. In a meta-analysis (8), the authors found that uterine rupture after myomectomy occurred before labor in all reported cases except one, in which the mode of myomectomy was unknown. These results suggest that labor is not an indispensable prerequisite for uterine rupture after LSM in pregnancy.

The present study has several limitations. First, we failed to collect complete data regarding surgical findings (such as endometrial cavity exposure, number of layers sutured, intensity of electrocoagulation used) because of missing data in the surgical records. Considerable literature has indicated that those factors probably contribute to the occurrence of uterine rupture (10, 16, 36). As a consequence, we speculate that those may be the only potential risk factors for uterine rupture, because the rates of all other factors were similar between women with and without ruptures. The other weakness of our analysis is in the study design, in which the incidences of obstetric complications other than uterine rupture after LSM were not compared with those after AM, although those incidences seem to be within acceptable ranges based on previously reported studies (6, 37). In conclusion, our data show that LSM is a safe surgical option in women who desire pregnancy. Uterine rupture is extremely rare, and concern over rupture based on the preoperative findings of myomas must not deter surgeons from using LSM. However, further large RCTs are warranted to clarify pregnancy outcomes according to the surgical techniques used for LSM.

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Table legends

Table 1. Basic characteristics and surgical findings at myomectomy (n=523)

Table 2. Obstetric outcomes after laparoscopic myomectomy (n=523)

Table 3. Detailed surgical findings and obstetric outcomes of the three cases with uterine rupture following laparoscopic myomectomy

Table 4. Clinical characteristics in uterine rupture from the cases of published studies (n=34) and the present study (n=3)

Figure legends

Fig. 1. Three cases of uterine rupture in pregnancy following myomectomy: laparoscopic view of pre- (a, c, e) and post-LSM (b, d, f) and gross finding (g) during laparotomy. Patient 1 had a 5-cm intramural myoma on anterior fundus (a), and the uterine defect was repaired using bipolar diathermy and suture (b). Patient 2 had a 5-cm subserosal myoma on the anterior fundus (c) with severe pelvic adhesion and endometriosis. A post-operative uterine defect (arrow) is seen in (d). Patient 3 had a 7-cm subserosal myoma on the posterior low segment of the uterus (e), and the defect was repaired without endometrial cavity exposure (f). In patient 3, a uterine rupture of 5 cm in diameter was seen on the LSM scar during exploratory laparotomy. The placenta (arrow) was difficult to implement, suggesting placental accrete (g).

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1. Basic characteristics and surgical findings at myomectomy (n=523)

Variables	
Age (years)	31.7 ± 3.5 (31.4, 32.0)
Body mass index (kg/m^2)	21.5 ± 2.8 (21.3, 21.8)
Parity	
Nulliparous	479 (91.6%)
Multiparous	44 (8.4%)
Number of myoma removed	
Single	339 (64.8%)
Multiple	184 (35.2%)
Myoma size* (cm)	4.9 ± 2.5 (4.7, 5.1)
Type of myoma*	
Intramural	243 (46.5%)
Subserosal	265 (50.7%)
Intraligamentary	15 (2.9%)
Location of the myoma*	
Uterine fundus	437 (83.6%)
Uterine low segment	71 (13.6%)
Intraligamentary	15 (2.9%)
Location of the myoma*	
Anterior uterine wall	267 (51.1%)
Posterior uterine wall	241 (46.1%)
Intraligamentary	15 (2.9%)
Suture of uterine incision site	
Yes	351 (67.1%)
No†	165 (31.5%)
Not recorded	7 (1.3%)
Estimated blood loss (ml)	162.5 ± 156.2 (149.8, 167608
Operative time (min)	97.6 ± 57.0 (92.8, 102.6)
Hospital stay (days)	3.2 ± 1.5 (3.1, 3.4)

Data are expressed as mean ± standard deviation (95% confidence interval) or number (%).
*, these findings refer to only the largest myoma in cases of multiple myomas.
†, includes cases using either bipolar hemocoagulation or endoscopic loops

2. Obstetric outcomes after laparoscopic myomectomy (n=523)

Variables	
Time interval between myomectomy and pregnancy (months)	13.9 ± 0.7 (12.6, 15.3)
History of cesarean section	16 (3.1%)
Conception method	
Spontaneous pregnancy	338 (64.6%)
In vitro fertilization	140 (26.8%)
Other assisted reproductive techniques*	45 (8.6%)
Twin pregnancy	46 (8.8%)
Pregnancy outcome	
Miscarriage (<20 weeks)	68 (13.0%)
Preterm delivery† (20≤ x <37 weeks)	54 (10.3%)
Full term delivery (≥37 weeks)	401 (76.7%)
Delivery mode	
Spontaneous abortion†	59 (11.3%)
Vaginal delivery	100 (19.1%)
Cesarean section	350 (66.9%)
Obstetric complications	
Uterine rupture	3 (0.6%)
Preterm premature rupture of membrane	14 (2.7%)
Cervical incompetence	17 (3.3%)
Placental abnormalities (previa, abruptio, accreta, percreta)	22 (4.2%)
Fetal malpresentation at delivery	23 (4.4%)
Preterm labor	54 (10.3%)

Data are expressed as mean ± standard deviation (95% confidence interval) or number (%).
*, includes controlled ovarian hyperstimulation and intrauterine insemination
†, includes intrauterine fetal death and artificial termination due to fetal anomaly and preterm premature rupture of membrane

3. Detailed surgical findings and obstetric outcomes of the three cases with uterine rupture following laparoscopic myomectomy

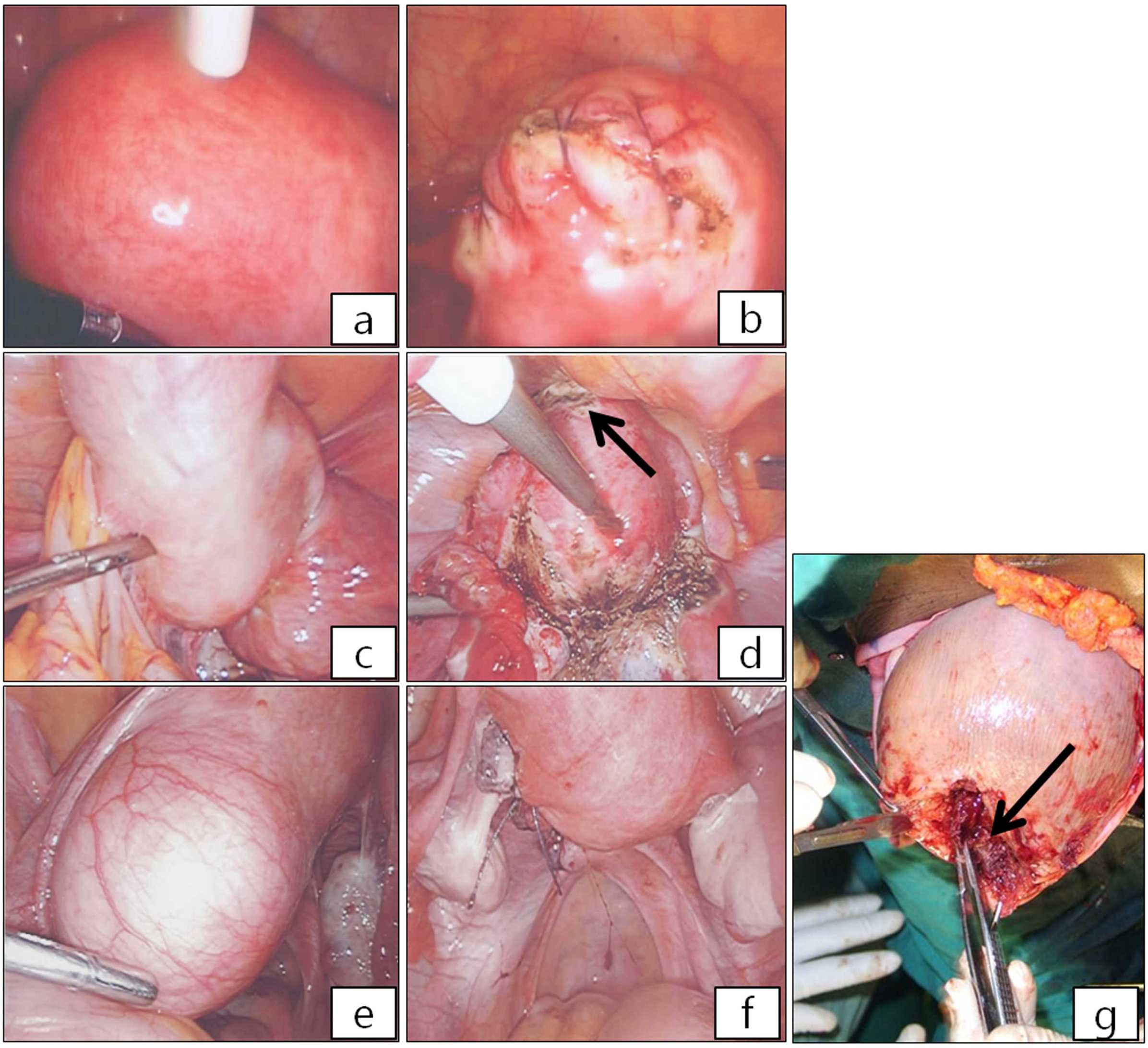
Variables	Pt 1	Pt 2	Pt 3
Age (years)	34	31	32
Body mass index (kg/m^2)	20.5	24.5	20.8
Parity	0	0	0
Number of myoma removed	Single	Single	Single
Myoma size (cm)	5	5	7
Myoma type	Intramural	Subserosal	Subserosal
Myoma location	Anterior fundus	Anterior fundus	Posterior low segment
Cavity entered	No	No	No
Method for hemostasis	Bipolar diathermy and suture	Bipolar diathermy and suture	Bipolar diathermy and suture
Suture	2-layer	1-layer	1-layer
Combined lesion	Pelvic endometriosis	Pelvic endometriosis	None
Conception method	Spontaneous pregnancy	In vitro fertilization	Spontaneous pregnancy
Time interval (months)*	13	6	5
Time of rupture (gestational weeks)	37	32	21
Labor	No	No	No
Maternal and fetal outcomes	Survived	Survived	Fetal demise
Possible risk factors	Excessive use of bipolar diathermy	Twin pregnancy, history of abdominal myomectomy 6 years previous	Placenta accreta at the site of myomectomy

*, between myomectomy and pregnancy

4. Clinical characteristics in uterine rupture from the cases of published studies (n=34) and the present study (n=3)

Variables	Total 37 cases
Age (years)	32.5 (24–41, 26 cases)
Multiparous women	6.3% (1/16)
Number of myomas removed	
Single	90.6% (29/32)
Multiple	9.4% (3/32)
Myoma size (cm)	4 (1.2–11, 30 cases)
Small myoma (≤3cm)	32.4% (11/34)
Type of myoma	
Intramural	47.2% (17/36)
Subserosal or pedunculated	52.8% (19/36)
Intraligamentary	0
Location of the myoma	
Uterine anterior wall	23.5% (4/17)
Uterine posterior wall	47.1% (8/17)
Other	29.4% (5*/17)
Cavity entered	20% (7/35)
Suture of the uterine defect	63.3% (19/30)
Time between myomectomy and pregnancy (months)	12 (6 weeks–8 years, 25 cases)
Time of rupture (gestational weeks)	34 (17–40, 37 cases)
Rupture during labor	8.3% (3/36)

Data are expressed as median (range, the entire number of the cases with eligible data) or proportion of the cases (case number by the entire number of the cases with eligible data).
*, myoma location was the lateral cornual area of the uterus in three cases and site unspecified fundus in two cases.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http://www.AAGL.org/jmig-22-5-JMIG-D-14-00652

Précis

In light of our experience with laparoscopic myomectomy, uterine rupture in pregnancy is extremely rare and can occur regardless of the clinical features of myomas.