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Characteristics of uterine rupture after laparoscopic surgery of the uterus: clinical analysis of 10 cases and literature review

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Abstract

Objective: An increasing trend of uterine rupture (UR) after laparoscopic surgery of the uterus (LSU) has been observed. Although the overall incidence is extremely low, UR may have catastrophic outcomes. Therefore, investigation of its potential risk factors is important.

Methods: We retrospectively reviewed the medical data of 10 women who developed UR after LSU performed at our hospital from October 2003 to October 2016 and conducted a literature review.

Results: All cases of UR occurred during the third trimester of pregnancy. The surgeries contributing to UR were laparoscopic myomectomy, adhesion decomposition, and salpingectomy, resulting in unfavorable outcomes especially for the fetus. Diathermy was routinely used for hemostasis, and multilayer suturing was not adequately performed in many cases. The posterior wall was the most common site of UR in most cases. Silent rupture with unremarkable symptoms was not rare. Similar risk factors were identified in the literature review.

Conclusions: Excessive use of energy equipment and the lack of multilayer suturing were the most common characteristics of UR after LSU. A history of LSU should always be considered a risk factor for UR.

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Introduction

With the rise of minimally invasive technology, laparoscopic treatment has become the dominant approach in the treatment of uterine disease because of its recognized superiority in terms of blood loss, postoperative analgesic requirements, febrile morbidity, and recovery time.[1] In recent decades, however, the incidence of uterine rupture (UR) after laparoscopic surgery of the uterus (LSU) has increased, mostly in the late stages of pregnancy or during labor, potentially leading **to hemorrhage, hysterectomy, preterm labor, neonatal asphyxia, and a high fetal mortality rate.**[2] **Risk factors for UR include the features of myomas and the methods of incision, closure, and hemostasis. Operative techniques, energy sources, and the interval of contraception can also contribute to UR. However, no consensus regarding the risk factors for UR has been established.**[3]

We retrospectively reviewed the medical records of 10 women who developed UR after LSU and were hospitalized at our institution. We also performed a review **of the English-language literature of UR following LSU during the past 10 years to investigate the contributing factors**. This study was performed because identification of the risk factors for UR is clinically important considering the potentially catastrophic outcomes of this condition.

Methods

This was a single-center case series. The patient databases at the Obstetrics and Gynecology Hospital, Fudan University, Shanghai, China were queried. The medical records of patients with a diagnosis of UR at the time of pregnancy or labor and who had previously undergone LSU from October 2003 to October 2016 were collected. The clinical characteristics, operative findings in the previous LSU, and detailed information of the subsequent obstetric outcomes were assessed. We reviewed previously published cases of UR to gather all available evidence and outline the effects of perioperative factors related to this serious complication. The institutional ethics board of our hospital approved the use of the patients' medical records (No. 2017-56,2019.9.19). In the search for published cases of UR, we used the keywords "laparoscopic surgery," "laparoscopic myomectomy," "uterine rupture," and "myomectomy" in PubMed and EMBASE from 2008 to 2018.

Results

Ten patients were included in the present study. The median age of the patients was 33 years (range, 27–38 years). Most (9/10) patients were nulliparous. All cases of UR occurred in the third trimester (range, 29–38 gestational weeks). The median interval between laparoscopy and the last menstrual period was 11 months (range, 3–26 months). The types of previous laparoscopy were laparoscopic myomectomy (LM) ($n = 6$), salpingectomy with/without cornual resection ($n = 2$), and cystectomy with pelvic adhesiolysis in patients with severe endometriosis ($n = 2$). **No patients developed complications during the laparoscopic surgeries, and all follow-ups were uneventful.**

Most of the patients (7/10) presented with abdominal pain, but only three complained of abdominal discomfort. Signs of maternal shock were present in two patients. Other signs and symptoms that raised suspicion for UR included fetal distress or intrauterine fetal demise (n = 4) and vaginal bleeding (n = 1). Only six patients received an early diagnosis by ultrasound; a missed diagnosis of UR on the posterior wall occurred in four patients (Table 1).

Among the six patients who had undergone LM, one myoma was removed in four patients and multiple myomas were removed in two patients. The diameter of the largest myoma removed was 10 cm (range, 2.5–10 cm). Most myomas were intramural; one was subserosal. All myomas were located in either the posterior or anterior wall. Most of the rupture sites were in accordance with location of the myomas in the posterior uterine wall (5/6), even in the one case of subserosal myoma. All patients underwent suture closure in one to two layers after myoma removal except the patient with the subserosal myoma; this patient underwent closure **using 0-polyglactin in a continuous suture pattern.** Monopolar and bipolar electrosurgery were routinely used for incision or hemostasis. Entry into the uterine cavity occurred in two patients; both had been taking birth control agents for almost 2 years (range, 24–26 months). The patients with the intramural myomas had been taking birth control agents for approximately 1 year (11–14 months), and the patient with the subserosal myoma had been taking such agents for 7 months (Table 2).

Table 1. Clinical characteristics of patients with uterine rupture (n = 10)

Variables	
Age, years	33 (27–38)
Nulliparous	9
Gestational week of rupture	33 (29–38)
Time interval to LMP, months	11 (3–26)
Type of previous laparoscopic surgery	
Myomectomy	6
Salpingectomy with/without cornual resection	2
Cystectomy and pelvic adhesiolysis	2
Chief complaint	
Abdominal pain	7
Abdominal discomfort	3
Classic symptoms and signs	
Fetal distress/demise	4
Vaginal bleeding	1
Signs of shock	2
Early diagnosis by ultrasound	6*

Data are expressed as median (range) or number of patients.
LMP, last menstrual period.
*Four cases of posterior wall rupture were missed diagnoses.

Among the four patients with UR who had previously undergone laparoscopic surgery other than LM, two underwent salpingectomy with or without cornual resection depending on the size of the focus. One-layer suture closure was performed after cornuostomy. Two patients with UR had undergone only cystectomy and pelvic adhesiolysis. Close and extensive adhesion of the endometriosis cyst to the posterior uterine wall was depicted in both surgery records. Bipolar electrosurgery was used as the main hemostasis method in all patients. The duration of birth control ranged from 3 to 11 months (Table 3).

Among all 10 patients, fetal death occurred in 4, perinatal asphyxia occurred in 1, and no specific findings were recorded in the remaining 5. Maternal outcomes were relatively favorable, with all uterine tissue preserved; however, transfusions were required in most patients, and severe complications occurred such as placental abruption, placenta accrete, and uterine atony. Seven patients had a full-thickness rupture and three had a rupture with no specific clinical findings (Table 4).

Table 2. Intraoperative findings and related data of previous laparoscopic myomectomy in six patients with uterine rupture

	Case					
Variables	1	2	3	4	5	6
Characteristics of myomas removed						
Number	3	2	1	1	1	1
Size, cm	2.5–5	3–10†	6	5.5	8	3
Type	IM	IM	IM	IM	SS	IM
Location	AW/PW*	AW/PW*	AW	PW	PW	PW
Cavity entered	No	No	Yes	Yes	No	No
Method for incision, closure, and hemostasis						
Uterine incision	MP	MP	MP	MP	MP	MP
Suture layers	2	1–2#	2	2	No	1
Use of bipolar electrosurgery	Yes	Yes	Yes	Yes	Yes	Yes
Time interval to LMP, months	14	11	24	26	7	13
Gestational week	33	32	34	38	34	32
Gravidity	2	1	1	2	1	1
Parity	0	0	0	0	0	0

†Myoma of 10 cm in diameter located at the anterior wall. *Location of the rupture site in the subsequent pregnancy. #One layer for posterior wall and two layers for anterior wall.
IM, intramural; SS, subserosal; AW, anterior wall; PW, posterior wall; MP, monopolar electrosurgery; LMP, last menstrual period.

Table 3. Detailed surgical findings and related data of four patients with uterine rupture who underwent previous laparoscopic surgery other than laparoscopic myomectomy

	Case			
Variables	1	2	3	4
Type of surgery	Salpingectomy with cornual resection	Salpingectomy	Cystectomy, pelvic adhesiolysis, and **lesion resection or electrocoagulation**	Cystectomy, pelvic adhesiolysis, and **lesion resection or electrocoagulation**
Uterine sutures	1 layer	None	–	–
Method for hemostasis	Bipolar electrosurgery	Bipolar electrosurgery	Bipolar electrosurgery	Bipolar electrosurgery
Time interval to LMP, months	11	4	3	3
Gestational week	**29**	**31**	**37**	**38**
Rupture site	Cornua	Cornua	Posterior wall	Posterior wall

LMP, last menstrual period.

In the literature review, we assessed the clinical features of 43 patients from 13 case reports or series of UR after LSU (Table 5). Based on the available data, most cases were post-LM. Rare cases of UR after laparoscopic salpingectomy as well as lesion resection and fulguration in patients with adenomyosis were also reported. The time

Table 4. Obstetric outcomes of 10 patients with uterine rupture

Variables	
Fetal outcome	
Intrauterine fetal death	4
Perinatal asphyxia	1
No specific findings	5
Maternal outcome	
Transfusion	7
Hysterectomy	0
Survived	10
No specific findings	3
Surgical findings	
Full-thickness rupture	7
Silent rupture	3*
Other obstetric complications	
Placental abruption	1
Placenta accreta	1
Uterine atony	1

*The three cases of silent rupture included **Cases** 1 and **3 (laparoscopic myomectomy)** and Case 2 (laparoscopic salpingectomy).

interval to the last menstrual period varied from 5 months to 8 years, and in almost all patients with subserosal myomas, the interval was longer than 6 months. The time point during pregnancy at which UR occurred ranged widely from 10 to 40 weeks of gestation. No specific characteristic of the myomas was found to be associated with UR except for subserosal or pedunculated myomas in most cases. Electrocoagulation was generally used for uterine incision and hemostasis. In most patients with subserosal or pedunculated myomas, the myomas were removed without suturing. The pregnancy outcome was unfavorable, with high fetal mortality and one case of hysterectomy. Inadequate suturing and excessive use of electrosurgery were regarded as possible risk factors by most authors.

Discussion

UR occurs in 0.035% of deliveries in the general population.[2] Most cases of UR occur in the third trimester of pregnancy and during labor or delivery.[4] Laparoscopic treatment has been broadly implemented for benign uterine disease; however, reports on subsequent lethal obstetric outcomes such as UR are increasing in number. Despite the quite low overall incidence of UR, the clinical consequences may be catastrophic, making investigation of its risk factors a worthy endeavor. Laparoscopic surgery has been a common treatment method for benign disease at our hospital since 2000. In the present study, we retrospectively examined 10 cases of UR that occurred after LSU during a 13-year period. This may be the second largest number of such patients ever reported, the largest being the case series by Parker et al.[3] in 2010.

Leiomyoma is a common benign disease in patients of reproductive age, and surgery is the optimal therapeutic option.[5] In a recent meta-analysis that included nine randomized controlled trials, LM was apparently superior to open surgery with fewer perioperative and short-term complications. Nevertheless, the analysis failed to compare the long-term obstetric adverse effects, including UR, because the follow-up time was not long enough. A meta-analysis of 56 articles published from 1970 to 2013 showed that after myomectomy, the risk of UR during pregnancy or labor was low (0.75%); additionally, the rate of UR was not significantly higher after a laparoscopic approach than after abdominal myomectomy. However, these results are controversial because significantly more elective cesarean sections were performed after LM than after the conventional open technique ($P = 0.001$).[6] In a recent systematic review of 23 studies involving 1825 deliveries after myomectomy, the overall incidence of UR was 0.6%, with an incidence of 0.67% (1/150) after abdominal myomectomy and 0.99% (6/606) after LM. The authors considered that the real incidence of UR was underestimated

Table 5. Clinical features of 43 patients from 13 case reports or series of UR after laparoscopic surgeries

First author	Cases, n	Previous surgery	Time interval to LMP, months	Gestational week at UR	Features of myoma or lesion				Uterine incision	Hemostasis	Incisional closure	Possible risk factors	Outcome
					Size, cm	Type	Cavity entered	Location					
Bernardi TS[2]	4	LM	NA	24/30/37/40	All ≥4	IM	50%	NA	No	BP electrosurgery	1–2 layers	Short LM-to-conception interval Large size (diameter ≥4 cm) Endometrial cavity entrance	1 fetal death
Parker WH[3]	19	LM	NA	17–40 (mean, 31)	1–11 (mean, 4.5)	SS (47.7%)	No	NA	NA	NA	1 layer (IM) No suturing (SS)	Inadequate suturing Electrosurgery	3 fetal deaths
Koo YJ[9]	3	LM	13/6/5	37/32/21	5/5/7	IM/SS/SS	No	AF/AF/PW	NA	BP electrosurgery	2/1/1 layers	Excessive use of BP electrosurgery Twin pregnancy Placenta accreta at site of myomectomy	1 fetal death
Pistofidis G[26]	7	LM	16.8 (mean, 6)	≥34	≤5 (71.4%)	SS (85.7%)	No	NA	MP electrosurgery	BP electrosurgery	1–2 layers (71.4%)	BP electrosurgery Inadequate suturing	1 fetal death
Kiseli M[27]	1	LM	NA	23	3	SS	No	Fundus	MP electrosurgery	BP electrosurgery	No	BP electrosurgery Inadequate suturing	NA
Torbé A[28]	1	LM	20	22	2	SS-P	No	Horn	MP electrosurgery	BP electrosurgery	No	Coagulation Location No suturing	Fetal death
Sizzi O[29]	1	LM	NA	33	8	IM	No	NA	MP electrosurgery	BP electrosurgery	1 layer	Reduced uterine volume	NA
Okada Y[30]	1	LM	7	10	Max, 6.5	IM	Yes	NA	NA	NA	2 layers	Short LM-to-conception interval IVF-ET Adenomyosis	Abortion
Sutton C[31]	1	LM	96	32	NA	NA	NA	AW	NA	NA	NA	Surgical technique	Survived
Nishijima Y[17]	1	Interstitial portion resection	48	26	/				NA	NA	No	Inadequate suturing	Survived
Trojanowski S[18]	1	Salpingectomy	13	38	/				NA	BP electrosurgery	No	Electrocoagulation	Survived
Pontis A[19]	1	Salpingectomy	NA	NA	/				NA	BP electrosurgery	No	Inadequate suturing Electrosurgery	NA
Fettback PB[21]	2	Lesion resection and fulguration	5/9	32/33	Extensive uterine endometriosis at posterior fundal wall/left fallopian tube				MP electrosurgery	BP electrosurgery	1 layer	Adenomyosis Extensive electrocoagulation	One hysterectomy

UR, uterine rupture; LM, laparoscopic myomectomy; IM, intramural; SS, subserosal; SS-P, subserosal pedunculated; AF, anterior fundus; PW, posterior wall; AW, anterior wall; BP, bipolar; MP, monopolar; NA, not available; LMP, last menstrual period.

because of the high rate of scheduled cesarean deliveries after the laparoscopic approach.[7] Furthermore, Tian et al.[8] found that some patients in the LM group underwent repair of uterine scar defects during elective cesarean section, while no patients underwent this procedure in the transabdominal myomectomy group. Because the incidence of UR is extremely low, more large-scale cohort studies are necessary to reveal the difference. Sufficient evidence is not yet available for selection of the optimal surgical approach depending on the type or other features of myomas considering the UR risk.[9] No significant correlation between the characteristics of the myoma and the risk and timing of UR were identified in either the present investigation or previous publications.

Bipolar electrosurgery-induced thermal damage to the myometrium can reportedly result in devascularization of normal tissue and deeper growth of connective tissue that has a different structure and function from those of the myometrium and that cannot remodel during pregnancy.[10] Tinelli et al.[11] reported that the fibroid pseudocapsule, which is beneficial to scar healing, is damaged by the use of diathermy. Monopolar and bipolar electrosurgery were routinely used for incision or hemostasis in all patients of the present study. Performing myomectomy or salpingectomy by electrosurgery with or without suturing can result in UR, suggesting that diathermy for hemostasis should be limited and that surgeons should not abandon their skills in open surgery.

Parker et al.[3] indicated that hematoma formation can have a deleterious effect on wound healing and that multilayered closure of the myometrium (described as three layers for the cavity entrance, two layers for the myometrium, and one layer for the serosa) is necessary to prevent UR. In our study, 50% of patients who underwent LM (Cases 2, 3, and 6 in Table 2) underwent suture closure with an inadequate number of layers as suggested above. Some experts have stated that wound healing is facilitated by prevention of local hematoma formation via placement of full-thickness, well-spaced sutures, not the number of suture layers.[12] Nevertheless, according to the data of our study and the literature review, an adequate number of suture layers provides more security. In a survey of experienced obstetricians, the authors considered entry into the uterine cavity at myomectomy to be a major risk factor for UR during labor and delivery,[13] implying the importance of multilayer suturing. Considering the variations in skills and surgical techniques and importance of avoiding dead space to prevent hematoma formation, we believe that it is wise to adhere to the rules of multilayer suturing depending on the depth of the defect.

Using magnetic resonance imaging and three-dimensional power Doppler ultrasound, specialists have concluded that the myometrium recovery process is complete 3 months after the operation.[14,15] Additionally, one study showed that after the removal of a pedunculated leiomyoma at 25 weeks of gestation, the patient uneventfully underwent spontaneous vaginal delivery.[16] Almost all patients with UR in both the literature and the present study had an adequate postoperative contraception interval, implying that the time interval from surgery to pregnancy is not the determining factor for the quality of uterine wound healing.[9]

Interestingly, the most common site of UR in the present study was the posterior wall, even in patients with scars in the anterior wall. Ultrasound seemed to be a poor technique for early diagnosis of UR at this location. We presume that effective suturing of defects on the posterior wall requires more skills and techniques than at other locations.

Despite the most common causes of UR, we have herein presented two cases of UR

due to laparoscopic resection of a fallopian tube, which has rarely been documented.[17–19] Laparoscopic salpingectomy is currently the most effective treatment of fallopian pregnancy; nonetheless, thermal injury may cause weakening of the cornual portion. Additionally, salpingectomy was not routinely accompanied by suture closure. When the ectopic pregnancy site is near the cornua, sufficient serosal and myometrial tissue for closure should be left after the incision, and a single layer of mattress sutures should be placed. Moreover, the use of bipolar cauterization should be minimal.[20]

Laparoscopy seems to be the optimal treatment in patients with endometriosis associated with pelvic pain, dysmenorrhea, and infertility. Notably, however, some reports have stated that laparoscopic cystectomy and adhesiolysis in patients with widespread endometriosis within the uterine wall led to UR secondary to thinning of the uterine wall and local ischemia.[21,22] Two similar cases occurred in the present study, and both patients had **severe pelvic endometriosis** with tight adhesion of cysts **and gut loops** to the posterior wall; this inevitably resulted in thinning of the uterine wall after adhesiolysis and **lesion resection or electrocoagulation.** As the main method of hemostasis, extensive fulguration is used to treat diffuse oozing of the lesion on the uterine wall, making it vulnerable to the tension that occurs during pregnancy.

Silent UR is an asymptomatic condition that may not raise any concern regarding ongoing rupture. Apart from incomplete UR with continuity of the serosal surface, some reports have revealed that silent UR may be occluded by intestinal adhesions after a previous surgery or by packing on the rupture site by the body of the fetus.[23–25] In the present study, patients with silent UR only presented with nonspecific abdominal discomfort with mild tenderness, without the classic signs and symptoms of UR such as hemorrhage and shock. Additionally, ultrasound examination resulted in a missed diagnosis in four patients, illustrating that diagnosis can be very difficult in the early stage.[23,24] Most cases were incidentally found during cesarean section for fetal distress. Therefore, patients with any suspected risk factors related to UR should be carefully evaluated and promptly treated if necessary.

In conclusion, pregnant women presenting with abdominal pain and a history of LSU (including not only LM but also extensive adhesiolysis procedures or salpingectomy) should be evaluated for UR. Surgeons should ensure strict training of laparoscopic suture skills, limit the use of energy equipment, and ensure effective hemostasis by suturing, and close the uterine defect with enough layers.

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