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Review Article

Risk Factors for Uterine Rupture after Laparoscopic Myomectomy

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ABSTRACT Case reports for uterine rupture subsequent to laparoscopic myomectomy were reviewed to determine whether common causal factors could be identified. Published cases were identified via electronic searches of PubMed, Google Scholar, and hand searches of references, and unpublished cases were obtained via E-mail queries to the AAGL membership and AAGL Listserve participants. Nineteen cases of uterine rupture after laparoscopic myomectomy were identified. The removed myomas ranged in size from 1 through 11 cm (mean, 4.5 cm). Only 3 cases involved multilayered closure of uterine defects. Electrosurgery was used for hemostasis in all but 2 cases. No plausible contributing factor could be found in 1 case. It seems reasonable for surgeons to adhere to techniques developed for abdominal myomectomy including limited use of electrosurgery and multilayered closure of the myometrium. Nevertheless, individual wound healing characteristics may predispose to uterine rupture. Journal of Minimally Invasive Gynecology (2010) 17, 551–554 © 2010 AAGL. All rights reserved.

Keywords: Uterine rupture; Laparoscopic myomectomy

Currently available instruments make laparoscopic myomectomy feasible, and prospective randomized studies in selected patients have demonstrated that laparoscopic myomectomy is associated with less postoperative pain, shorter hospital stay, and shorter recovery time compared with abdominal surgery [1]. After abdominal myomectomy, uterine rupture during pregnancy seems to be a rare event, based on reviews of delivery records of large numbers of women. Two studies comprising 236 454 deliveries reported 209 instances of uterine rupture; however, only 4 were attributable to previous myomectomy [2,3]. Because the number of women who had previously undergone myomectomy was not known, the incidence of rupture in these studies could not be determined. However, a retrospective study of 412 women who underwent abdominal myomectomy reported uterine rupture in only 1 woman (0.2%). Although a large study reported no uterine ruptures after laparoscopic myomectomy, during the last 18 years, at least 15 cases of uterine rupture after laparoscopic myomectomy have been reported worldwide [4–19]. It is not clear whether the laparoscopic procedure is associated with higher risk of subsequent rupture or whether these cases are being more systematically reported.

At present, there is no consensus about the factors that increase the risk of uterine rupture after laparoscopic myomectomy. Moreover, operative techniques, instruments, and energy sources used during laparoscopic myomectomy can differ from those used during laparotomy. Failure to adequately suture myometrial defects, lack of hemostasis with subsequent hematoma formation, or excessive use of monopolar or bipolar electrosurgery with devascularization of the myometrium have all been postulated to interfere with myometrial wound healing and increase the risk of rupture [20]. In the present study, cases of uterine rupture subsequent to laparoscopic myomectomy were reviewed in an attempt to determine whether common causal factors could be identified.

Methods

Nineteen cases of uterine rupture after laparoscopic myomectomy were identified by reviewing previously published cases via electronic searches using PubMed and Google Scholar and hand searches of references and abstracts using

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the search terms ''Laparoscopic myomectomy,'' ''Uterine rupture,'' and ''Uterine dehiscence.'' Publications were reviewed for technical details of the surgical procedure, position and size of myomas, gestational age at time of uterine rupture, and outcomes of mother and baby. Authors were queried by E-mail or postal mail to ascertain missing information. In addition, an E-mail was distributed to the AAGL membership, and a query placed on the AAGL Listserve, requesting information about unpublished cases. Given that all information was either previously published or blinded to the authors, institutional review board exclusion was obtained through the John Wayne Cancer Institute at Saint John's Health Center.

Results

Nineteen cases of uterine rupture after laparoscopic myomectomy were identified (Table 1). The removed myomas ranged in size from 1 through 11 cm (mean, 4.5 cm). Two small myomas (both 1.2 cm) were removed in 1 woman, and 1 myoma in all of the other women. Pedunculated subserous myomas were removed in 4 women, subserosal myomas in 5, and intramural myomas in 10.

In 13 procedures, uterine incisions were made using monopolar electrosurgery. Two surgeons used bipolar scissors, 1 used cold scissors, and 1 used ultrasonic scissors (UltraCision; Ethicon Endo-Surgery, Inc., Cincinnati, OH). Five cases involved entry into the endometrial cavity. Hemostasis was obtained using monopolar electrosurgery in 6 cases, bipolar electrosurgery in 7, bipolar and suture in 3, and suture alone in 2. No uterine defects were present in 4 women with pedunculated myomas; however, hemostasis of the pedicles was achieved with electrosurgery. Uterine defects were closed with only 1 suture in 3 women and 1 layer of sutures in 4 women, and in 1 woman, only the serosa was closed. Uterine defects were not closed in 3 cases. Multilayer closure was used in only 3 cases. Use of adhesion barriers were reported in 2 women.

Gestational age at the time of uterine rupture ranged from 17 through 40 weeks (mean, 31 weeks). There were no instances of maternal deaths; however, 3 fetuses died, at 17, 28, and 33 weeks' gestation, respectively. Missing information is noted in Table 1.

Case-by-case analysis revealed a number of potential factors contributing to poor wound healing of the myometrium. Only 3 cases involved multilayered closure of uterine defects, and electrosurgery was used for hemostasis in all but 2 cases. In only 1 case was there no ostensible factor found that might interfere with wound healing.

Discussion

Review of published and unpublished cases yielded 19 cases of uterine rupture during pregnancy after laparoscopic myomectomy. Several factors may contribute to uterine rupture during pregnancy after laparoscopic myomectomy. Surgical factors potentially related to wound healing in the myometrium include but may not be limited to the means used to make incisions in the myometrium, the method used for myometrial hemostasis, the extent of local tissue destruction, the method used to close the myometrial defect, the presence of infection or hematoma formation within the myometrium, and individual healing characteristics related to production of growth factors or excess collagen deposition. Carbon dioxide pneumoperitoneum, unique to laparoscopic surgery, may also affect wound healing [21]. These factors have not been studied after either abdominal or laparoscopic myomectomy in human or animal models.

The classic surgical technique used for abdominal myomectomy, described by Berkeley and Bonney [22] in 1911, used a scalpel to make the uterine incision, suture ligation of bleeding vessels in the myometrium, and interrupted mattress silk sutures to obliterate dead space in the myometrium and achieve wound closure. Variations of this technique have been described, and all seem to be associated with low rates of uterine rupture [2,3]. Recent descriptions recommend a multilayer uterine closure, 2 layers for myometrium and 1 for serosa, to avert hematoma formation [23,24]. Expeditious suturing of myometrium, rather than electrosurgery, is used to achieve hemostasis.

Uterine scars resulting from abdominal (n = 10) or laparoscopic (n = 5) myomectomy have been examined at subsequent cesarean section [25]. After abdominal myomectomy, the scars were of similar thickness to normal myometrium. In contrast, the scars after laparoscopic myomectomy were strained, had poorly defined edges, and were more contracted and thinner than normal myometrium. The authors concluded that these differences were likely due to the use of sutures to achieve hemostasis during abdominal myomectomy, whereas bipolar coagulation was used during laparoscopic myomectomy. Resultant thermal damage to the myometrium induces proliferation of connective tissue, which cannot remodel during pregnancy.

Wound healing, in general, is a complex process that involves inflammation, angiogenesis, new tissue formation, and tissue remodeling [26]. Balanced collagen deposition requires growth factors released from the injured area, and pathologic scar conditions such as hypertrophic scars have altered growth factor expression [27]. At 28 days, wound healing of tongue muscle in live hamsters showed numerous organized muscle bundles and scarce fibrous connective tissue when incisions were made with a scalpel [28]. However, atrophic muscle bundles and a predominance of connective tissue over muscle fibers, with an infiltrate of mononuclear inflammatory cells, were observed when incisions were made at electrosurgery. Similar studies have yet to be performed in uterine muscle.

Uterine involution and remodeling after delivery is a unique event, and wound healing after cesarean section cannot be extrapolated to myomectomy [29]. However, some correlations may be generally relevant. Tissue sampling of uterine dehiscence shows high collagen content and

Table 1
Identified cases of uterine rupture after laparoscopic myomectomy

Case [reference]	Year of Surgery	Myoma size, cm	Myoma type	Cavity entered	Uterine incision	Hemostasis	Closure	Uterine rupture, wk	Fetal survival	Maternal survival
1 [5]	1992	DM	IM	Yes	Sharp	ENC	1 Layer	28	DM	Yes
2 [6]	1992	3	SS	No	MP	MP	Serosa	34	Yes	Yes
3	1995	3	IM	No	MP	BP, S	1 Layer	34	Yes	Yes
4 [7]	1998	5	IM	Yes	MP	BP, S	1 Layer	28	Yes	Yes
5 [8]	1996	5	IM	Yes	DM	S	DM	28	Yes	Yes
6 [9]	1996	DM	IM	Yes	MP	BP	2 Layers	29	Yes	Yes
7	1997	9	IM	No	MP	BP, S	2 Layers	33	Yes	Yes
8 [10]	1997	5	SS	No	MP	BP	No	33	No	Yes
9 [11]	1997	11	SS-P	No	MP	MP	No	34	Yes	Yes
10 [12]	2000	4	SS	No	MP	MP	No	17	No	Yes
11	DM	2.5	DM	No	UC	S	3 Layers	28	No	Yes
12 [13]	2000	8	SS	No	BP	BP	No	40	Yes	Yes
13 [14]	2001	1.2, 1.2	SS-P	No	MP	MP	No	29	Yes	Yes
14 [15]	2001	3	IM	Yes	DM	BP	1 Layer	26	Yes	Yes
15	2002	2	SS	No	MP	BP	1 Suture	33	Yes	Yes
16	2002	4	SS-P	No	BP	BP	No	35	Yes	Yes
17 [16]	2003	4	SS-P	No	MP	MP	No	36	Yes	Yes
18 [17]	DM	2.5	IM	No	MP	MP	1 Figure-of-8	36	Yes	Yes
19 [18]	2004	4	IM	No	MP	BP	1 Figure-of-8	35	Yes	Yes

BP = bipolar electrosurgery; DM = data missing; ENC = endocoagulator; IM = intramural; MP = monopolar electrosurgery; S = suture; SS = subserosal; SS-P = subserosal pedunculated; UC = UltraCision [ultrasonic scissors].

reduction of smooth-muscle fibers, which likely accounts for decreased tensile strength of the myometrium [26]. Tissue sampling of the scar shows a marked decrease in transforming growth factor-β3 reduction in connective tissue growth factor, an increase in basic fibroblast growth factor, and slight enhancement in vascular endothelial growth factor, platelet-derived growth factor, and tumor necrosis factor-α expression, all of which are important for wound healing.

Sonographic measurement of lower uterine segment thickness greater than 3.5 mm at 37 weeks' gestation selects women who are unlikely to have uterine dehiscence or rupture, with a negative predictive value of 99.3% [30]. However, another study found that 20% of women who had a previous cesarean section had detectable myometrial thinning at repeat cesarean section. In that uterine rupture after previous cesarean section is rare, occurring in 35 of 10 000 laboring women, the relationship of myometrial thinning to likelihood of rupture is uncertain [31,32]. Surgical technique during repair of the lower uterine segment during cesarean section has been studied, with single-layer closure associated with 4-fold risk of uterine rupture during subsequent labor compared with double-layer closure [33].

Ultrasonographic evaluation of abdominal myomectomy scars performed 60 to 90 days after surgery found mixed echogenic areas, thought to be the result of hyperplastic myometrium, small hematomas, and suture material. Gradual shrinkage of the myometrium, resolution of hematomas, and absorption of suture material led to a decrease in the size of the scar over 3 months [34]. A study of uterine wound healing using magnetic resonance imaging demonstrated that the uterine healing process was complete at 12 weeks after abdominal myomectomy in the absence of hematoma or edema formation in the myometrium [35]. At sonographic evaluation, a preoperative myoma greater than 10 cm and the experience of the surgeon were significantly correlated with formation of uterine scar hematomas. Wound healing seemed to be complete within 3 months [36]. A study of laparoscopic myomectomy scars found hematomas in 74% of women 1 day after surgery, and in 8% of women 6 weeks later [37]. The authors suggested that hematomas resulted from closure of the uterine defect with only a single layer of sutures. Nevertheless, imaging studies examine surrogate outcomes of wound healing but not wound strength.

We reviewed 19 cases of uterine rupture after laparoscopic myomectomy. While definite conclusions and recommendations about appropriate surgical technique must await proper study of myometrial wound healing, it seems that almost all of the cases documented herein contain a deviation from standard technique as described for abdominal myomectomy, confirming the earlier impression of others [20]. In 3 cases, the uterine defect was not repaired; in 3 cases it was repaired with a single suture; in 4 cases it was repaired in only 1 layer; and in 1 case, only the serosa was closed. In 16 cases, monopolar or bipolar energy was used for hemostasis.

Comparison of laparoscopic myomectomy cases with or without subsequent rupture will be necessary to determine whether there are identifiable factors that predispose to this outcome. Future studies might consider sonographic evaluation of the myomectomy sites to identify women with marked myometrial thinning that might predispose to uterine rupture. In that all uterine ruptures in the cases presented herein occurred before 35 weeks (range, 17–35 weeks), with a median gestational age of 29 weeks, evaluation with ultrasound would need to be performed before that time.

Animal studies of wound healing and tensile strength after 3 months are needed to determine the optimal means to incise the myometrium, achieve hemostasis, and close the myometrial defect. The effects of carbon dioxide pneumoperitoneum on wound healing and an understanding of the individual healing characteristics related to production of growth factors or excess collagen deposition are also necessary.

At present, it seems prudent for surgeons to adhere to time-tested techniques developed for abdominal myomectomy including limited use of electrosurgery and multilayered closure of myometrium in other than superficial uterine defects. Yet, even with ideal surgical technique, individual wound healing characteristics may predispose to uterine rupture.

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