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Suturing method as a factor for uterine vascularity after laparoscopic myomectomy

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ABSTRACT

Objective: To evaluate the vascularity of the myometrium after laparoscopic myomectomy sutured by two different methods using contrast-enhanced Magnetic Resonance Imaging.
Study design: Twenty-eight women who had symptomatic leiomyomas and underwent laparoscopic myomectomy between June 2013 and July 2014 were included in the present study. In the first half period, continuous sutures were used in 12 patients, and in the latter half period, single interrupted sutures were used in 16 patients. Contrast-enhanced Magnetic Resonance Imaging was used 3 or 6 months after surgery to evaluate vascularity after laparoscopic myomectomy. We defined avascularity index as the percentage of avascular area after surgery to cross sectional area of myoma before surgery. The Wilcoxon rank-sum test was applied to compare avascularity indeces in the two study groups.
Results: At 3 months after surgery, avascularity index in continuous sutures group was significantly higher than that in single interrupted sutures group (median 5.0 vs.1.2, $p < 0.001$), suggesting a poorer vascular recovery of the myometrium sutured continuously.
Conclusion: Simple interrupted suturing might be superior to continuous suturing in terms of vascularity evaluated using contrast enhanced Magnetic Resonance Imaging.

Introduction

Uterine myoma is a common tumor of the pelvis among women and causes menorrhagia, abdominal pain, abdominal discomfort, and subfertility. Approximately 20–40% of women of reproductive age have uterine myomas, and the frequency increases in the later reproductive years [1,2]. Myomectomy is the most popular treatment option for women who desire to preserve their child-bearing potential. Laparoscopic myomectomy (LM) was described for the first time in 1980 [3]. Due to advances in laparoscopic devices and procedures, the indication of LM have expanded from small subserous myomas to large intramural ones. LM is more advantageous than traditional abdominal myomectomy (AM) in terms of operative blood loss, postoperative pain, recovery time, and overall complications [4–6]. Therefore, in recent years, LM has become a common procedure in numerous institutions throughout the world.

Uterine rupture during pregnancy or labor is a rare but serious complication associated with myomectomy. There have been only a few studies on the risk of uterine rupture after laparoscopic myomectomy, and the risk has been reported to be 0.6–1% [7,8]. There have been several papers comparing the risk of uterine rupture after LM versus after AM. In some of them, the perinatal outcomes show no significant differences between LM and AM [9,10]. However, a retrospective study conducted in Korea revealed 2 cases of uterine rupture or dehiscence in 54 patients who underwent LM [11]. In another study that evaluated the wound of myomectomy at the time of cesarean section, the results showed that the scars of LM were thinner than those of AM [12].

Several factors that might be related to uterine rupture after LM have been reported. Cobellis et al. suggested that the imperfect healing process observed following LM might be related to thermal damage with bipolar coagulation [12]. An animal study showed that carbon dioxide pneumoperitoneum might be related to wound healing [13]. A review of previous reports on uterine rupture after LM recommended a multilayer closure, as well as limited use of electrosurgery [14].

The relationship between suturing methods and wound healing has been more intensively studied for Cesarean sections. Single-layer closure was previously reported to be related to shorter operative time [15] and larger scar defects [16], and have a four-fold increase in the risk of uterine rupture to a double-layer closure [17]. Ceci et al. compared 2 types of single-layer sutures used for cesarean sections and reported that continuous sutures seem to

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cause larger defects than interrupted sutures [18]. Sumigama et al. reported that continuous sutures are related to increased incidence of placenta accreta for subsequent pregnancies [19].

To our knowledge, to date, there have been no reports comparing the different suturing methods in terms of wound healing after LM. Therefore, this study was conducted to evaluate the vascularity of the myometrium after LM closure with 2 different suturing methods, by using contrast-enhanced magnetic resonance imaging (CE-MRI).

Methods

This prospective cohort study was approved by the Institutional Review Board of Sanraku Hospital. Patients who had symptomatic leiomyomas and who underwent LM in Sanraku Hospital between June 2013 and July 2014 were eligible for the study. In the first 7 months, between June and December 2013, continuous sutures were used (group A). In the latter 7 months, between January and July 2014, single interrupted sutures were used (group B). Small myomas with single layered suture were excluded from the analysis, and two to three layered continuous or interrupted sutures were made in each group.

The surgeries included in the study were operated by three gynecologists (C.M., Y.H., and A.H.). All the three doctors had more than three years of experiences in gynecological laparoscopic surgery. All the surgeries were performed under guidance by A.F., who had more than ten years of experiences in gynecological laparoscopic surgery and was authorized by Japan Society of Gynecologic and Obstetric Endoscopy and Minimally Invasive Therapy.

Prior to surgery, MRI was conducted on all patients to accurately diagnose uterine myoma and to evaluate the size, position, and number of leiomyomas (Fig. 1A). A gonadotropin-releasing hormone (GnRH) agonist was not mandatory. It was not administered to those who had leiomyomas <6 cm, had no anemia, and hoped to undergo surgery as soon as possible.

LM was performed as follows: diluted vasopressin was injected and a horizontal incision was made using ultrasonic scalpel; leiomyomas were then enucleated; two to three layered sutures were made by using a multifilament thread (0-POLYSORB®, Covidien Japan Co. LTD., Tokyo, Japan); and, leiomyomas were removed by using an electrical morcellator or trans umbilical manual morcellation.

When making interrupted sutures, we used the threads without cutting. After suturing the myometrium, we pulled out the needle through the 12-mm port until the short tail became suitable for handling, and made slip knots intracorporeally. When making continuous sutures, we used the threads which were cut into half, and kept them intracorporeally until the end of one layer suturing. We did not choose extracorporeal suturing nor barbed suture to minimize cost of surgery. The aim of the present study was to compare suturing methods, therefore, we used multifilament threads in both groups and not barbed sutures, which were exclusively used for continuous sutures and not for interrupted ones.

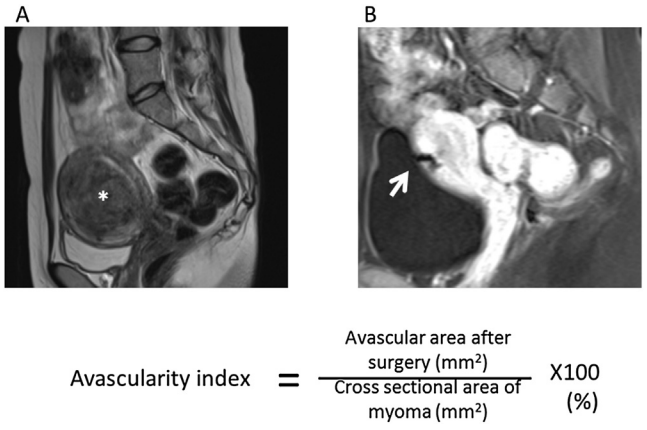

Fig. 1. Examples of MRI conducted before surgery (A) and CE-MRI that was taken 3 months after surgery (B) in the same patient. The asterisk shows intramural myoma nodule in the anterior wall, and the arrow shows avascular area in the myometrium where myoma was removed and sutured.

All the patients underwent CE-MRI 3 months after surgery. Some of them repeated CE-MRI 6 months after surgery.

In the CE-MRI that was taken after surgery, avascular areas were observed in accordance with the positions of leiomyomas (Fig. 1B). To evaluate the vascularity after LM quantitatively, the researchers defined an avascularity index, as the percentage of avascular area after surgery to the cross-sectional area of myoma before surgery (Fig. 1).

Excel Statistics Ver.6.0 (Esumi Co Ltd, Tokyo, Japan) was used as a statistical software program. The chi-square and Fisher's exact probability tests were used to investigate the distribution of categorical variables. The Wilcoxon rank-sum test and signed-ranks test were applied to compare continuous unpaired and paired variables, respectively. Statistical significance was set at $p < 0.05$.

Results

During the study period, 12 patients underwent LM with continuous sutures (group A), and 16 with single interrupted sutures (group B). All patients underwent CE-MRI 3 months after surgery. Seven patients in group A underwent another MRI 6 months after surgery.

The characteristics and outcomes of the surgery are listed in Table 1. There were no significant differences in age, body mass index, myoma size, number of myomas, myoma position, myoma classification, presence or absence of GnRH agonist before surgery, operation time, or blood loss between groups A and B.

Fig. 2 shows the distribution of the avascularity index in the MRI performed 3months after surgery in the 2 study groups. The avascularity index in group A (median 5.0, min 2.1–max 9.0) was significantly higher than that in group B (median 1.2, min 0.1–max 3.7, $p < 0.001$). This result suggested poorer vascular recovery of the myometrium that was sutured continuously compared to that of the one with interrupted sutures. In both groups, preoperative administration of GnRH agonist had no influence on the avascularity index (data not shown).

The date of MRI after surgery was planned irrespective of the menstrual cycles. The menstrual periods after surgery were noted in 9 and 10 patients in group A and B, respectively. In all the 19 patients, the uterine myometrium surrounding the avascular area was clearly and evenly enhanced, and there was no relation between menstrual cycle and avascularity index.

The avascularity index was then compared among the 7 cases in group A, 3 months versus 6 months after surgery (Fig. 3). The avascularity index at 6 months after surgery was significantly lower than that at 3 months after surgery ($p = 0.028$), indicating a better vascular recovery in 6 months than in 3 months after surgery with continuous sutures.

The avascularity index was then compared between the MRI of group B patients 3 months after surgery and that of group A patients 6 months after surgery (Fig. 2). The avascularity index in group A 6 months after surgery (median 4.2, min 2.2–max 7.5) was still significantly higher than that in group B 3 months after surgery (median 1.2, min 0.1–max 3.7, $p < 0.001$).

Table 1
The characteristics of the patients and myomas in the 3 study groups and outcomes of the surgery. Values are given as median (min-max) unless otherwise indicated.

	Group A-3m (n = 12)	Group A-6m (n = 7)	Group B-3m (n = 16)	*p (A–3 m vs. B/ A–6 m vs. B)*
Age	38 (29–43)	30 (29–43)	38 (27–44)	0.74/0.25
BMI	21.6 (19.2–27.1)	20.8 (19.2–23.5)	21.8 (16.8–26.3)	0.69/0.95
myoma diameter(mm)	66.9 (34.5–103.1)	69.5 (51.6–92.1)	60.6 (39.1–100.8)	0.30/0.32
No. of myomas	1 (1–7)	1 (1–6)	3 (1–13)	0.11/0.12
myoma position (anterior/posterior/others)	7/4/1	4/3/0	8/6/2	0.23/0.96
myoma classification (FIGO type2/5/6)	5/5/2	3/3/1	6/6/4	0.28/0.33
GnRH±	7/5	5/2	11/5	0.70/1.00
Ope time (min)	233 (142–340)	222 (173–340)	191 (100–504)	0.19/0.27
Blood loss(ml)	327 (50–700)	200 (50–600)	175 (30–650)	0.27/0.64

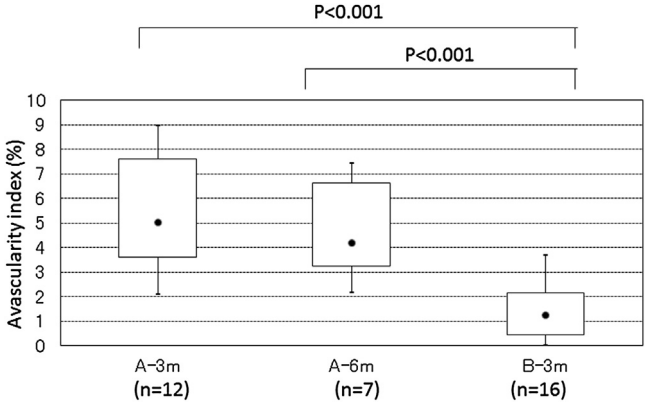

Fig. 2. Box plots showing the distribution of avascularity index in group A, 3 and 6 months after surgery, and group B, 3 months after surgery.

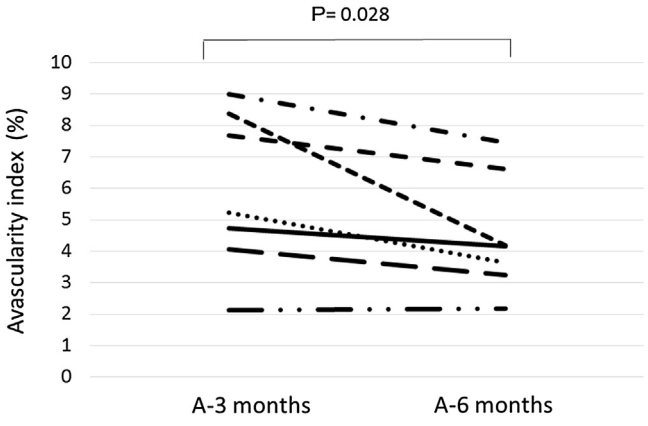

Fig. 3. Changes of avascularity index in 7 patients in group A between 3 and 6 months after surgery.

Comment

To the best of our knowledge, this is the first report regarding the influence of suturing methods on vascularity after LM. Our results indicate that interrupted sutures are associated with better vascularization of the myometrium than are continuous sutures after LM.

Regarding the effect of suturing methods on the wound healing of uterine tissue, Ceci et al. reported that in a cesarean section, continuous sutures seem to cause a larger defect than do interrupted sutures, probably because a greater ischemic effect is exerted on the uterine tissue [18]. Currently, continuous sutures are generally used in LM in many institutions throughout the world because they are associated with fewer knots, low foreign body content, shorter suturing time, and faster hemostasis compared to interrupted sutures. However, they might cause excessive ischemia on the myometrium and delayed vascularization after surgery. In the present study, we showed that there were no differences in operation time or blood loss between the 2 study groups, indicating the feasibility of interrupted sutures to be used by trained surgeons. Actually, our methods in interrupted sutures seemed less stressful for the surgeons because they did not have to handle the needles with long threads intracorporeally like in continuous sutures.

Hematoma formation or dead space after suturing may have an impact on vascularity after surgery. However, no hematomas or dead spaces were observed in any patients included in the study. Another possible factor associated with pregnancy following surgery is adhesion formation. We have no results regarding post-operative adhesions, which may have influence on fecundity after surgery. Second-look laparoscopy might elucidate this problem.

There have been several reports on the healing process of the myometrium after AM. Post-surgical examination with ultrasound showed that wound healing is usually complete within 3–6 months [20,21].

In this study, the results showed that the vascularity of the scar after LM with continuous sutures did not fully recover within 3–6 months after surgery. These findings could not be clearly observed on ultrasound or MRI with no contrast enhancer; however, they could be quantitatively evaluated by using CE-MRI. The evaluation of all the patients after a longer period, for example, 6 or 12 months after surgery might produce meaningful results regarding myometrial wound healing after LM. However, it was practically very difficult for us, because most of the patients were referred to our hospital for surgical treatment from other clinics, and after a contraceptive period, which we defined as 3 months after LM, many patients dropped out. Furthermore, mean age of the patients in the present study was 38. Six months or 1 year of contraception after surgery for follow-up MRI may not be appropriate for women of late reproductive age who are willing to conceive as soon as

possible. In a previous report by Tsuji et al., MRI after AM showed that the recovery process was complete 12 weeks after surgery [22]. In that study, the uterine defect was closed in 2 layers of continuous sutures and 1 suture of the serosa; MRI then showed that there were no cases of uneven contrast 12 weeks after the operation. The difference between the findings of Tsuji et al. and those of this study might be due to the differences in suturing techniques used with laparoscopy and open surgery, or to the detrimental effect of carbon dioxide pneumoperitoneum on the wound healing, as reported by Rosch et al. [13].

There is a lack of evidence regarding the relationship between a large avascular area after LM and an increased risk of uterine rupture. The avascular areas showed low density in both T1- and T2- weighed images, which is suggestive of fibrosing tissue. In patients with hypertrophic cardiomyopathy or myocardial infarction, fibrosing myocardial tissue showed first-pass perfusion defects in CE-MRI and delayed enhancement by 15 min [23]. We hypothesize that a large fibrosing area in the uterus might cause a decline in contractile function and tensile strength, leading to uterine rupture during pregnancy or labor. To confirm our hypothesis, future studies on the delayed enhancement of avascular area observed in this study and pathological examination of the ruptured or unruptured uterus with a history of myomectomy are necessary.

One of the limitations of the present study is that it is not a randomized trial. In the beginning, we compared the wound healing process of myometrium after LM with that after AM using CE-MRI as a pilot study. We had used continuous suturing in LM and interrupted suturing in AM, and observed a better vascularization in several patients after AM than after LM. Then we changed the aim and compared the effect of different suturing methods in LM.

Whether LM is related to the increased risk of uterine rupture compared with AM is controversial. Claeys et al. reviewed the previous articles and reported that there was a trend for an increased occurrence of uterine rupture following LM versus following AM, though the differences were not statistically significant [24]. Furthermore, the likelihood of a primary cesarean section was significantly increased following LM versus AM, probably reflecting the surgeon's anxiety on a possible increased risk of uterine rupture following LM. An important goal is to improve the safety of LM to be equivalent to that of AM regarding the risk of uterine rupture, and to reduce the ratio of cesarean section following LM to secure the advantage of minimally invasive surgery.

Consequently, interrupted sutures were associated with faster vascularization of the myometrium than are continuous sutures after LM.

The myometrium sutured continuously showed better vascularization after 6 months than it did after 3 months, but still had a larger avascular area than the myometrium 3 months after interrupted sutures. Considering that uterine rupture is a rare but very serious complication, we have to make every effort to improve the safety of laparoscopic myomectomy. The sample size of this paper is small and this study is not a randomized trial. Therefore, to confirm the superiority of single interrupted sutures over continuous sutures in terms of the risk of uterine rupture, a large scale study in multiple institutions will be necessary.

Furthermore, we consider that CE-MRI is an effective examination method to evaluate myometrial vascularity after LM. The evaluation of myometrial vascularity might be useful to decide a contraceptive period and for advisability of vaginal delivery after LM.

Conflict of interest

All authors have nothing to disclose.

References

[1] Marshall LM, Spiegelman D, Barbieri RL, Goldman MB, Manson JE, Colditz GA, et al. Variation in the incidence of uterine leiomyoma among premenopausal women by age and race. Obstet Gynecol 1997;90:967–73.
[2] Lurie S, Piper I, Woliovitch I, Glezerman M. Age-related prevalence of sonographicaly confirmed uterine myomas. J Obstet Gynaecol 2005;25:42–4.
[3] Semm K, Mettler L. Technical progress in pelvic surgery via operative laparoscopy. Am J Obstet Gynecol 1980;138:121–7.
[4] Seracchioli R, Rossi S, Govoni F, Rossi E, Venturoli S, Bulletti C, et al. Fertility and obstetric outcome after laparoscopic myomectomy of large myomata: a randomized comparison with abdominal myomectomy. Hum Reprod 2000;15:2663–8.
[5] Jin C, Hu Y, Chen XC, Zheng FY, Lin F, Zhou K, et al. Laparoscopic versus open myomectomy—a meta-analysis of randomized controlled trials. Eur J Obstet Gynecol Reprod Biol 2009;145:14–21.
[6] Shen Q, Chen M, Wang Y, Zhou Q, Tao X, Zhang W, et al. Effects of laparoscopic versus minilaparotomic myomectomy on uterine leiomyoma: a meta-analysis. J Minim Invasive Gynecol 2015;22:177–84.
[7] Koo YJ, Lee JK, Lee YK, Kwak DW, Lee IH, Lim KT, et al. Pregnancy outcomes and risk factors for uterine rupture after laparoscopic myomectomy: a single-center experience and literature review. J Minim Invasive Gynecol 2015;22:1022–8.
[8] Dubuisson JB, Fauconnier A, Deffarges JV, Norgaard C, Kreiker G, Chapron C. Pregnancy outcome and deliveries following laparoscopic myomectomy. Hum Reprod 2000;15:869–73.
[9] Fukuda M, Tanaka T, Kamada M, Hayashi A, Yamashita Y, Terai Y, et al. Comparison of the perinatal outcomes after laparoscopic myomectomy versus abdominal myomectomy. Gynecol Obstet Invest 2013;76:203–8.
[10] Campo S, Campo V, Gambadauro P. Reproductive outcome before and after laparoscopic or abdominal myomectomy for subserous or intramural myomas. Eur J Obstet Gynecol Reprod Biol 2003;110:215–9.
[11] Kim MS, Uhm YK, Kim JY, Jee BC, Kim YB. Obstetric outcomes after uterine myomectomy: laparoscopic versus laparotomic approach. Obstet Gynecol Sci 2013;56:375–81.
[12] Cobellis L, Pecori E, Cobellis G. Comparison of intramural myomectomy scar after laparotomy or laparoscopy. Int J Gynaecol Obstet 2004;84:87–8.
[13] Rosch R, Junge K, Binnebosel M, Mirgartz N, Klinge U, Schumpelick V. Gas-related impact of pneumoperitoneum on systemic wound healing. Langenbecks Arch Surg 2008;393:75–80.
[14] Parker WH, Einarsson J, Istre O, Dubuisson JB. Risk factors for uterine rupture after laparoscopic myomectomy. J Minim Invasive Gynecol 2010;17:551–4.
[15] Roberge S, Demers S, Berghella V, Chaillet N, Moore L, Bujold E. Impact of single- vs double-layer closure on adverse outcomes and uterine scar defect: a systematic review and metaanalysis. Am J Obstet Gynecol 2014;211:453–60.
[16] Hayakawa H, Itakura A, Mitsui T, Okada M, Suzuki M, Tamakoshi K, et al. Methods for myometrium closure and other factors impacting effects on cesarean section scars of the uterine segment detected by the ultrasonography. Acta Obstet Gynecol Scand 2006;85:429–34.
[17] Bujold E, Bujold C, Hamilton EF, Harel F, Gauthier RJ. The impact of a single-layer or double-layer closure on uterine rupture. Am J Obstet Gynecol 2002;186:1326–30.
[18] Ceci O, Cantatore C, Scioscia M, Nardelli C, Ravi M, Vimercati A, et al. Ultrasonographic and hysteroscopic outcomes of uterine scar healing after cesarean section: comparison of two types of single-layer suture. J Obstet Gynaecol Res 2012;38:1302–7.
[19] Sumigama S, Sugiyama C, Kotani T, Hayakawa H, Inoue A, Mano Y, et al. Uterine sutures at prior caesarean section and placenta accreta in subsequent pregnancy: a case-control study. BJOG 2014;121(866)74 discussion 875.
[20] Darwish AM, Nasr AM, El-Nashar DA. Evaluation of postmyomectomy uterine scar. J Clin Ultrasound 2005;33:181–6.
[21] Pun TC, Chau MT, Lam C, Tang G, Leong L. Sonographic evaluation of the myomectomy 'scars'. Acta Obstet Gynecol Scand 1998;77:218–21.
[22] Tsuji S, Takahashi K, Imaoka I, Sugimura K, Miyazaki K, Noda Y. MRI evaluation of the uterine structure after myomectomy. Gynecol Obstet Invest 2006;61:106–10.
[23] Matsunaka T, Hamada M, Matsumoto Y, Higaki J. First-pass myocardial perfusion defect and delayed contrast enhancement in hypertrophic cardiomyopathy assessed with MRI. Magn Reson Med Sci 2003;2:61–9.
[24] Claeys J, Hellendoorn I, Hamerlynck T, Bosteels J, Weyers S. The risk of uterine rupture after myomectomy: a systematic review of the literature and meta-analysis. Gynecol Surg 2014;11:197–206.