



Review article

Reduced-port surgery in gynecologic fields



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ABSTRACT

Reduced-port surgery (RPS) is widely used for various abdominal surgeries. In this paper, we review RPS as it applies specifically to the field of obstetrics and gynecology with a view toward its usefulness and future prospects. Due to an advisory that was issued by the U.S. Food and Drug Administration in May 2014 sales of the Johnson & Johnson Morcelllex devices were discontinued, as a result a great number of institutions are forced to seek alternative methods of morcellation. Thus, we also approach the question of specimen retrieval during myomectomy. When RPS, including single-port surgery, is performed by a competent surgeon for established indications, it is superior to conventional laparoscopic surgery in cosmetic outcome, and it can also reduce pain and shorten the hospital stay. Although ligature manipulations can be problematic, sealing devices are useful for performing total hysterectomy and adnexectomy without ligature. Furthermore, using a single-port technique when it is possible to extend the umbilical incision, manual tissue morcellation is facilitated.

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Introduction

Abdominal laparoscopy began as a diagnostic procedure performed via a small wound, and the procedure proved to be cosmetically appealing and minimally invasive. The options for minimal invasion have progressed to reduced-port surgery (RPS), which is less invasive than conventional laparoscopic surgery because of the reduction in both the size and number of ports.^{1,2} Historically, laparoscopic surgery arose out of a technological advancement, with the expectation that a laparoscope could provide an excellent view of the abdominal cavity. Thus, the concept of minimal invasion was tightly linked to the achievement of an

excellent surgical view. Further development of laparoscopic surgery in general involved an increase in the number of ports, giving surgeons more freedom, and thus, making the surgeries easier to perform. RPS is a different kind of advancement in that it fully exploits the concept of minimal invasion by reducing the number of ports.

RPS is widely used for various abdominal surgeries and has been gaining traction within the field of gynecology. RPS poses limitations, however. Thus, even if RPS is conducted within the accepted range of indications, it may be possible to achieve a minimally invasive surgery but not realize the full advantages of the procedure under the restrictions of single-incision access.²

Herein, we review RPS as it applies specifically to the field of obstetrics and gynecology with a view toward its usefulness and future prospects. We also approach the practical matter of specimen retrieval during myomectomy. The information presented herein is based on a review of the English literature published before September 2014 and the results of a clinical study performed

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at Juntendo Tokyo Koto Geriatric Medical Center in which three different specimen retrieval methods used during myomectomy were compared.

Methods

Literature review

A systematic review of published papers pertaining to minimally invasive obstetric and gynecologic surgery was conducted. Our search was limited to English-language articles on laparoscopic surgery within the field of obstetrics and gynecology. We conducted a PubMed search of the MEDLINE database using the following keywords: “gynecology,” “surgery,” “laparoscopy,” and “single port,” “reduced port,” “two port,” “NOTES” or “natural orifice transluminal endoscopic surgery,” and “SILS” or “single-incision laparoscopic surgery.” Of the papers that were retrieved, we manually selected those that focused on minimally invasive obstetric and gynecologic surgery. Thereafter, we narrowed our selection to those papers that discussed the usefulness of RPS or single-port surgery and to those that discussed indications for RPS.

Clinical study overview

During the period from April 1, 2014, to mid-July, 2014, three different myoma retrieval methods were used for laparoscopic leiomyomectomy performed at Juntendo Tokyo Koto Geriatric Medical Center. These were as follows: retrieval using the disposable Morcellex power morcellator (Johnson & Johnson Co. Ltd., Tokyo, Japan), which was no longer available to us beyond May 2014; retrieval using a newly marketed, reusable SuperCut morcellator (KARL STORZ Endoscopy Japan K. K. :Tokyo, Japan), which we began using in June 2014; and retrieval by manual in-bag morcellation via the umbilicus, which we introduced in July 2014. We obtained and analyzed data representing 25 patients treated during that 4-month period and covering approximately 1-month use of each of the three retrieval methods. All patients provided informed consent for the laparoscopic leiomyomectomy procedure including the specific tissue retrieval method applied. The use of patient data for study purposes was approved by the hospital's Internal Review Board.

Laparoscopic leiomyomectomy procedure

Laparoscopic leiomyomectomy was performed as previously described.^{3–6} The patient, under general anesthesia, was placed in a head-down position for 15 minutes while pneumoperitoneum of 10 mmHg was created. Trocars were arranged in parallel, with one 12-mm trocar in the umbilicus and one to the left of the umbilicus,

and a 5-mm port was inserted in the left inguinal region. The surgeon stood at the patient's left side, which allowed for the use of both hands for the umbilical port on the left and the port in the left inguinal region. The assistant stood at the patient's right side, and worked the scope through a right inguinal port.

Myoma retrieval and variables investigated

Myoma retrieval by either of the two electric morcellators was performed under laparoscopic visualization, and the morcellators were introduced and withdrawn via the left umbilical trocar. Retrieval time was calculated as the time from the initial cut of the morcellator to the time the morcellator was withdrawn.

Myoma retrieval was achieved by manual in-bag morcellation and withdrawal through the umbilicus. The first step to myoma retrieval was placement of an open Z-shaped incision, as shown in Figure 1. A wound retractor and EZ Access (Hakko Co. Ltd., Tokyo, Japan) were inserted, pneumoperitoneum was created as usual, and the leiomyomectomy was then performed. After the enucleated myoma was pulled into the retrieval bag (Heiwa Catch, Heiwa Medical Instruments, Yamaguchi, Japan), a cold knife was used to manually morcellate the specimen in the bag, and the bag was removed from the abdominal cavity via the umbilicus (Figure 2). Retrieval time was calculated as the time from the initial cut with the cold knife to the time the bag was withdrawn.

All retrieval times were calculated by an operating room nurse not involved in the surgery and were recorded in minutes. A collection efficiency rate was later calculated by dividing the weight of the enucleated myoma by the retrieval time.

Results

Findings from literature review

Our PubMed search yielded 283 papers, from which, after excluding papers that were not directly related to RPS, we selected 132 papers that pertained to manual RPS. Twenty-eight of these papers described comparative investigations of RPS, including single-port surgery and conventional laparoscopic surgery, and the remaining 104 papers pertained to procedural methodology (Figure 3).

All 132 papers were published after the year 2000. Notably, the number of papers written about RPS in the field of gynecology increased rapidly from 2009 onward. All 28 of the comparative investigations were published after 2010, and the two that noted the usefulness of RPS for treating malignant tumors were published in 2014.

Of the 28 comparative investigations, nine pertained to pain, and this was the most common topic. Five papers reported that RPS,

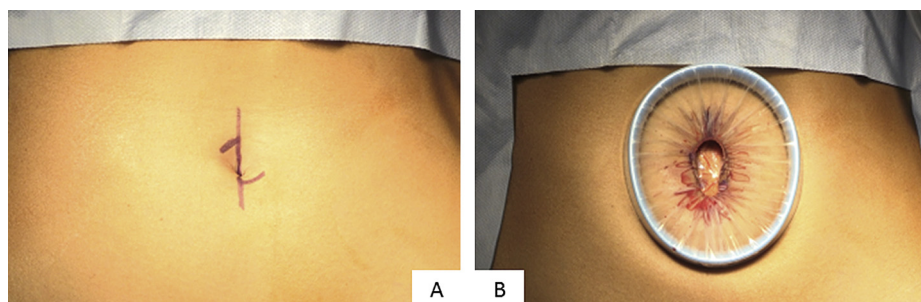


Figure 1. Initial steps to in-bag myoma retrieval. (A) The first step is the creation of an open Z-shaped incision; (B) the umbilicus is then opened widely with a wound retractor and EZ Access port (Hakko Co. Ltd., Nagano, Japan).

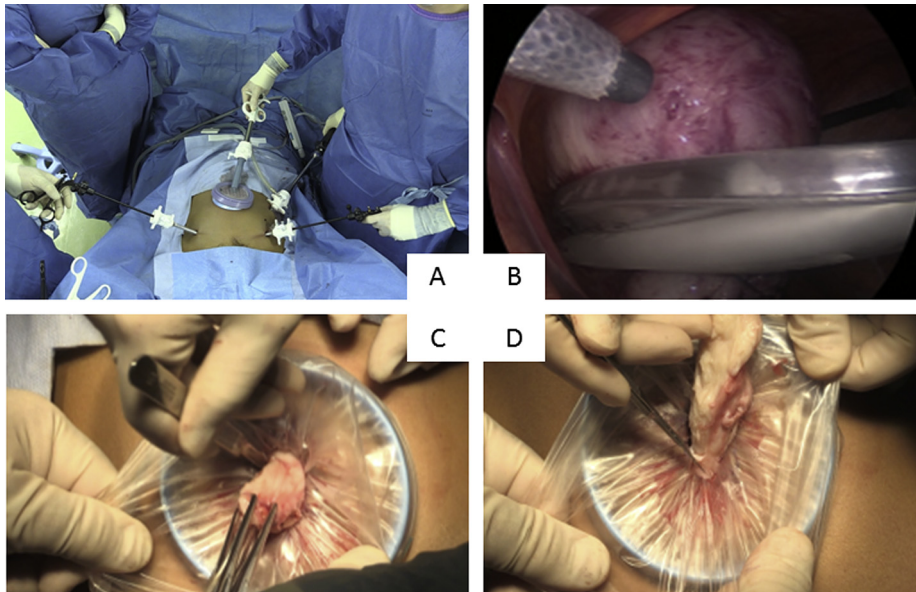


Figure 2. Myoma retrieval. (A and B) The enucleated myoma is pulled into the retrieval bag, which has been inserted from the umbilical wound; (C and D) a cold knife is used to manually morcellate the specimen in the bag, and the bag is removed from the abdominal cavity via the umbilicus.

in comparison to conventional methods, significantly reduced postoperative pain,^{7–11} four of these papers pertained to total hysterectomy.^{7–10} Although four other papers reported no difference between RPS and conventional laparoscopic methods in terms of pain,^{12–15} three of these four papers pertained to cystectomy^{12–14} and one concluded that a prolonged operation increased postoperative pain, particularly shoulder pain resulting from the pneumoperitoneum.¹⁴

Five papers described comparative investigations of the cosmetic aspects of RPS, and all five concluded that the cosmetic outcomes of RPS were superior to those achieved by conventional laparoscopic surgery.^{16–20}

One comparative investigation was in a porcine model and showed levels of stress hormones to be significantly lower in animals in which bilateral salpingo-oophorectomy was performed by RPS than in animals in which the organ removal was performed by

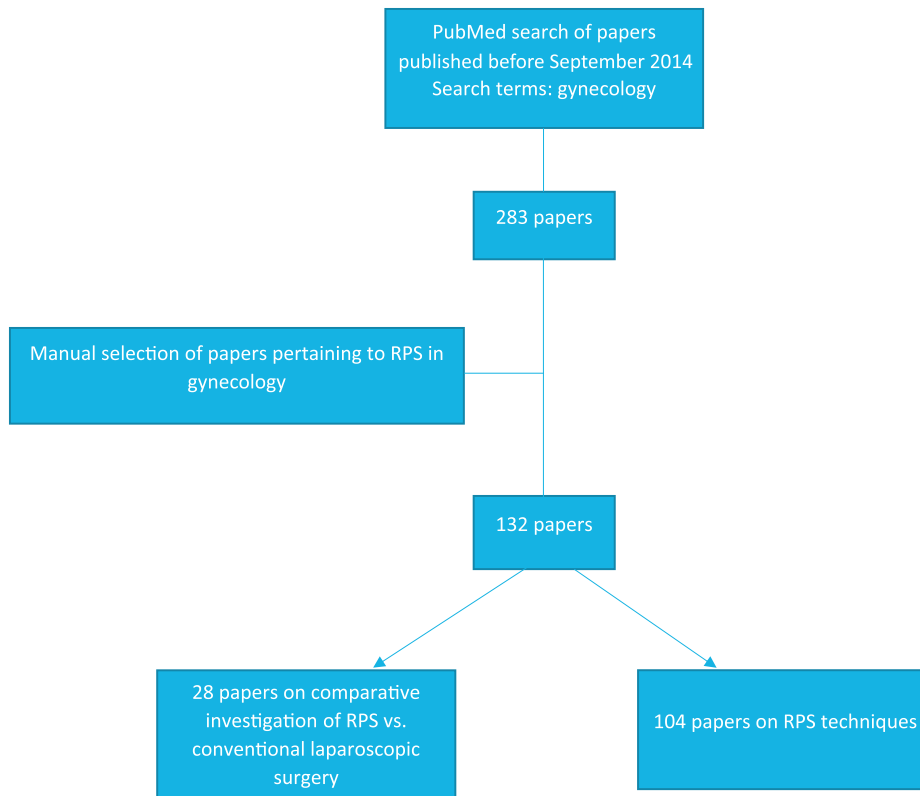


Figure 3. Flow chart of the study population.

conventional laparoscopic surgery,²¹ and several papers reported that minimally invasive surgery was indeed achieved when RPS was limited to the surgical indications recognized by the respective institutions.

Other reports dealt with surgical outcomes.^{22–31} Most of these indicated that the outcomes of RPS and conventional surgery are comparable. However, two papers reported that the operation time was increased but concluded that the time required would decrease as the surgeon gains experience.

When accuracy of the surgical technique was compared between RPS and the conventional method, the anti-Müllerian hormone (AMH) level was measured before and after cystectomy, and no difference was found between the two procedures with regard to the change in AMH.³⁰ In cases of cystectomy, the RPS procedure did not inflict any greater damage to the ovary than that inflicted by conventional laparoscopy, indicating that RPS is not technically problematic. In addition, there was a report indicating that there is no difference in surgical outcomes for leiomyomectomy if the RPS is performed within the range of indications.³¹

Two papers regarding malignant tumors were obtained, one of which reported that 5.3% of cases required conversion to laparotomy,³² and both of which concluded that the hospital stay was shortened and the technique was useful.^{32,33}

Results of our myoma retrieval study

Tumor weights, retrieval times, and collection efficiency rates obtained during our study of myoma retrieval techniques used during RPS are shown for each retrieval method in Table 1. Collection efficiencies achieved with the Morcellex (10 patients), SuperCut (7 patients), and manual in-bag morcellation (8 patients) were 37.0 g/min \pm 14.8 g/min, 32.6 g/min \pm 5.9 g/min, and 21.2 g/min \pm 11.8 g/min, respectively, and analysis of variance confirmed a significant difference ($p = 0.032$) among the methods, which was subsequently shown by Dunnett's multiple comparisons test to be a difference in myoma retrieval performed using the Morcellex power morcellator and that performed by manual in-bag morcellation; collection efficiency achieved using the Morcellex power morcellator exceeded that of the manual morcellation method ($p = 0.019$). However, no significant difference in collection efficiency was found between the Morcellex use and the SuperCut use or between the use of the SuperCut and manual morcellation.

Discussion

Usefulness of RPS in gynecologic surgery

In the field of gynecology, it is advisable to take cosmesis into consideration as much as possible, out of respect for the needs of female patients. Vaginal access for natural orifice transluminal endoscopic surgery (NOTES) addresses this issue, which has been discussed in the field of obstetric and gynecologic surgery for quite

some time.² Although NOTES is considered a new surgical technique useful for avoiding external surgical scars, our search of the literature produced only three papers on NOTES.^{34–37} Further evolution of NOTES is anticipated, but at this point in time, NOTES remains in the developmental stage.

Laparoscopy was first used for intraperitoneal observation, and only a scope was inserted. Subsequently, manipulating forceps were added, and it became possible to perform surgical procedures with this technique. RPS attempts to reduce the number of trocars to increase the degree of freedom. The gain in freedom, however, results in increased operation time and increased blood loss, and if patients' clinical burden is increased, it becomes difficult to say that the procedure is minimally invasive. Accordingly, improved tools and techniques will be needed to compensate for these inevitabilities. In addition, limitations will arise in terms of the forceps traction vectors with the reduction in the number of ports, and we believe this will limit the potential indications, ruling out cystectomy and cases with extensive adhesions that require countertraction.

The concept of RPS, which started as single-port surgery and spread into various surgical fields, is comparatively new in the field of gynecology. Reports of this surgical technique have increased rapidly in number since 2009, and starting in 2010, investigations into the usefulness of RPS increased. Fundamentally, most of the comparative reports indicate that RPS, in comparison to conventional laparoscopic surgery, is advantageous in terms of cosmesis, postoperative pain, and length of the hospital stay. In addition, RPS is most certainly preferable in terms of patient satisfaction, particularly with regard to the cosmetic outcome.

The difficulty of RPS is considered to be relatively high, but the degree of difficulty depends on the competence of the surgeon and the surgical indications. As noted earlier, the increased operation time increases the invasiveness of the procedure, which in turn has a bearing on postoperative pain. RPS has not replaced the conventional laparoscopic method for all types of procedures, but we believe that investigation and determination of the types of patients for whom RPS is indicated are warranted. Our search of the literature yielded no studies of overall gynecologic surgery indications.

We found two reports of RPS for treatment of malignant tumors, both published in early 2014. The reported range of indications for this type of surgery is limited. We believe that RPS is useful for intraperitoneal examination and for tumor resection. There are reports that RPS is useful for total hysterectomy, but the reports are few, and if conversion to laparotomy becomes necessary, RPS cannot be said to be minimally invasive.

An experienced surgeon can perform reduced-port leiomyomectomy when a laparoscopic approach is indicated, and from the reports that we reviewed of RPS performed within a specific range of indications, we found the degree of patient satisfaction to be very high, and we were able to confirm that RPS is useful for various gynecologic diseases.

Table 1
Summary of variables and collection efficiency for each myoma retrieval method.

Variable	Power morcellation with Morcellex (10 patients)	Power morcellation with SuperCut (7 patients)	Manual in-bag morcellation (8 patients)
Myomas, N	2 (1–10)	4 (1–15)	1.5 (1–8)
Tumor weight, g	206 \pm 147	217.2 \pm 92.1	198 \pm 116.0
Retrieval time, min	6.4 \pm 5.5	6.6 \pm 2.6	11.6 \pm 8.6
Collection efficiency, g/min	37.0 \pm 14.8 ^a	32.6 \pm 5.9	21.2 \pm 11.8

Values are shown as median (range) or mean \pm standard deviation.

^a Collection efficiency using Morcellex exceeded that of the manual morcellation method ($p = 0.019$, by Dunnett's test performed after analysis of variance). However, no significant difference in collection efficiency was found between the two power morcellation methods (Morcellex vs. SuperCut) or between SuperCut power morcellation and manual morcellation retrieval methods.

Suturing in particular can be quite difficult during RPS; therefore, RPS is considered most beneficial for surgeries that do not require suturing. For example, sealing devices, which have become much more sophisticated in recent years, are used when ligature is not required and are considered favorable. Sealing devices are thought to be useful during total hysterectomy, salpingo-oophorectomy, and salpingectomy for tubal pregnancy. Surgery for comparatively young patients in particular should address the matter of cosmesis, and the hospital stay needs to be as short as possible. RPS is considered useful for oophorectomy and cryopreservation prior to cancer chemotherapy.³⁸

For cystectomy, in which countertraction is required, a small incision is placed in the suprapubic region or in the hypogastrium, and the procedure can be conducted by drawing the cyst out of the body through this incision,³⁹ or the incision can be used for insertion of an inspection endoscope. The procedure is carried out without pneumoperitoneum, and RPS is considered to be of great value as a surgical method that can be conducted by elevating the abdominal wall in the same manner performed during laparotomy.^{40,41} The important point is that the surgical invasiveness should be reduced as much as possible; thus, measures should be taken to ensure that the surgical incision is as small as possible.

Application of myoma retrieval methods

A power morcellator is a very useful tool for retrieving large tumors during laparoscopic surgery. Power morcellators have been widely used in the field of gynecology for the retrieval of specimens after total hysterectomy and after leiomyomectomy. However, there are concerns regarding the risk of tumor dissemination, and such risk cannot be overlooked in cases of malignant tumor or parasitic myoma. For this reason, an advisory was issued by the U.S. Food and Drug Administration in May 2014 and subsequently, sales of the Johnson & Johnson Morcellex devices were discontinued.⁴² Consequently, a great number of institutions have been forced to seek alternative methods of morcellation.

This is not to say that power morcellators should not be used under any circumstances, but manual in-bag morcellation may be more ideally suited to minimizing the risk of tumor dissemination. There is a report of morcellation performed with an electric morcellator in a large isolation bag.⁴³ In practice, if a power morcellator cannot be used, then a manual method of retrieval is necessary. The manual retrieval routes include passage through the vagina and through the abdominal wall, but because the size of the incision corresponds to the amount of material collected, we believe that retrieval via the umbilicus is suitable. By taking advantage of the concavity of the umbilicus, the surgical incision line can be extended, and the Z-shaped incision can be used to gain a sufficiently large opening (Figure 1).

In our clinical study, the Morcellex was shown to be highly efficient for tissue recovery, but this disposable device can no longer be used. There was no clinically meaningful difference between the SuperCut method and the manual method, and the manual method was performed at acceptable speed. We regard the manual method highly because we can collect the myoma in a bag, and thus, prevent scattering of small tissue fragments. Our patient numbers were small, so we expect to conduct further in-depth analyses in larger groups of patients and thus be able to further improve the efficiency of the RPS specimen retrieval procedure.

Conclusion

When RPS, including single-port surgery, is performed by a competent surgeon for established indications, it is superior to conventional laparoscopic surgery in terms of the cosmetic

outcome and it can reduce pain and shorten the hospital stay. Ligature manipulations can be problematic, but sealing devices are useful for conducting total hysterectomy and adnexectomy without ligature. Furthermore, using a single-port technique when it is possible to extend the umbilical incision, manual tissue morcellation is facilitated. The RPS technique should be further analyzed as a useful and advantageous laparoscopic surgery method for obstetric and gynecologic disorders.

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