—Report on Experiments and Clinical Cases—

Evaluation of Laparoendoscopic Single-site Gynecologic Surgery with a Multitrocar Access System

Masao Ichikawa, Shigeo Akira, Katuya Mine, Nozomi Ohuchi,
Nao Iwasaki, Keisuke Kurose and Toshiyuki Takeshita

Division of Reproductive Medicine, Perinatology and Gynecologic Oncology, Graduate School of Medicine, Nippon Medical School

Abstract

Objects: Laparoendoscopic single-site surgery (LESS) is an ideal approach for gynecologic surgery and yields better cosmetic results. However, a standard umbilical approach with LESS is not appropriate for gynecologic surgery requiring intra-abdominal suturing and dissection requiring traction. Therefore, we have developed a new multitrocar access system for gynecologic LESS. The purpose of this study was to evaluate the efficacy of gynecologic LESS using this access system.

Methods: This access system consists of one 12-mm trocar, two 5-mm trocars, and a 5-mm flexible laparoscope. Two 5-mm trocars with small port heads were inserted cross-wise on opposite sides of the sleeve of the centrally positioned 12-mm trocar to maintain triangulation. Thirty-eight patients with various gynecologic conditions underwent LESS with this access system. The results of these surgeries were retrospectively compared to those of conventional laparoscopic procedures.

Results: Of the 38 LESS procedures performed with this access system, none was up-converted, converted to an open laparotomy, or required blood transfusion. The Salpingo-oophorectomy with LESS had several benefits, such as no extension of the skin incision of the trocar site and no leakage of the contents of the ovarian cyst into the peritoneal cavity, over that with conventional laparoscopy. A comparison of LESS (11 patients) and conventional laparoscopy (16 patients) for total hysterectomy showed no significant difference in total blood loss (234.0 mL vs. 221.6 mL) or the weight of the resected uterus (276.0 g vs. 285.0 g), although the mean total operative time was greater with LESS (199.0 min vs. 168.5 min).

Conclusion: Our multitrocar access system is safe and secure, and can be adapted for various gynecologic surgeries involving complicated procedures. LESS with this access system achieves results comparable to those of conventional laparoscopy with 4 ports, although the operative time is longer.

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Key words: laparoendoscopic single-site surgery, multitrocar single-site access system, salpingo-oophorectomy, total laparoscopic hysterectomy

Correspondence to Masao Ichikawa, MD, PhD, Department of Obstetrics and Gynecology, Nippon Medical School, 1–1–5 Sendagi, Bunkyo-ku, Tokyo 113–8603, Japan
E-mail: masai@nms.ac.jp
Journal Website (http://www.nms.ac.jp/jnms/)

Introduction

Both laparoendoscopic single-site surgery (LESS), using a wound retractor and gloves[1–3], and single-incision laparoscopic surgery (SILS)[4–7] have been reported for the treatment of gynecologic conditions. The former surgery, LESS, has several problems, such as difficulties with set-up and the inappropriate use of gloves, and the latter surgery, SILS, requires special instruments (reticular forceps) and a specific technique (cross-hand method) which make it inappropriate for some laparoscopic procedures, such as total laparoscopic hysterectomy (TLH), which require intra-abdominal suturing and dissection requiring traction. Therefore, we have developed a new multitrocar access system to suit above techniques. The results of LESS using this access system are reported herein.

Materials and Methods

Patients

From February 2009 through April 2011, 38 patients underwent LESS with our multitrocar access system at Nippon Medical School Hospital. The LESS procedures included laparoendoscopic single-site salpingo-oophorectomy (LESS-SO) for 17 patients and laparoendoscopic single-site total hysterectomy (LESS-TH) for 11 patients (**Table 1**). The indications for individual procedures are shown in **Tables 1, 2, and 3**.

The results of 13 of 17 LESS-SO procedures were retrospectively compared to the results of 13 conventional laparoscopic salpingo-oophorectomies (LSOs) that were performed from February 2006 through June 2009. Four patients who underwent LESS-SO were excluded for the following reasons: 1 patient concomitantly underwent transvaginal mesh surgery; 1 patient had a paraovarian cyst instead of an ovarian cyst; and 2 patients had ovarian tumors exceeding 10 cm. The specimens were removed through the umbilicus during LESS-SO or through the left-lower 12-mm trocar in LSO.

The results of 11 LESS-TH procedures were retrospectively compared with those of 16 conventional TLH procedures with 4 ports performed by a single surgeon from April 2009 through April 2011. The indication for LESS-TH and for conventional TLH was that the fundus of the uterus was below the height of the promontory at the time of surgery, regardless of whether the patient had been treated with a gonadotrophin-releasing hormone analogue.

The unpaired Student's *t*-test and the chi-square test were used to calculate the statistical differences between the study groups. A p value <0.05 was considered to indicate statistical significance.

Single-site Access System

A Z-shaped 3-cm skin incision was made (**Fig. 1A–D**). A 12-mm trocar (Endopath Xcel; Ethicon EndoSurgery, Cincinnati, OH, USA) was inserted through the umbilical incision. A 5-mm flexible camera (Visera Endoeye flexible laparoscope; Olympus America, Inc., Center Valley, PA, USA) was introduced through a 12-mm trocar. Two 5-mm trocars with small port heads (Linaport; LiNA Medical ApS, Glostrup, Denmark) were inserted cross-wise on opposite sides of the 12-mm trocar, with an attempt to maintain approximately 2 cm between the 5-mm trocars (**Figs. 1B and C, 2A and B**). During this procedure, the 12-mm trocar was lifted by the left hand to create a safe space (**Fig. 1 B**).

In this system, the parallel method to manipulate instruments was used throughout the surgery. Forceps with a 43-cm shaft (5-mm HiQ Plus forceps; Olympus America, Inc.) and an electric device with the cord connected the rear of the body (Aesculap AG; B. Braun Melsungen AG, Germany) were used to minimize sword fighting (**Figs. 2C [arrow] and D [circle]**). A transabdominal suture[8] was used to compensate for the reduced ports in number as needed (**Fig. 2A**).

Results

In 38 patients with various gynecologic conditions, our multitrocar access system was used to perform LESS, including LESS-SO in 17 patients and LESS-TH in 11 patients (**Table 1**). No cases were up-

Table 1 Laparoendoscopic single-site surgeries using a novel access system at Nippon Medical School Hospital

	Number of patients
Salphingo-oophorectomy	17 (44.7%)
Mature cystic teratoma	10
Serous cystadenoma	4
Mucinous cystadenoma	1
Simple cyst	1
Paraovarian cyst	1
Cystectomy	2 (5.2%)
Mature cystic teratoma	2
Salpingectomy	2 (5.2%)
Ectopic pregnancy	2
Myomectomy	5 (13.1%)
Laparoscopically assisted vaginal hysterectomy	1 (2.6%)
Uterine fibroid	1
Hysterectomy	11 (28.9%)
Uterine fibroid	8
Adenomyosis	2
Hematometra	1
Total number of patients	38

Values are given as n (%)

Table 2 Comparison of patient charactristics and surgical outcomes between LESS-SO and conventional LSO

	LESS-SO N=13	Conventional LSO N=13	P value
Indication of surgery			
Mature cystic teratoma	9 (64.2%)	8 (61.5%)	
Serous cystadenoma	3 (21.4%)	4 (30.7%)	
Mucinous cystadenoma	0 (0.0%)	1 (7.6%)	
Simple cyst	1 (7.1%)	0 (0.0%)	
Age (years)	60.6 (50–77)	54.6 (44–82)	0.101
BMI (kg/m^2)	24.0 (20.0–29.2)	23.0 (17.9–34.1)	0.295
Parity	1.8 (0–4)	1.5 (0–3)	0.240
Tumor size (cm)	6.8 (6–10)	6.1 (4.4–10)	0.138
BSO/total number	11/13 (84.6%)	7/13 (53.8%)	0.202
Mean operation time (mins)	81.0 (50–104)	89.0 (50–123)	0.186
Total blood loss (g)	6.9 (0–50)	16.5 (0–200)	0.274
Rate of expansion of skin incision	0/13 (0%)	5/13 (38.4%)	0.046*
Leakage of contents	0/13 (0%)	2/13 (15.3%)	0.461

Values are given as mean (range) and n (%)
BMI, body mass index; *BSO*, bilateral salpingo-oophrectomy
*P<0.05

converted, converted to open laparotomy, or required intraoperative blood transfusions. No patient had a prolonged hospital stay because of operation-related problems. However, 1 patient who underwent LESS-TH was readmitted 7 days after discharge because of a fever of unknown origin. Observational laparoscopy indicated that the fever had been caused by an infection involving adhesion-preventing materials, the removal of which resolved the fever. No other complications occurred; therefore, the rate of complications in gynecologic LESS with this access system was 2.6%.

Table 3 Comparison of patient characteristics and surgical outcomes between LESS-TLH and conventional TLH

	LESS-TLH N=11	Conventional TLH N=16	P value
Indication for hysterctomy			
Uterine fibroid	8 (45.4%)	13 (62.5%)	
Adenomyosis	2 (18.1%)	3 (18.7%)	
Hematometra	1 (9.0%)	0 (0.0%)	
Age (years)	43.7 (40–47)	42.4 (29–47)	0.393
BMI (kg/m^2)	22.7 (19.5–26.9)	22.0 (15.8–27.5)	0.309
Parity	2.1 (0–3)	1.3 (0–3)	0.014*
Mean operation time (mins)	199.0 (155–323)	168.5 (124–223)	0.037*
Total blood loss (g)	234.0 (0–610)	221.6 (0–710)	0.401
Weight of resected uterus (g)	276.0 (120–456)	285.0 (129–526)	0.427
Complication**	1 (9.0%)	1 (6.2%)	0.637

Values are given as mean (range) and n (%)
BMI body mass index.
*$P<0.05$
**One patient in each group was readmitted after discharge owing to fever of unknown origin.

Table 2 shows patients' characteristics and the results of LESS-SO (13 patients) and conventional LSO (13 patients) for ovarian tumors not exceeding 10 cm. The groups did not differ significantly in mean age, body mass index (BMI), parity, maximum tumor size, operative time, total blood loss, or the ratio of bilateral SO to unilateral SO. However, extension of the skin incision at the trocar site to remove specimens was significantly more frequent in the conventional SO group (38.4%) than in the LESS-SO group (0.0%). It is noteworthy that unexpected leakage of the content of ovarian cysts during recovery of the specimen through the trocar site occurred in 15.3% of cases in the conventional SO group but in none of the cases in the LESS-SO group.

Table 3 shows a comparison of patient characteristics and surgical outcomes between LESS-TH (11 patients) and conventional TLH (16 patients). The LESS-TH group and the TLH group did not differ significantly in mean age, BMI, total blood loss, or weight of the resected uterus. However, operative time was significantly longer in the LESS-TH group than in the TLH group.

Discussion

The most distinctive features of our multitrocar access system is that 3 trocars are transversely aligned at the fascia and that the centrally positioned 12-mm trocar intersects with adjacent working ports at an angle of 15 to 45 degrees (**Fig. 2 A**). The central trocar serves as the fulcrum of the working ports and stabilizes the formation of this access system. If a distance of approximately 2 cm is maintained between the working ports, the forceps can be manipulated freely in a parallel method without any "sword fighting."

We believe this access system is safe and secure. All 38 LESS procedures were completed without additional ports, and the outcomes of LESS-SO and LESS-TH were acceptable and comparable to those of conventional laparoscopic surgeries.

Several umbilical single-site access systems have been reported. Most such systems are multichannel single-port systems, and representative instruments include the SILS[4–7] port (Covidien, Mansfield, MA, USA), Triport[6,9] (Advanced Surgical Concepts, Wicklow, Ireland), Quad Port[5,7] (Advanced Surgical Concepts), and the single-site laparoscopy access system[7] (Ethicon Endosurgery). In assessing the

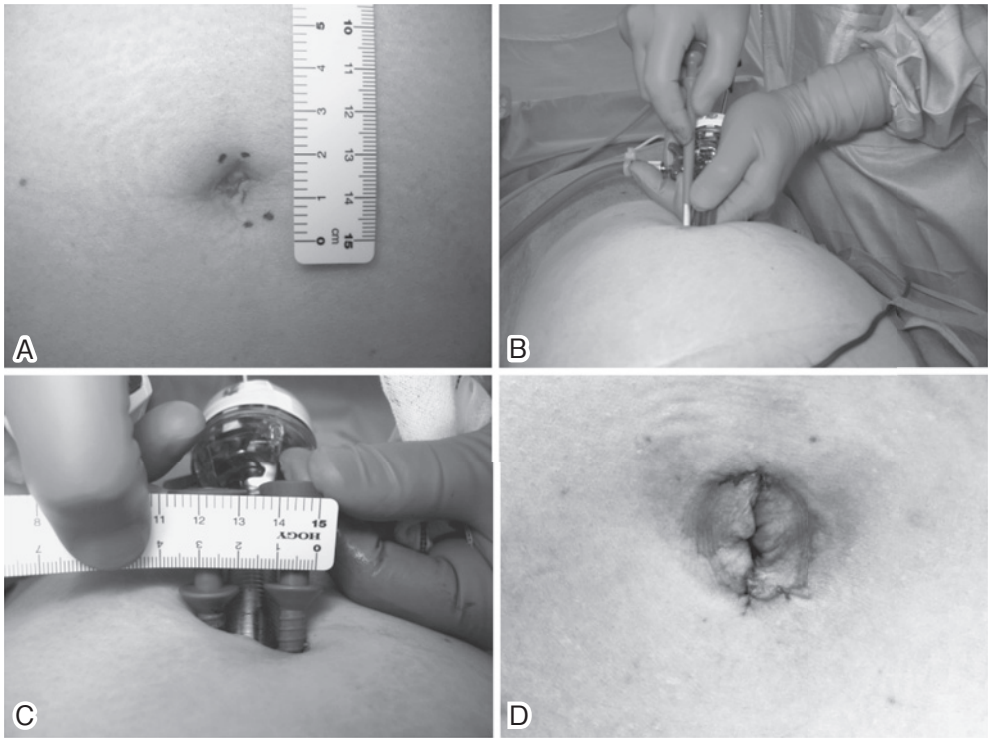

Fig. 1 Procedure with the single-port access system. **A**: Z-shaped 3-cm incision. **B**: Puncture with 5-mm trocars. A 12-mm trocar was lifted with the left hand to create a safe space during this step. **C**: The sum of the widths of the 3 trocars is approximately 3-cm. **D**: The appearance of the Z-shaped incision after surgery.

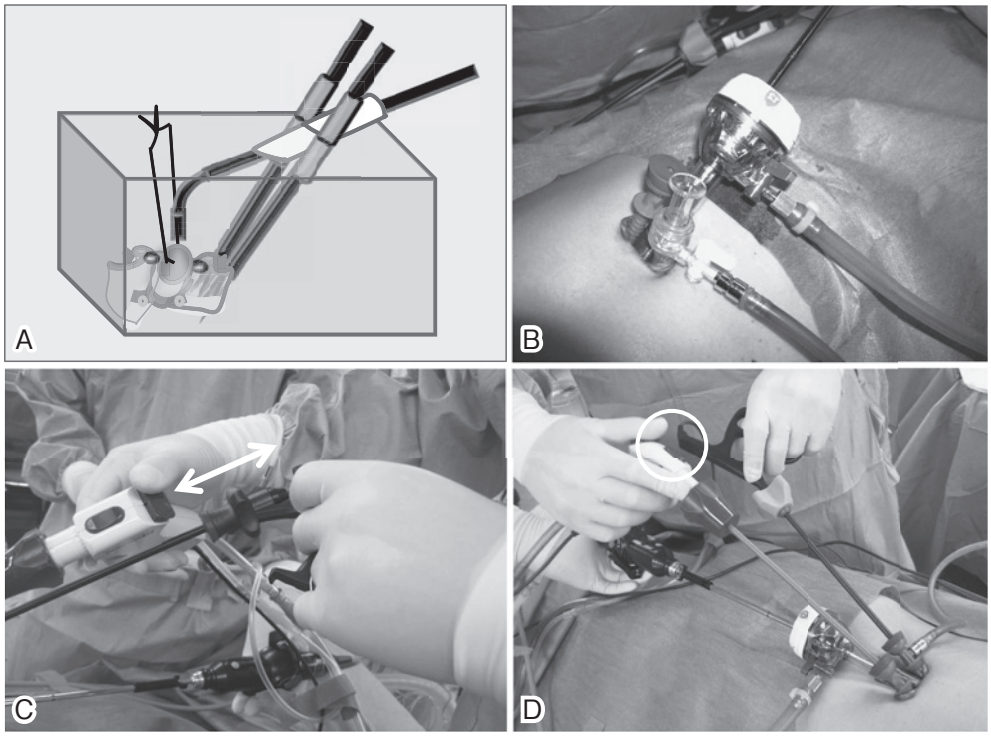

Fig. 2 **A**: Schematic diagram of a single-site multitrocar access system. The operative field is visualized with a 5-mm flexible camera inserted through a 12-mm trocar. **B**: A photograph of the entire access system. Two 5-mm trocars with small housings were inserted cross-wise on opposite sides of the 12-mm trocar, with approximately 2 cm between the trocars to maintain triangulation. **C, D**: A forceps with a 43-cm-long shaft **(arrow)** and an electric device with a cord connected to the rear of the body **(circle)** were used to minimize sword fighting.

adaptability of these devices for treating various gynecologic conditions, we should focus on 2 major factors. First, the required techniques for gynecologic laparoscopy are intra-abdominal suturing and dissection by traction in a parallel manner. To perform these techniques, the distance between the working channels must be at least 2 cm to establish triangulation. Next, a 12-mm trocar is always necessary for gynecologic LESS for the insertion into or removal from the peritoneal cavity of needles, specimen retrieval pouches, or antiadhesive sheets. The single-site laparoscopy access system that would fulfill these criteria might be comparable with our system, although such a system is not available in Japan.

In contrast, few reports of multitrocar access systems have been published; however, one group recently described a multitrocar access system similar to our system and reported that it was efficacious[10]. An important advantage of our multitrocar single-site access system is the minimal fascial incision, which might decrease rates of port-site hernia[11–14]. The umbilicus is a particularly thin region of the abdominal wall[7] and tends to be a site of herniation. Therefore, a larger incision of the fascia for multichannel single-port access could considerably increase the risk of herniation beyond that in conventional laparoscopy (0.02% to 3.1%)[11,13]. More specifically, LESS-TH, which does not require an extension of the fascial incision to remove specimens, can achieve maximum benefit from this access system.

In conclusion, gynecologic LESS using our multitrocar access system is a safe and secure method with many benefits and can be adopted for the treatment of various gynecologic conditions requiring complicated procedures.

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