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Single-site robotic surgery in gynecologic cancer: a pilot study

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Objective: To discuss the feasibility of single-site robotic surgery for benign gynecologic tumors and early stage gynecologic cancers.
Methods: In this single institution, prospective analysis, we analyzed six patients who had undergone single-site robotic surgery between December 2013 and August 2014. Surgery was performed using the da Vinci Si Surgical System. Patient characteristics and surgical outcomes were analyzed.
Results: Single-site robotic surgery was performed successfully in all six cases. The median patient age was 48 years, and the median body mass index was 25.5 kg/m^2 (range, 22 to 33 kg/m^2). The median total operative time was 211 minutes, and the median duration of intracorporeal vaginal cuff suturing was 32 minutes (range, 22 to 47 minutes). The median duration of pelvic lymph node dissection was 31 minutes on one side and 27 minutes on the other side. Patients' postoperative courses were uneventful. The median postoperative hospital stay was 4 days. No postoperative complications occurred.
Conclusion: When used to treat benign gynecologic tumors and early stage gynecologic cancers, the single-site da Vinci robotic surgery is feasible, safe, and produces favorable surgical outcomes.

Keywords: Gynecology; Minimally Invasive Surgical Procedures; Operation Time; Postoperative Complications; Robotic Surgical Procedure; Single-site

INTRODUCTION

Minimally invasive surgery including single-port surgery has been a new option in gynecologic surgery. Among the potential benefits are aesthetic improvements, less pain, and greater patient satisfaction [1,2]. In addition, obtaining specimen is easier with a larger umbilical opening. Nevertheless, poor ergonomics, loss of triangulation, instrument collision, and insufficient traction are hurdles to the use of this technique.

Robotic systems are among the latest advances in the field of minimally invasive surgery. A robotic system provides the surgeon with an expanded view of the operative field with good ergonomics. Robotic systems can overcome the technical difficulties of single-port surgery and offer the advantages of greater dexterity, tremor filtration, and three-dimensional vision [3]. Moreover, robotic-assisted hysterectomies for women with benign disease resulted in reduced hospital readmission rates, less estimated blood loss (EBL), and shorter overall hospital stays [4]. Single-site robotic surgery combines the advantages of single-port surgery and robotic surgery [5,6]. However, to date, there have been few published studies of single-site gynecologic robotic surgery. Herein, we report our successful initial experience with single-site da Vinci (SS-dV, Intuitive Surgical, Sunnyvale, CA, USA) surgery for benign gynecologic tumors and early stage gynecologic cancers.

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MATERIALS AND METHODS

1. Patients

From December 2013 through August 2014, SS-dV surgery was performed on six patients with benign gynecologic

tumors or early-stage gynecologic cancers. Case no. 1 had a 7.6 cm right ovarian mass that appeared to be a borderline-to-malignant tumor and underwent an SS-dV hysterectomy with bilateral salpingo-oophorectomy. Case no. 2 was referred to our hospital with a conization result of invasive squamous cell carcinoma that had a positive endocervical resection margin. She also had a history of two previous cesarean sections. The patient had an SS-dV hysterectomy. Case no. 3 had imaging suspicious of endometrial cancer stage Ia before the surgery. Therefore, an SS-dV hysterectomy, right salpingo-oophorectomy, and left salpingectomy were performed. While waiting for the frozen biopsy result, the surgeon started with a left pelvic lymph node dissection (PLND). The result showed no cancer invasion beyond the endometrium, and therefore no further operation was required. In Case no. 4, an endometrial biopsy showed grade 1 endometrioid adenocarcinoma. Since the RUMI (uterine manipulator; CareFusion, Basingstoke, Hampshire, UK) could not be used due to vaginal tightness, her colpotomy was performed from the vaginal approach. With the exception of this case, the RUMI manipulator was used in all other SS-dV hysterectomies. Because pelvic lymph node metastasis was present, the final diagnosis of Case no. 4 was endometrial cancer IIIc, and she received adjuvant pelvic radiotherapy with six cycles of weekly-cisplatin. Case no. 5 was referred to our hospital with a grade 1 adenocarcinoma diagnosed via endometrial biopsy. She also had adenomyosis, which delayed the timing of her colpotomy. Case no. 6 was suspected of having a borderline-to-malignant ovarian cancer arising from endometriosis based on imaging. A single-port laparoscopic left salpingo-oophorectomy was initially performed to obtain a frozen biopsy. Then, an omentectomy and a para-aortic lymph node dissection (PaLND) were performed. Finally, the surgeon dissected bilateral pelvic lymph nodes using SS-dV.

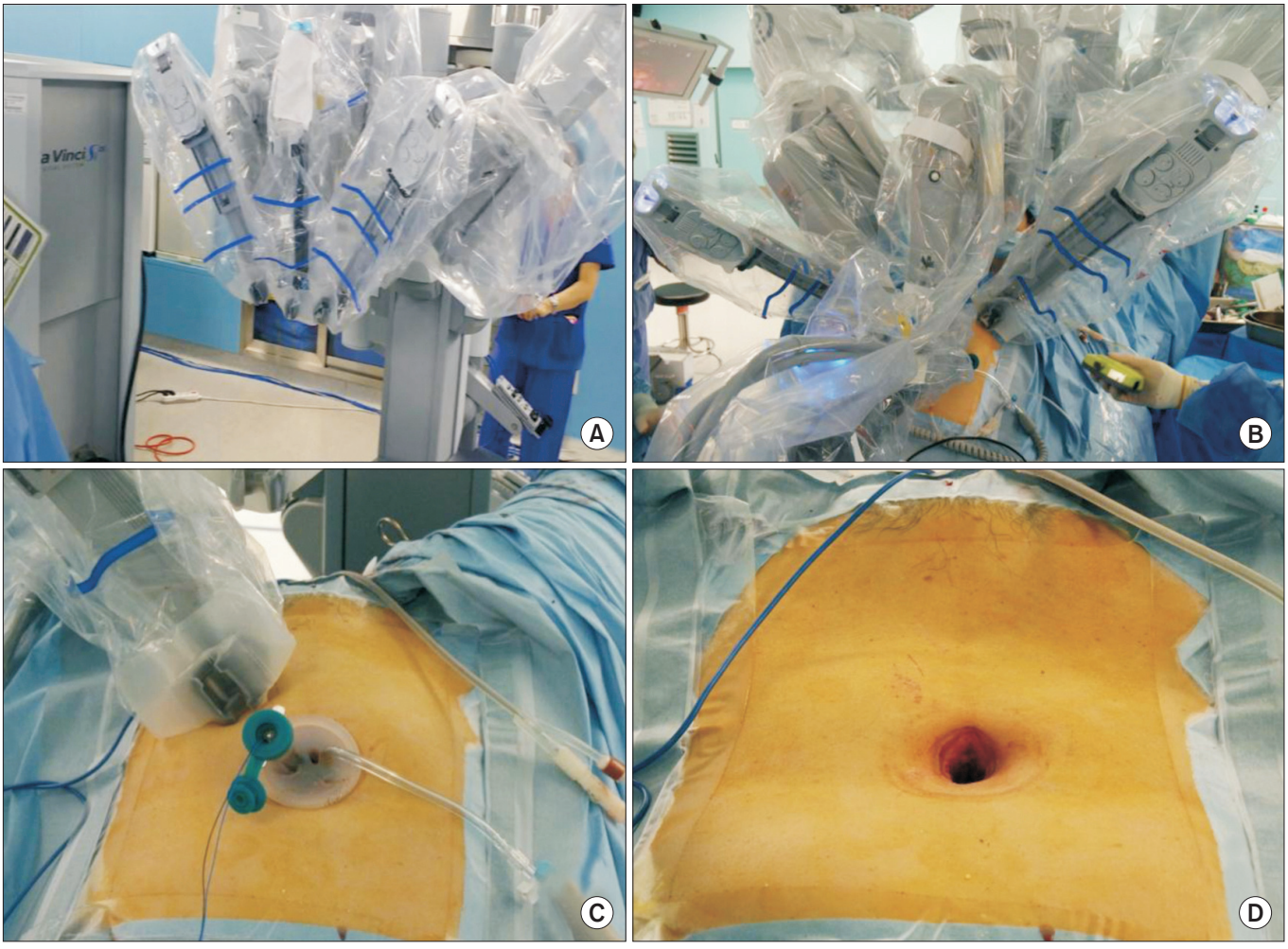

Fig. 1. The da Vinci Si Surgical system. (A) Before docking. (B) After docking. (C) Platform. (D) Abdominal wall after platform removed.

2. Surgical techniques

Patients were placed in dorsal lithotomy positions after anesthetization. After uterine sounding and cervical dilation, a RUMI uterine manipulator with a Koh Colpotomizer system (Cooper Surgical, Trumbull, CT, USA) was fixed onto the cervix to effectively manipulate the uterus. After patients were draped, a single 2.5- to 3-cm umbilical incision was made using the open Hasson approach. The port was then inserted into the abdominal cavity using atraumatic forceps. Pneumoperitoneum was inflated at a pressure of 12 mm Hg. The SS-dV Surgical System was docked between the patients' legs (**Fig. 1**). A three-dimensional 8.5-mm endoscope was used, along with two trocars for the robotic instruments. The assistant's trocar was then inserted and used as a laparoscopic

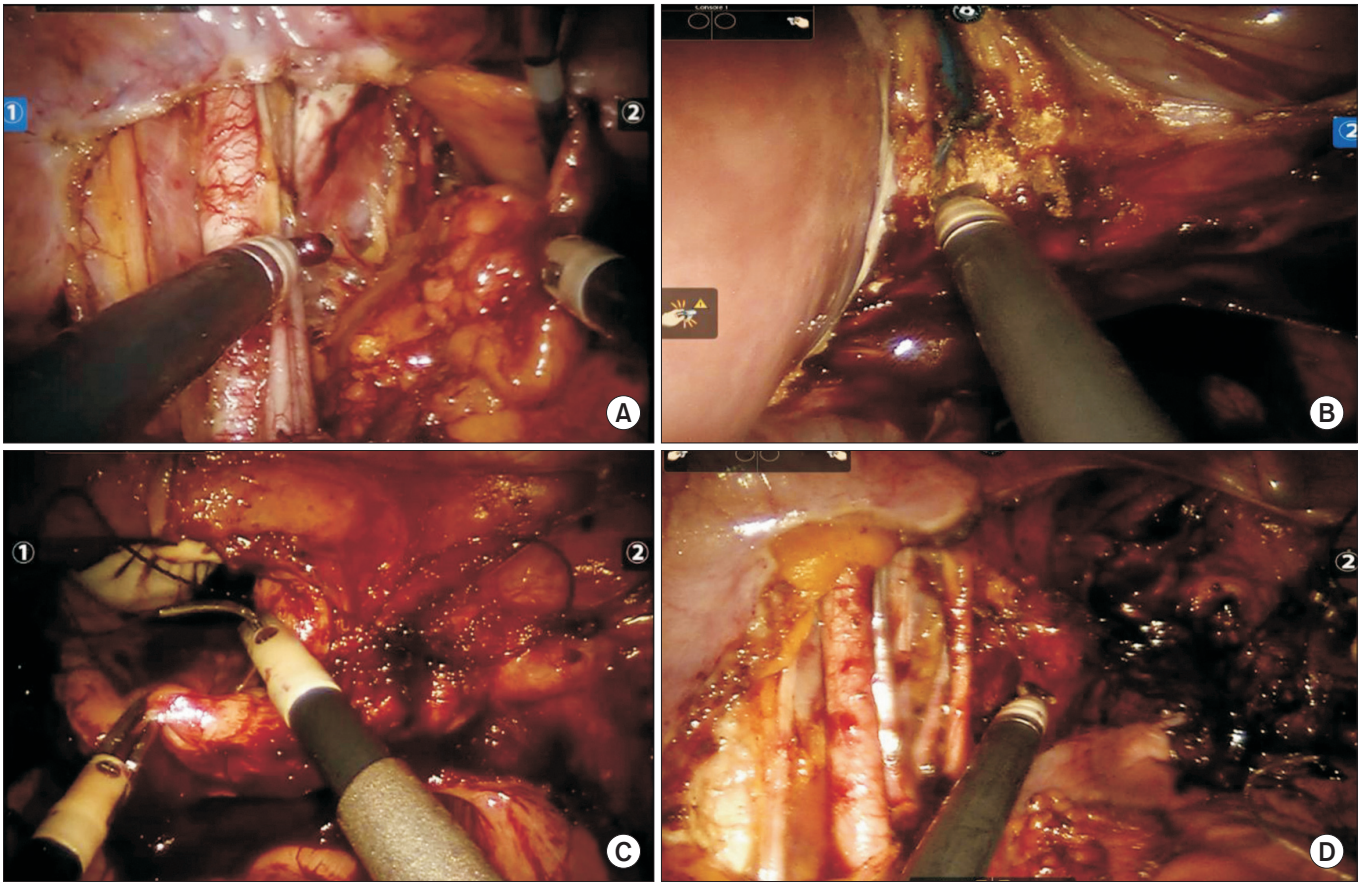

Fig. 2. (A) Lymph node dissection with assistant's grasper. (B) Colpotomy. (C) Intracorporeal closure of vaginal stump. (D) Postoperative view.

Table 1. Patient characteristics

Case	Age (yr)	BMI (kg/m^2)	No. of previous abdominal surgery	Diagnosis	Operation
1	52	26	0	Right ovary mucinous cystadenoma	SS-dV H, bilateral SO
2	39	23	2	Cervical cancer Ia1	SS-dV H (s/p conization)
3	39	33	0	Endometrial cancer Ia, grade 1	SS-dV H, right SO, left salpingectomy, left PLND
4	71	26	0	Endometrial cancer IIIc, grade 1	SS-dV H, bilateral SO, bilateral PLND
5	48	23	0	Endometrial ca Ia, grade 1	SS-dV H, bilateral SO, bilateral PLND
6	41	22	1	Ovarian cancer Ia, grade 3 (clear cell type)	Single-port laparoscopic left SO, omentectomy, PaLND SS-dV bilateral PLND

BMI, body mass index; H, hysterectomy; PaLND, para-aortic lymph node dissection; PLND, pelvic lymph node dissection; SO, salpingo-oophorectomy; SS-dV, single site da Vinci.

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grasper (**Fig. 2**). To reduce collision, the assistant's instrument was placed underneath the camera. Since a bipolar device specific to the SS-dV system was not available to us, advanced bipolar devices operated by an assistant were used in all our cases. The general procedure was similar to the previously described single-port surgery procedure [7]. A 37-cm LigaSure blunt tip (Valleylab, Covidien, Mansfield, MA, USA) was used in the first case and a 45-cm Enseal G2 (Ethicon Endo Surgery Inc., Cincinnati, OH, USA) was used in the remaining cases. A roticulator grasper (Covidien, Mansfield, MA, USA) was also used. Vaginal cuff closure was performed using a needle driver and a Maryland dissector with V-loc 2-0 sutures. During cuff closure, pneumoperitoneum was maintained with a saline-filled glove ball. The umbilical incision was repaired with an absorbable suture layer by layer. The skin was then approximated using Dermabond skin adhesive (Johnson & Johnson, New Brunswick, NJ, USA).

RESULTS

SS-dV surgery was successfully completed in six patients between December 2013 and August 2014. **Table 1** lists patient characteristics, diagnoses, and operation names. Five of the patients underwent SS-dV hysterectomy. The median patient age was 48 years (range, 52 to 71 years) and the median body mass index (BMI) was 25.5 kg/m^2 (range, 22 to 33 kg/m^2). In Case no. 3, there was difficulty in placing the platform due to the patient's obesity (BMI, 33 kg/m^2), necessitating the use of a wound retractor (Alexis, Applied Medical, Rancho Santa Margarita, CA, USA). Platform insertion therefore took 10 minutes in this case. One operation was performed on benign gynecologic tumor while the remaining five were performed on presumed early stage gynecologic cancers.

Table 2 shows the operative times, EBL, postoperative hospital stays, and postoperative complications. The median total operative time was 211 minutes. The median intracorporeal vaginal cuff suturing time was 32 minutes (range, 22 to 47 minutes). In Case no. 4, the RUMI uterine manipulator could not be used owing to vaginal tightness. Instead, the surgeon resected and sutured the vaginal cuff with an extracorporeal approach. PLND was successfully performed in four out of six cases. The median PLND time was 31 minutes on one side and 27 minutes on the other. In Case no. 3, only a left lymph node dissection (LND) was performed. In the other cases, bilateral pelvic lymph nodes were dissected. None of the operations was converted to open surgery. The postoperative course was uneventful in all patients. The median hospital stay was 4 days. The median EBL was 125 mL (range, 50 to 200 mL). None

Table 2. Surgical outcomes of single-site robotic surgery

Case no.	Total operation time (min)	SS-dV platform insertion (min)	Patient cart docking (min)	Hysterectomy & adnexectomy time (min)					Cuff closure time (min)	PLND (min) (No. of dissected lymph node)		EBL (mL)	Postoperative hospital stay (day)	Complications
				Step 1: right side dissection	Step 2: left side dissection	Step 3: vesico-uterine reflection	Step 4: colpotomy	Step 5: specimen removal		Right	Left			
1	178	5	15	22	24	12	9	3	32	NA	NA	200	3	None
2	164	5	20	16	24	13	7	3	28	NA	NA	200	3	None
3	243	10	32	19	24	9	17	2	47	NA (0)	33 (9)	<50	3	None
4	237	5	15	9	15	17	NA	NA	NA	39 (11)	32 (10)	150	4	None
5	249	5	11	15	15	11	18	4	22	33 (7)	15 (9)	100	6	None
6	193	6	10	NA	NA	NA	NA	NA	NA	20 (10)	26 (12)	<50	4	None
Median	211	6	17	16	140	12	13	3	32	31	27	125	4	

EBL, estimated blood loss; NA, not available; PLND, pelvic lymph node dissection; SS-dV, single-site da Vinci.

of the patients received a transfusion. There were no other postoperative complications.

DISCUSSION

Single-incision and single-port surgeries have recently become the preferred surgical methods, involving less blood loss, shorter hospital stays, and improved recovery time [8]. However, there are limitations to these techniques including poor ergonomics and loss of triangulation. Surgeons must cross hands inside the abdomen, leading to fatigue and decreased performance. However, the application of robotic-assisted techniques can overcome these difficulties. Robotic-assisted surgery provides better ergonomics with 3-dimensional visualization and a superior range of motion compared to conventional single-port surgery [9]. In addition, single-port surgery has the advantages of minimal scarring, minimal pain, low blood loss, and high patient satisfaction [10]. Thus, the da Vinci Si Surgical System represents a new angle in gynecologic surgery.

While it has gained popularity among surgeons, there are few available reports on single-site robotic surgery. The first single-site robotic surgery in humans was reported by Kaouk et al. in the urology field [11]. Nam et al. [5] reported seven cases of robotic single-port transumbilical total hysterectomy. Kaouk et al. [11] and Nam et al. [5] performed single-site robotic surgery without the SS-dV platform. PLND is also feasible. Scheib and Fader [12] performed robotic single-site surgery on 40 patients with benign and malignant gynecologic conditions. Tateo et al. [13] presented a case report of robotic single-site pelvic lymphadenectomy in endometrial cancer. The robotic surgery using single-site instruments provides surgeons with greater control, precision, better ergonomics, and improved visualization.

There are several exceptional features to our case series. To the best of our knowledge, this is the first study to report on SS-dV surgery for early stage gynecologic cancers and benign tumors in Korea. The robotic system affords fine movement and tremor control [14]. In four out of six cases, the surgeon successfully accomplished PLND. In all cases, there were no postoperative complications.

In all surgeries, no major bleeding occurred during the operation. As a result, the median EBL was only 125 mL. A bedside assistant used a suction and irrigation system to manage minor bleeding, which requires close collaboration between the operator and assistant. With the operator exercising experienced control in handling the scope, the assistant's instrument can reach the target point with a better view and less between-instrument collision.

With Case no. 3, there was difficulty placing the SS-dV platform on the umbilicus due to obesity. We were able to place the platform with the help of a wound retractor. The current SS-dV platform is problematic for obese patients and requires improvement.

There have been some reports on LND performed with the SS-dV. Tateo et al. [13] described the feasibility of single-site robotic surgery for PLND using bipolar forceps and a monopolar hook. In our study, the surgeon successfully dissected the pelvic lymph nodes in four cases. While assisted by a roticulator grasper, dragging the obliterated hypogastric artery to the medial side simplified the procedure. This required collaboration with an assistant surgeon. When dissecting pelvic lymph nodes, the surgeon switched the position of the instruments between hands. This was to avoid collision between the instruments inside the abdomen. For example, when dissecting the right lymph node, the surgeon would hold the monopolar hook in his right hand while pulling the lymph node to the left with a Maryland dissector held in his left hand. When dissecting the left lymph node, the operator dragged the lymph node to the right with a Maryland dissector in his right hand and so on. To remove the dissected lymph nodes, a 5-mm cannula was changed to a 10-mm cannula at the end of the surgery. Then, dissected lymph nodes were removed from the pelvic cavity with an endobag. A PaLND is barely possible to perform at present because there is too much proximity between the umbilicus and the operative field for the current guidewire to work.

The most challenging procedure was the vaginal cuff closure. Using a long cannula would have made the procedure easier; however, the short one had to be used due to the inconvenience of changing guide cannula. Since the surgeon used a semiflexible instrument with a short guidewire, it was difficult to build up sufficient force for closure. Moreover, the non-flexible endo-wristed needle driver represented another obstacle. With Case no. 5, we used a long guide cannula (30 cm) instead, which shortened the operation time. According to Scheib and Fader [12], moving the distal portion of the cannula in closer proximity to the surgical field may provide some rigidity. Recently, the Single-Site Wristed Needle Driver (Intuitive Surgical) received Food and Drug Administration clearance for use with the da Vinci Si Surgical System. Its tip has up to 45 degrees of motion in all directions as well as serrated jaws to facilitate needle handling. This provides surgeons with precision and the ability to overcome challenges in suturing the vaginal cuff.

Single-site robotic surgery is still in its infancy. Ours is a pilot study reporting on the first few cases of single-site robotic

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surgery. Although there are some limitations, the present cases demonstrate the feasibility and safety of this procedure. Further studies are strongly recommended to fully appreciate the advantages of single-site robotic surgery and identify ways to overcome its shortcomings.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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