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Original Article

Robotic surgery in complicated gynecologic diseases: Experience of Tri-Service General Hospital in Taiwan

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Abstract

Objective: Minimally invasive surgery has been the trend in various specialties and continues to evolve as new technology develops. The development of robotic surgery in gynecology remains in its infancy. The present study reports the first descriptive series of robotic surgery in complicated gynecologic diseases in Taiwan.
Materials and Methods: From March 2009 to February 2011, the records of patients undergoing robotic surgery using the da Vinci Surgical System were reviewed for patient demographics, indications, operative time, hospital stay, conversion to laparotomy, and complications.
Results: Sixty cases were reviewed in the present study. Forty-nine patients had benign gynecologic diseases, and 11 patients had malignancies. These robot-assisted laparoscopic procedures include nine hysterectomy, 15 subtotal hysterectomy, 13 myomectomy, eight staging operation, two radical hysterectomy, five ovarian cystectomy, one bilateral salpingo-oophorectomy and myomectomy, two resections of deep pelvic endometriosis, one pelvic adhesiolysis, three sacrocolpopexy and one tuboplasty. Thirty-three patients had prior pelvic surgery, and one had a history of pelvic radiotherapy. Adhesiolysis was necessary in 38 patients to complete the whole operation. Robotic myomectomy was easily accomplished in patients with huge uterus or multiple myomas. The suturing of myometrium or cervical stump after ligation of the uterine arteries minimized the blood loss. In addition, it was much easier to dissect severe pelvic adhesions. The dissection of para-aortic lymph nodes can be easily accomplished. All these surgeries were performed smoothly without ureteral, bladder or bowel injury.
Conclusion: The present analyses include various complicated gynecologic conditions, which make the estimation of the effectiveness of robotic surgery in each situation individually not appropriate. However, our experiences do show that robotic surgery is feasible and safe for patients with complicated gynecologic diseases.

Keywords: adhesions; hysterectomy; myomectomy; robotic staging; subtotal hysterectomy

Introduction

Minimally invasive surgery has been the trend in various specialties including gynecology for a long time and continues to evolve as new technology develops. The development of laparoscopy has been considered superior to laparotomy with shorter hospital stay, decreased blood loss, improved cosmesis and less postoperative pain [1]. Despite the advantages over laparotomy, the slow learning curve, less dexterity, limited range of movement, counter-intuitive hand motions, two-dimensional vision, ergonomic difficulty and tremor amplification limit the application of laparoscopy in complex surgical tasks [2], especially in those with suspected alteration in the anatomical operating field or huge lesions occupying the surgical space.

Since the approval by the US Food and Drug Administration (FDA) in April 2005, robotic surgeries using the da Vinci Surgical System (Intuitive surgical Inc., Sunnyvale, CA, USA) have been applied widely in many surgical fields including

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Table 1
Patient summary.

Patient	Age (y)	BMI	Indication	Prior surgery	Robotic procedure	T_D	Wt
1	36	21	Myoma, endometrioma of ovary	–	M, RAOC, adhesiolysis	–	–
2	31	19.2	Myoma	–	M	—	150
3	55	22.6	Endometrial cancer	–	Staging operation (extrafascial hysterectomy + BSO + BPPLND)	–	–
4	39	19.9	Cervical cancer, stage IA1	–	Staging operation (extrafascial hysterectomy + BPPLND)	–	–
5	40	18.7	Myoma	–	M	–	230
6	35	23.7	Adenomyosis, myoma	CS, laparoscopic adhesiolysis(3)	RAVH, LSO, adhesiolysis	–	158
7	67	27.7	Chronic pelvic pain	CS	RAVH, BSO, adhesiolysis	–	48
8	49	25.9	Endometrial cancer	CS	Staging operation (extrafascial hysterectomy + BSO + BPPLND), adhesiolysis	–	–
9	40	21.8	Adenomyosis	CS(3), appendectomy, salpingectomy	RAVH, adhesiolysis	–	160
10	44	19.9	Myoma	–	M	–	125
11	60	22.5	Cervical cancer, stage IVB post-chemoradiation therapy	–	RAVH, BSO, pelvic and para-aortic lymph nodes sampling	–	–
12	51	19.4	Adenomyosis, myoma	Tubal sterilization	RAVH, BSO, adhesiolysis	–	970
13	47	23.5	Myoma	CS	M	–	–
14	46	19	Myoma	–	M	–	–
15	38	19.4	Adenomyosis	CS(2), laparoscopy	SH, ligation of UA, adhesiolysis	–	–
16	41	22.7	Endometrial cancer	–	Staging operation (extrafascial hysterectomy + BPPLND)	–	–
17	41	17.7	Adenomyosis, myoma	CS	M, adhesiolysis	8	90
18	43	21.9	Adenomyosis, myoma	LAOC(2), appendectomy	SH, ligation of UA, adhesiolysis	7	190
19	35	18.4	Chronic pelvic pain	CS	Adhesiolysis	13	–
20	39	20	Adenomyosis, myoma	M	SH, ligation of UA, adhesiolysis	12	245
21	64	21.4	Prolapse of vaginal vault	LAVH + BSO	Sacrocolpopexy, adhesiolysis	4	–
22	45	30.2	Adenomyosis, myoma	LAOC(2)	SH, RSO, adhesiolysis	5	180
23	43	18.4	Myoma	–	SH	2	110
24	46	22.1	Endometrioma of ovary, myoma	M(2), ovarian cystectomy	BSO, adhesiolysis, M	7	40
25	37	18.6	Cervical cancer, stage IB1	–	RH, BPPLND	2	–
26	63	26.9	Prolapse of uterus and anterior vaginal wall	–	Sacrocolpopexy, Burch colposuspension	6	–
27	39	20	Adenomyosis	–	SH, adhesiolysis	3	125
28	61	27.8	Cervical cancer, stage IB2	–	RH, BSO, BPLND	3	–
29	51	20.2	Endometrial cancer	M	Staging operation (extrafascial hysterectomy + BSO + BPPLND), adhesiolysis	5	–
30	48	26.2	Complex hyperplasia of endometrium, adenomyosis, myoma	Laparoscopy, tubal sterilization	RAVH, ligation of UA, adhesiolysis	3	1150
31	28	20	Myoma	—	M, adhesiolysis	4	30
32	29	22.8	Tubal obstruction	Laparoscopic adhesiolysis	Tuboplasty, adhesiolysis	4	–
33	56	34.1	Myoma	–	RAVH, BSO	4	370
34	40	34.6	Adenomyosis	CS(3), laparoscopic drainage of TOA	RAVH, LSO, adhesiolysis	3	210
35	56	22.3	Endometrial cancer	LAVH	Staging operation (BSO + BPPLND)	2	–
36	35	20	Adenomyosis, myoma	CS, salpingectomy, laparoscopic colpopexy + pelvic adhesiolysis	SH, suspension of bilateral ovary, adhesiolysis	4	120
37	33	20.3	Endometrioma of ovary	–	RAOC, adhesiolysis	3	–
38	52	18.9	Myoma	Oophorectomy	SH, adhesiolysis	2	600
39	38	23.7	Myoma	–	M	4	200

(*continued on next page*)

Table 1 (*continued*)

Patient	Age (y)	BMI	Indication	Prior surgery	Robotic procedure	T_D	Wt
40	45	25.7	Myoma	CS, laparoscopic appendectomy, ovarian cystectomy	RAVH, adhesiolysis	6	200
41	31	18.8	Myoma	M	M	7	60
42	34	20.6	Adenomyosis	–	SH, adhesiolysis	5	70
43	48	24.4	Prolapse of uterus	Appendectomy	Sacrocolpopexy, adhesiolysis	6	–
44	28	21	Endometrioma of ovary	–	RAOC, abscess drainage, salpingoplasty, adhesiolysis	6	–
45	29	21.9	Adenomyosis	LAOC(2), appendectomy, CS	SH, adhesiolysis	7	90
46	38	19.9	Myoma	Laparoscopy	SH	3	104
47	50	23.5	Myoma	–	SH, BSO	4	462
48	36	19.1	Myoma	–	M	4	71
49	36	29.1	Endometrial cancer	Appendectomy, LAOC	Staging operation (extrafascial hysterectomy + BSO + BPPLND)	3	–
50	45	20.9	Myoma	CS(2)	SH, adhesiolysis	5	120
51	31	19.8	Pelvic endometriosis	CS(2)	Resection of pelvic endometriosis, adhesiolysis, ligation of UA	4	–
52	46	33.7	Endometrial cancer	Laparoscopy	Staging operation (extrafascial hysterectomy + BSO + BPPLND), adhesiolysis	3	–
53	40	22.4	Adenomyosis, bladder endometriosis	–	SH, adhesiolysis, resection of bladder endometriosis	5	90
54	31	20.4	Endometrioma of ovary	–	RAOC, resection of pelvic endometriosis, adhesiolysis, tuboplasty	4	–
55	46	22.5	Myoma	CS(2)	M, adhesiolysis	4	170
56	33	26.8	Pelvic endometriosis	Laparoscopy, adhesiolysis	Resection of pelvic endometriosis, M, adhesiolysis,	8	–
57	27	21.5	Endometrioma of ovary	–	RAOC, resection of pelvic endometriosis, adhesiolysis	5	–
58	30	19.4	Teratoma of ovary	–	RAOC	5	–
59	42	21.5	Adenomyosis, endometrioma of ovary	–	SH, RAOC, adhesiolysis	3	202
60	34	19.2	Myoma	LAOC, M, appendectomy	M, adhesiolysis	3	70

Numbers in parentheses indicate the number of procedures. BMI, body mass index; BPLND, bilateral pelvic lymph node dissection; BPPLND, bilateral pelvic and paraaortic lymph node dissection; BSO, bilateral salpingo-oophorectomy; CS, cesarean section; LAOC, laparoscopic-assisted ovarian cystectomy; LAVH, laparoscopic-assisted vaginal hysterectomy; LSO, left salpingo-oophorectomy; M, myomectomy; RAOC, robotic-assisted ovarian cystectomy; RAVH, robotic-assisted vaginal hysterectomy; RH, radical hysterectomy; SH, subtotal hysterectomy; T_D, docking time (min); TOA, tubo-ovarian abscess; UA, uterine artery; Wt, weight of specimen (g).

gynecology, urology, orthopedics, general surgery and cardiothoracic surgery [3]. The three-dimensional vision system and the wrist-like structure of EndoWrist instruments (Intuitive surgical Inc., Sunnyvale, CA, USA) recapitulating the motion of the surgeon's hand make precise procedures easier than in conventional laparoscopy, which allows robotic surgery to overcome some of the shortcomings and limitations of traditional laparoscopy [4]. However, the application of robotic surgery in gynecology remains in its infancy, and its indications are still undetermined. The present study reports the first descriptive series of robotic surgery in complicated gynecologic diseases in Taiwan.

Materials and methods

From March 2009 to February 2011, 60 patients with complicated benign or malignant gynecologic surgical conditions initially considered for laparotomy were admitted for robotic gynecologic surgery, using the da Vinci Surgical System by a single attending surgeon and rotating assistants. Records were reviewed for patient demographics, indications, operative time (defined as skin-to-skin time), hospital stay, conversion to laparotomy, and complications.

All patients were positioned in a lithotomy position. A uterine manipulator and a Foley catheter were inserted. Four or five trocars were used after pneumoperitoneum was obtained. Trocar sites varied according to different procedures. Generally, 3 cm midline above the umbilicus for the scope and 8–10 cm lateral to the scope at 15 degrees for the arms are the most commonly adopted sites for surgical staging for endometrial cancer or extended hysterectomy of cervical cancer. Scope at 30° is the choice for para-aortic lymph node dissection up to the inferior mesentery artery, while scope at 0° was used for the rest of the procedures. The umbilicus could be used as the scope for benign conditions. However, trocar sites at higher levels may be helpful in patients with huge or multiple myomas or dense pelvic adhesions, because of the better panoramic view and operation depth. The accessory port could be 6–8 cm caudo-lateral or cephalo-medial to the left arm. Once all ports were in place, the patient was placed in a steep Trendelenburg position, and the patient-side cart was set between the patient's legs, followed by docking of the robotic arms. Robotic surgery was performed with EndoWrist instruments such as PreCise bipolar forceps, a monopolar cautery spatula and needle drivers. A grasper, curved scissors or a morcellator was used for assistance via an accessory port depending on different procedures. A survey of the operative field was performed, followed by the main procedure and other procedures such as morcellation, adhesiolysis or ligation of uterine artery if needed. After hemostasis and removal of the specimen via the trocar site or by colpotomy, the arms were undocked and the instruments were removed. Finally, the intra-abdominal gas was released, and the trocar sites were closed with sutures.

Results

Sixty cases were reviewed in the present study. Forty-nine patients had benign gynecologic diseases, and 11 patients had malignancies (seven endometrial cancer and four cervical cancer) (Table 1). A variety of robot-assisted laparoscopic procedures included nine vaginal hysterectomy, 15 subtotal hysterectomy with ligation of the uterine arteries, 13 myomectomy, eight staging operation, two radical hysterectomy, five ovarian cystectomy, one bilateral salpingo-oophorectomy and myomectomy, two resection of deep pelvic endometriosis, one pelvic adhesiolysis, three sacrocolpopexy and one tuboplasty. Thirty-three (55%) patients had prior pelvic surgery, and one patient had a history of pelvic radiotherapy for cervical cancer (Table 2). Extensive adhesiolysis was necessary in 38 patients (63.3%) to complete the whole operation (Fig. 1). We did not record the docking time until Patient 18. The mean docking time from Patients 18 to 60 was 4.9 ± 2.3 minutes.

In the robot-assisted laparoscopic vaginal hysterectomy group, the mean age of the nine patients was 49.1 ± 10.4 years

Table 2
Procedure summary.

Major robotic procedure	n	Severe adhesions	Wt	Mean operation time (min)	Blood loss (mL)	Mean hospital stay (d)
Hysterectomy	9	7	408.3 ± 414.7	171.9 ± 52.4	341.7 ± 316.9	3.4 ± 0.9[a]
Subtotal hysterectomy	15	12	193.4 ± 153.8	162.9 ± 62.2	140 ± 94.9	3.2 ± 0.8
Myomectomy	13	6	119.6 ± 66.2	206.8 ± 67.7[b]	245 ± 145.9	3.5 ± 0.7
Staging operation	8	3	–	238.1 ± 52.4	133.3 ± 98.3	4.8 ± 2.6[c]
Radical hysterectomy	2	0	–	363 ± 29.7	750 ± 990	8 ± 1.4
Ovarian cystectomy	5[d]	4	–	109.2 ± 20.4	62 ± 21.7	3.4 ± 2.1
Bilateral salpingo-oophorectomy + myomectomy	1	1	–	223	600	4
Resection of pelvic endometriosis + adhesiolysis	2	2	–	139.5 ± 27.6	150	4.5 ± 0.7
Pelvic adhesiolysis	1	1	–	136	50	3
Sacrocolpopexy	3	1	–	166.7 ± 69	53.3 ± 83.7	3 ± 1
Tuboplasty	1	1	–	184	100	4

n, number of cases; Wt, weight of specimen (g).
[a] One case was excluded from this analysis, because of rehabilitation for nerve injury.
[b] Two cases were excluded from this analysis, because of morcellator failure.
[c] Another two cases were excluded from this analysis: one underwent a course of chemotherapy after the operation; the other was treated with thrombectomy as a result of occlusion of arteriovenous shunt.
[d] One case also underwent tuboplasty and drainage of tubo-ovarian abscess and had a prolonged hospital stay of 7 d for antibiotic therapy.

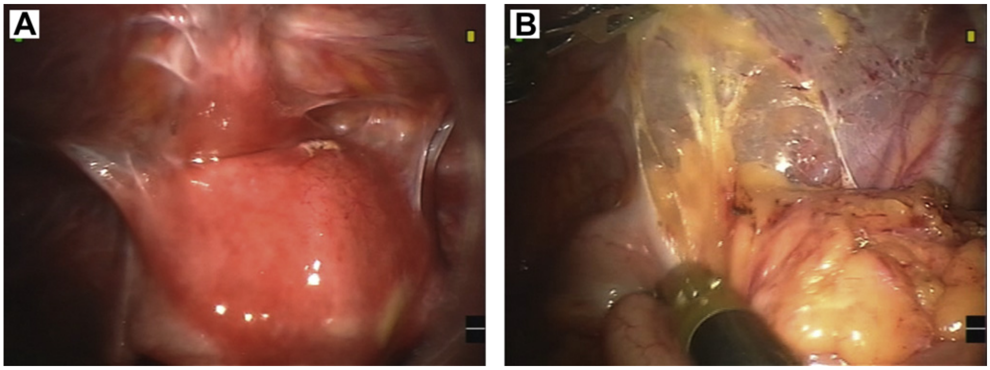

Fig. 1. Pelvic adhesions. (A) Severe adhesions between the bladder and the anterior uterine wall after cesarean section. (B) Extensive adhesions at the left gutter region.

and the mean body mass index (BMI) was 26.1 ± 5.2 kg/m^2. Seven patients (78%) had prior pelvic surgery-related pelvic adhesions, including extensive pelvic adhesions in four patients, and one had a history of pelvic radiotherapy. The mean operative time was 171.9 ± 52.4 minutes, and the mean weight of specimen was 408.3 ± 414.7 g. The mean blood loss was 341.7 ± 316.9 mL, and the mean length of hospital stay was 3.4 ± 0.9 days. A patient was complicated with common peroneal nerve injury caused by positioning of the leg and was excluded in the analysis of hospital stay because of her rehabilitation program.

Fifteen patients with a mean age of 40.8 ± 6.0 years and mean BMI of 21.3 ± 2.8 kg/m^2 underwent robot-assisted laparoscopic subtotal hysterectomy. Eight patients (53.3%) had a history of pelvic surgery with resultant severe pelvic adhesions, and four (26.7%) had pelvic adhesions without a history of pelvic surgery. Four of the 15 patients were nulliparous. Uterine arteries were dissected and cauterized for the control of bleeding before supracervical hysterectomy. The mean operative time was 162.9 ± 62.2 minutes, and the mean weight of specimen was 193.4 ± 153.8 g. The mean blood loss was 140 ± 94.9 mL, and the mean length of hospitalization was 3.2 ± 0.8 days. One patient also had bladder endometriosis and underwent partial resection of bladder and primary repair, followed by removal of the Foley catheter 1 week later.

There were 13 patients undergoing robot-assisted laparoscopic myomectomy. The mean age was 38.3 ± 6.3 years, and the mean BMI was 20.2 ± 1.9 kg/m^2. Of the 13 patients, six (46.2%) had multiple huge myomas, one was associated with bilateral ovarian endometrioma and severe pelvic adhesions, and four had prior pelvic surgery with pelvic adhesions. The mean operative time was 206.8 ± 67.7 minutes, and two cases were excluded in the analysis of operation time because of dysfunction of the morcellator. The mean weight of specimen was 119.6 ± 66.2 g, and the mean blood loss was 245 ± 145.9 mL. The mean hospital stay was 3.5 ± 0.7 days.

A robot-assisted laparoscopic staging operation was performed for eight patients with a mean age of 46.6 ± 7.4 years and a mean BMI of 24.6 ± 4.8 kg/m^2. Three had pelvic adhesions as a result of prior pelvic surgery. The mean operative time was 238.1 ± 52.4 minutes, and the mean blood loss was 133.3 ± 98.3 mL. The mean number of lymph nodes dissected were 18.8 ± 11.0. The mean length of hospital stay was 4.8 ± 2.6 days. Two patients with other medical or surgical conditions were excluded for the analysis of hospital stay, including one undergoing chemotherapy and the other with thrombectomy.

Two patients of cervical cancer underwent robot-assisted laparoscopic radical hysterectomy. One took 384 minutes with a blood loss of 1450 mL as a result of the bulky tumor mass and need for blood transfusion. The other took 342 minutes with blood loss of 50 mL. The lymph nodes were 24 and 20, respectively. The mean length of hospital stay was 8 ± 1.4 days.

Robot-assisted laparoscopic ovarian cystectomy was performed for four patients with ovarian endometrioma and extensive pelvic adhesions or posterior cul-de-sac obliteration. One patient is with bilateral ovarian teratoma. One patient with endometriosis, pelvic abscess and tubal obstructions at the same times underwent drainage of tubo-ovarian abscess, ovarian cystectomy and tuboplasty. The longer hospital stay was for antibiotic therapy.

Robot-assisted laparoscopic resection of deep pelvic endometriosis was done in two patients with chronic pelvic pain. Both had complete obliteration of the posterior cul-de-sac associated with endometriosis. We explored the rectovaginal septum and excised deep endometriosis in uterosacral ligaments or the rectovaginal septum. The mean operative time was 139.5 ± 27.6 minutes. The blood loss was 150 mL in both cases. The mean length of hospital stay was 4.5 ± 0.7 days.

Three patients with a mean age of 58.3 ± 9.0 years and a mean BMI of 24.2 ± 2.8 kg/m^2 underwent robot-assisted laparoscopic sacrocolpopexy using Gynemesh. Two of them were uterus-sparing sacrocolpopexy. The mean operative time was 166.7 ± 69.0 minutes, and the mean blood loss was 53.3 ± 83.7 mL. The mean length of hospital stay was 3 ± 1 days.

Discussion

In the present preliminary study, we evaluate the feasibility of robotic surgery in various complicated gynecologic diseases. It can be performed safely with acceptable operative time and hospital stay, even in challenging situations which are difficult and exhausting if using conventional laparoscopy. Excellent dexterity afforded by the instruments and three-dimensional vision help greatly to overcome the limitations of conventional laparoscopy.

Hysterectomy could be approached by the vaginal or abdominal route until the development of minimally invasive surgery. The outcomes of laparoscopic hysterectomy have been observed better than those after abdominal hysterectomy [5]. However, abdominal hysterectomy remains the most common route in patients with pelvic adhesions because of the limitations of laparoscopy, such as less dexterity, limited range of movement and two-dimensional visualization. In addition, some factors including obesity, large uterine size, large myoma, and a history of prior abdominal or pelvic surgery make laparoscopic hysterectomy challenging and difficult [6]. With increasing experience of robotic surgery, gynecologic surgeons can perform the operation more easily and smoothly. Advincula and Reynolds first showed successful robot-assisted laparoscopic hysterectomy in six patients who had a scarred or obliterated anterior cul-de-sac as a result of previous cesarean deliveries in 2005 [7]. They also reported a series of 16 patients who underwent either an American Association of Gynecologic Laparoscopists (AAGL) type IVE hysterectomy (totally laparoscopic removal of the uterus and cervix including vaginal cuff closure) or a laparoscopic supracervical hysterectomy (LSH) III hysterectomy (totally laparoscopic supracervical procedure with removal of the uterine corpus including division of the uterine arteries) with robotic assistance having acceptable outcomes in 2006 [8]. In 2009, Boggess illustrated the feasible application of robot-assisted hysterectomy to benign gynecologic diseases with complex pathology [9]. In our case series, most patients undergoing robot-assisted laparosopic vaginal hysterectomy had prior pelvic surgery and pelvic adhesions. We performed the robotic surgery smoothly with minimal blood loss and without ureteral, bladder or bowel injury. Technically, there should be no problems in doing suturing using robotic EndoWrist instruments. However, robotic vaginal cuff suturing has been reported to be associated with a higher incidence of vaginal cuff dehiscence [10]. There were no vaginal cuff dehiscences in our series. Two layers of suturing may minimize this complication. Suturing the vaginal cuff can be done by robotic EndoWrist or through the vagina depending on surgeons' experiences and preferences, and on patients' perspectives such as about the cost. Robot-assisted total laparoscopic hysterectomy (TLH) using robotic needle drivers increases the cost of consumables. Therefore, we did TLH in most patients, but not in others.

Subtotal hysterectomy is an alternative for patients who do not want to undergo total hysterectomy. Its advantages are still being discussed and remain in controversy. Undoubtedly, this procedure is more difficult than total hysterectomy when being done by laparoscopy and needs well-skilled surgeons to overcome the difficulties of the suturing and knot-tying with laparoscopic instruments. With a robotic system, laparoscopic subtotal hysterectomy can be performed safely, even in those with prior pelvic surgery and pelvic adhesions [8]. The present study also supports the advantages of subtotal hysterectomy with robotic assistance. Easier dissection of tissue allows the anatomy be clearly seen and helps to divide the uterine arteries. Robot-assisted suturing and ligation of the uterine arteries not only minimize the blood loss and burning fumes caused by bleeding during the operation, but also reduce the risk of postoperative cervical stump bleeding arising from compromised suturing in conventional laparoscopy.

Laparoscopic myomectomy has been considered to have some advantages compared with laparotomy, including shortened hospitalization, less pain, and possibly reduced risk of postoperative adhesions [11]. However, difficulty in suturing the uterine incisions has troubled many gynecologic surgeons. Since Advincula et al [12] reported the first experience of robot-assisted laparoscopic myomectomy in 2004, many studies have demonstrated similar outcomes between robotic and laparoscopic myomectomy but better performance when removing myomas and closing the incised myometrium layer by layer with robotic instruments [13]. In our experience, robotic myomectomy can be easily accomplished in patients with huge uterus or multiple myomas. The performance is even more outstanding when dealing with multiple myomas needing multiple incisions and suturing (Fig. 2), which may be an exhausting task when being done by conventional laparoscopy. In addition, it is much easier and more delicate to dissect severe pelvic adhesions, especially in patients associated with endometriosis or multiple previous surgeries.

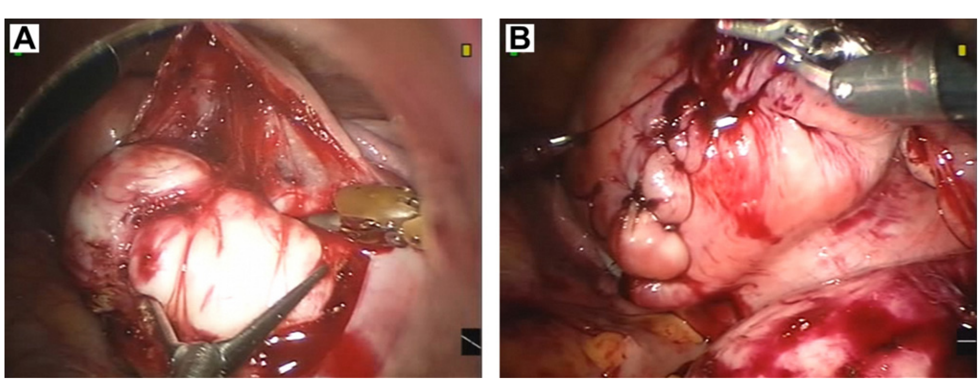

Fig. 2. Myomectomy. (A) The myomas were dissected with unipolar spatula. (B) Suturing of the uterus.

Minimally invasive approaches have been recently adopted by gynecologic oncologists for the treatment of endometrial cancer. A large randomized trial showed laparoscopic surgical staging is feasible and safe and has comparable outcomes to laparotomy [14]. The latest reports demonstrated that robot-assisted surgical staging has the advantages of less blood loss and shorter hospital stay with similar complication rates compared with conventional laparoscopic surgical staging despite longer operative time [15,16]. In the present study, the mean operative time is comparable to the preliminary experience reported by Reynolds et al (257 minutes) [17]. Since the first robot-assisted laparoscopic radical hysterectomy reported by Sert and Abeler [18], the case number has been growing. In spite of variation in operator experience, many studies demonstrate that robot-assisted radical hysterectomy results in less blood loss and shorter hospital stay compared with laparotomy and traditional laparoscopy [19]. The dissection of para-aortic lymph nodes up to inferior mesenteric artery and pelvic lymph nodes down to the obturator fossa can be easily accomplished without much bleeding, which is much easier than conventional laparoscopic surgical staging. In addition, better visualization by the three-dimensional vision makes identification and manipulation of the ureters easier, protecting them from iatrogenic injury. Our results demonstrated the yield of lymph nodes equivalent to those performed by laparotomy with much less blood loss.

Laparoscopic sacrocolpopexy has been performed with comparable results and decreased morbidity when compared with laparotomy [20], but the requirement of well-skilled and experienced surgeons limits its application. With the development of robotic technology, a retrospective study comparing robot-assisted laparoscopic sacrocolpopexy and abdominal sacrocolpopexy showed comparable outcomes, less blood loss and shorter hospital stay in the robotic group [21]. Our experience also demonstrated short operative time, minimal blood loss and reasonable length of hospitalization and surgical outcome. However, long-term results are needed to assess the durability of this new minimally invasive approach for pelvic organ prolapse.

Pelvic endometriosis is the presence of endometrial glands or stroma in the pelvis other than the uterine cavity and is believed to be one of the major causes of chronic pelvic pain in women of reproductive age. Surgical treatment of endometriosis aims to remove all visible lesions and restore pelvic anatomy by adhesiolysis. Meta-analysis has demonstrated a statistically significant benefit of laparoscopic surgery for the treatment of pelvic pain associated with endometriosis [22]. Nezhat et al also reported that there were no significant differences in blood loss, hospitalization, intraoperative or postoperative complications between robot-assisted laparoscopic and standard laparoscopic treatment of endometriosis [23]. For most of our patients with either ovarian endometrioma or deep pelvic endometriosis or obliterated cul-de-sac, we could complete the dissection without complications. All patients experienced symptom improvement.

Obesity and adhesive diseases caused by various underlying diseases or following pelvic surgical procedures are viewed as great challenges to laparoscopists and are often associated with increased complication and conversion to laparotomy [15,24]. Leonard et al reported that 29 of 416 (7%) patients who underwent total laparoscopic hysterectomy were converted to laparotomy and 16 (55.2%) of the conversion cases were the result of extensive adhesions [6]. In recent studies, acceptable intra- and postoperative outcomes have been observed in obese patients undergoing laparoscopic surgery [25]. George et al also reported that obesity was not a risk factor for poor surgical outcome with robotic surgery [26]. Furthermore, another study supported that robotic surgery was superior to conventional laparoscopy with less blood loss and shorter hospital stay in obese patients [27]. Obesity *per se* is not a problem.

The present analyses include various complicated gynecologic conditions, which make the estimation of the effectiveness of robotic surgery in each situation individually not appropriate. However, our experiences do show that robotic surgery is feasible and safe for patients with either benign or malignant gynecologic disease even in complicated conditions like severe pelvic adhesions. The ease of operating the robotic system may overcome the limitations and long learning curve of conventional laparoscopic surgery in complicated conditions (which are either not possible by conventional laparoscopy or can be accomplished by only a few surgeons). It is more appropriate to specify a learning curve on a specific procedure considering various confounding factors such as surgeon's training background and experiences in laparoscopy or laparotomy. Since this report includes various procedures, the description of learning curve may be quite subjective. The success of robotic surgery depends on a teamwork. How to establish a robotic gynecologic surgery team is an important issue, especially at the beginning. Indeed, there have been reports showing that a gynecologist can master robotic surgical staging in 20 patients [28]. A study also demonstrated that there was no significant difference between novice and expert laparoscopists when learning to master an operation using the da Vinci Surgical system [29]. Further research about the learning curve in different settings for different procedures by different doctors with different training background would be warranted. How to establish and integrate the training of robotic surgery in the training program of general gynecology or gynecologic oncology should be considered in the coming future. Obstacles such high cost, bulkiness of the device, loss of haptic feedback, inconvenience for the assistant to manipulate the uterus and to exchange instruments can be overcome as the robotic technology evolves. More evidence is mandatory to evaluate the role of robotic surgery in different surgical indications and its cost-effectiveness in different healthcare systems.

In conclusion, the widespread use and the continuing evolution of robotic surgery may further change the picture of gynecologic surgery in the future. How to delineate the indications and integrate robotic surgery into current training programs in Taiwan warrants further investigations.

References

[1] Yuen PM, Yu KM, Yip SK, Lau WC, Rogers MS, Chang A. A randomized prospective study of laparoscopy and laparotomy in the

management of benign ovarian masses. Am J Obstet Gynecol 1997;177: 109–14.

[2] Stylopoulos N, Rattner D. Robotics and ergonomics. Surg Clin North Am 2003;83:1321–37.

[3] Advincula AP, Wang K. Evolving role and current state of robotics in minimally invasive gynecologic surgery. J Minim Invasive Gynecol 2009;16:291–301.

[4] Nezhat C, Lavie O, Lemyre M, Unal E, Nezhat CH, Nezhat F. Robot-assisted laparoscopic surgery in gynecology: scientific dream or reality? Fertil Steril 2009;91:2620–2.

[5] Nieboer TE, Johnson N, Lethaby A, Tavender E, Curr E, Garry R, et al. Surgical approach to hysterectomy for benign gynaecological disease. Cochrane Database Syst Rev 2009;3:CD003677.

[6] Leonard F, Chopin N, Borghese B, Fotso A,, Foulot H, Coste J, et al. Total laparoscopic hysterectomy: preoperative risk factors for conversion to laparotomy. J Minim Invasive Gynecol 2005;12:312–7.

[7] Advincula AP, Reynolds RK. The use of robot-assisted laparoscopic hysterectomy in the patient with a scarred or obliterated anterior cul-de-sac. J Soc Laparoendscopic Surgeons 2005;9:287–91.

[8] Reynolds RK, Advincula AP. Robot-assisted laparoscopic hysterectomy: technique and initial experience. Am J Surg 2006;191:555–60.

[9] Boggess JF, Gehrig PA, Cantrell L, Shafer A, Mendivil A, Rossi E, et al. Perioperative outcomes of robotically assisted hysterectomy for benign cases with complex pathology. Obstet Gynecol 2009;114: 585–93.

[10] Kho RM, Akl MN, Cornella JL, Magtibay PM, Wechter ME, Magrina JF. Incidence and characteristics of patients with vaginal cuff dehiscence after robotic procedures. Obstet Gynecol 2009;114:231–5.

[11] Mais V, Ajossa S, Guerriero S, Mascia M, Solla E, Melis GB. Laparoscopic versus abdominal myomectomy: a prospective, randomized trial to evaluate benefits in early outcome. Am J Obstet Gynecol 1996;174: 654–8.

[12] Advincula AP, Song A, Burke W, Reynolds RK. Preliminary experience with robot-assisted laparoscopic myomectomy. J Am Assoc Gynecol Laparosc 2004;11:511–8.

[13] Bedient CE, Magrina JF, Noble BN, Kho RM. Comparison of robotic and laparoscopic myomectomy. Am J Obstet Gynecol 2009;201:566.e1–5.

[14] Walker JL, Piedmonte M, Spirtos NM, Eisenkop SM, Schlaerth JB, Mannel RS, et al. Laparoscopy compared with laparotomy for comprehensive surgical staging of uterine cancer: Gynecologic Oncology Group Study LAP2. J Clin Oncol 2009;27:5331–6.

[15] Seamon LG, Cohn DE, Henretta MS, Kim KH, Carlson MJ, Phillips GS, et al. Minimally invasive comprehensive surgical staging for endometrial cancer: Robotics or laparoscopy? Gynecol Oncol 2009;113:36–41.

[16] Cardenas-Goicoechea J, Adams S, Bhat SB, Randall TC. Surgical outcomes of robot-assisted surgical staging for endometrial cancer are equivalent to traditional laparoscopic staging at a minimally invasive surgical center. Gynecol Oncol 2010 Feb 6;117:224–8.

[17] Reynolds RK, Burke WM, Advincula AP. Preliminary experience with robot-assisted laparoscopic staging of gynecologic malignancies. J Soc Laparoendscopic Surgeons 2005;9:149–58.

[18] Sert BM, Abeler VM. Robot-assisted laparoscopic radical hysterectomy (Piver type III) with pelvic lymph node dissection: case report. Eur J Gynaecol Oncol 2006;27:531–3.

[19] Cho JE, Nezhat FR. Robotics and gynecologic oncology: review of the literature. J Minim Invasive Gynecol 2009;16:669–81.

[20] Paraiso MF, Walters MD, Rackley RR, Melek S, Hugney C. Laparoscopic and abdominal sacral colpopexies: a comparative cohort study. Am J Obstet Gynecol 2005;192:1752–8.

[21] Geller EJ, Siddiqui NY, Wu JM, Visco AG. Short-term outcomes of robotic sacrocolpopexy compared with abdominal sacrocolpopexy. Obstet Gynecol 2008;112:1201–6.

[22] Jacobson TZ, Duffy JM, Barlow D, Koninckx PR, Garry R. Laparoscopic surgery for pelvic pain associated with endometriosis. Cochrane Database Syst Rev 2009 Oct 7;4:CD001300.

[23] Nezhat C, Lewis M, Kotikela S, Veeraswamy A, Saadat L, Hajhosseini B, et al. Robotic versus standard laparoscopy for the treatment of endometriosis. Fertil Steril 2010;94:2758–60.

[24] Sokol AI, Chuang K, Milad MP. Risk factors for conversion to laparotomy during gynecologic laparoscopy. J Am Assoc Gynecol Laparosc 2003;10:469–73.

[25] Martinek IE, Haldar K, Tozzi R. Laparoscopic surgery for gynaecological cancers in obese women. Maturitas 2010 Jan 13;65:320–4.

[26] George A, Eisenstein D, Wegienka G. Analysis of the impact of body mass index on the surgical outcomes after robot-assisted laparoscopic myomectomy. J Minim Invasive Gynecol 2009;16:730–3.

[27] Gehrig PA, Cantrell LA, Shafer A, Abaid LN, Mendivil A, Boggess JF. What is the optimal minimally invasive surgical procedure for endometrial cancer staging in the obese and morbidly obese woman? Gynecol Oncol 2008;111:41–5.

[28] Seamon LG, Fowler JM, Richardson DL, Carlson MJ, Valmadre S, Phillips GS, et al. A detailed analysis of the learning curve: robotic hysterectomy and pelvic-aortic lymphadenectomy for endometrial cancer. Gynecol Oncol 2009;114:162–7.

[29] Lowe MP, Johnson PR, Kamelle SA, Kumar S, Chamberlain DH, Tillmanns TD. A multiinstitutional experience with robot-assisted hysterectomy with staging for endometrial cancer. Obstet Gynecol 2009;114:236–43.