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Major complications of operative gynecologic laparoscopy in Southern Taiwan: A follow-up study

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KEYWORDS:
Laparoscopy;
Complications;
Bladder;
Ureteral;
Bowel;
Major vessel injury;
Vaginal stump hematoma

Abstract

STUDY OBJECTIVES: This follow-up study examined the major complications among 4307 operative gynecologic laparoscopies. The overall complication rate and each individual category were compared with those of our previous study period. The clinical outcome and salvage procedures were correlated with the time of recognition and the severity of initial procedures in the individual injury type.

DESIGN: Retrospective, comparative study based on medical record reviewing (Canadian Task Force classification II-3).

SETTING: Tertiary teaching hospital, Chi Mei Foundation Hospital in southern Taiwan.

PATIENTS: Records of women (n = 4307) aged 40.5 ± 11.7 years (mean ± SD [95% CI 40.1–40.5]) who underwent operative gynecologic laparoscopies from January 2000 through February 2006 were reviewed in this study. The complications were compared with those of our previous study based on 1507 laparoscopies performed between December 1992 and November 1999 for follow-up comparison.

INTERVENTIONS: Gynecologic laparoscopic surgeries.

MEASUREMENTS AND MAIN RESULTS: Thirty-four complications occurred in 31 patients requiring repair procedures, 3 of whom had multiple complications, with an overall complication rate of 0.72% (31/4307). There were 13 bladder injuries (0.30%), 7 bowel injuries (0.16%), 3 cases of internal bleeding (0.07%), 4 vaginal stump hematomas or abscesses (0.09%), 3 ureteral injuries (0.07%), 3 major vessel injuries (0.07%), and 1 trocar site hematoma (0.02%). In addition, there were 125 (2.88%) postoperative blood transfusions without additional operative intervention. The major complication rate decreased compared with that of the previous study (0.72% [95% CI 0.51%–1.02%] vs 1.59% [95% CI 1.07%–2.36%]; p = .005). The overall complication rates were not significantly different between laparoscopic hysterectomy (LH) group and non-LH group. However, bladder injury happened more frequently in the LH group, whereas bowel injury was more common in the non-LH group. In addition,

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the severity of the original injury, timing of recognition, and accompanying salvage procedures correlated with the clinical outcomes.

CONCLUSION: The significantly decreased major complication rate, as compared with that of our previous study period, confirms the importance of experience accumulation and use of preventive maneuvers in reducing the complication rate. There were no significant differences among the individual injury category during these 2 study periods. The manifestations of bowel injury were highly variable and individualized. The accumulation of surgical experience with the aid of preventive maneuvers is helpful to reduce the complication rate significantly.

Operative laparoscopy is widely accepted as an efficacious technique in the treatment of gynecologic lesions. Patients, as well as surgeons, enthusiastically accept these new minimally invasive techniques in treating gynecologic diseases.[1] Although the complication rate may decrease when more experience is gained with the laparoscopic procedure, the increasingly advanced and difficult procedures performed by the gynecologists via laparoscopy further potentiates the higher risk of complications.[2] According to a recent literature review among 1 549 360 patients, the overall laparoscopic complication rate ranges from 0.2% to 10.3%.[2] An early learning curve with limited cases may account for the high complication rate, up to 10.3% (47 of 452 patients).[3,4] In a Finnish nation-wide study,[5] the major complication rate in overall gynecologic laparoscopies was 0.4% (130/32 205) among total procedures, and 1.26% (118/9337) in operative laparoscopies. In an American Association Gynecologic Laparoscopy (AAGL) membership survey for laparoscopic-assisted vaginal hysterectomy (LAVH) the major complication rate was 6.59% (983/14 911).[6] In Taiwan, Chang Gung Memorial Hospital reported a major complication rate of 1.66% (12/722) in the LAVH group.[7] Our previous study reported 1.59% (24/1507).[8] Since laparoscopic surgery is highly experience-dependent, follow-up studies in different study periods deserve continuous attention. In this study, we further updated our data and compared the results with those of our previous study.

Urinary bladder and bowel injuries make up the main part of the complications. Bladder injuries are relatively common in the gynecologic field, especially in LAVH. This complication rate was 2.4% (22/9337) in the Finnish study[5] and 1.08% (161/14 911) in the AAGL study.[6] It was reported as 0.8% (6/722) in the Chang Gung study[7] and 0.40% (6/1507) in our previous study.[8] Bowel injury, although not common, is one of the most serious complications when not detected and managed promptly. The reported bowel injury rates ranged from 0.16% (15/9337)[5] to 0.62% (93/14,911),[6] 0.28% (2/722) in the Chang Gung LAVHs group,[7] and 0.33% (5/1507) in our previous study.[8] One recent review literature based on 29 studies reported 0.13% (430/329 935) in overall cases; and 0.36% (105/29 532) in specified types of injury.[9]

We conducted this study as a continued part of a 2-phase study to compare the complication rates at different study periods. In this study, we presented the overall complications and classified them into individual categories. To offer the supporting evidence that laparoscopic surgery is highly experience-dependent, we also compared these data with those of our previous study for a comparison purpose. Clinical courses accompanied with the initial injury severity, timing of recognition and repair procedures were also reported.

Materials and methods

The follow-up study was performed from January 2000 through February 2006 in Chi Mei Foundation Hospital, a tertiary medical center in southern Taiwan. Every individual patient undergoing a gynecologic procedure in the Department of Obstetrics and Gynecology was recruited into the study during this study period. The information of the patients, including age, body weight, body mass index (BMI), gravida, parity, indication of surgery, type of surgery, and types of complications, were registered into our data bank with Access software (Microsoft Corp., Seattle, WA). BMI was used to evaluate the effect of obesity because it takes into account the woman's weight and height and is a more accurate predictor of how the woman's weight might influence laparoscopic surgery.[10] The detailed clinical courses of these complications and repair procedures were reviewed from the medical records, retrospectively. Before laparoscopy, informed consent was obtained from the patients with awareness of the risks and the complications of the laparoscopic procedures and a possible switch to laparotomy if the procedures could not be finished via the laparoscopic route. At surgery, the pneumoperitoneum was established via Veres needle with intraabdominal pressure of around 15 mm Hg. Then, the patients were placed in the low dorsal lithotomy and 30-degree Trendelenburg position, as previously described.[11] After the establishment of video-laparoscopy, the patients received individual laparoscopic procedures accordingly.

In LAVH (also called laparoscopic hysterectomy [LH], Type III, AAGL classification system),[12,13] uterine and ovarian artery pedicles were desiccated by bipolar Kleppinger forceps (Richard Wolf Instruments, Vernon Hills, IL) and cut by scissors according to desired ovarian preservation. The uterine vessels were desiccated and cut at the level of the internal cervix. The bilateral portions of cardinal uterosacral complex, as well as anterior and posterior col-

potomy, were also performed laparoscopically with monopolar electrosurgery. In addition, 1 of our senior laparoscopists (Lin YS) conducted a modified procedure of LAVH by preligating the uterine arteries, in which a pair of polydioxanone clips were placed at the uterine artery located between the ureter and the bifurcation of the hypogastric artery before the uterine vessels were desiccated.[14] The other gynecologists did not routinely perform this procedure. In the myomectomy group, only posterior colpotomy was done in the same way as LAVH for the removal of the surgical specimens. After the specimen was removed, colpotomy was sutured vaginally. At the completion of the procedure, we routinely suture the trocar wound if the trocar port is 10-mm or larger.[15]

All the major complications that happened during or after laparoscopy were recorded and analyzed. The major operative complications were defined as bowel, bladder, ureter, major vessel laceration injuries, trocar site hematoma, incision herniation, significant ileus, and intraperitoneal bleeding. Significant ileus was defined as patients with nasogastric intubation for more than 24 hours, whereas intraperitoneal bleeding was defined as patients with postoperative blood transfusion because of surgical-related causes as a consequence of blood loss during surgery or unstable vital signs demanding a repair operative procedure. Blood loss before surgery because of gynecologic diseases, such as ectopic pregnancy, ovarian cyst rupture, and other causes of hemoperitoneum, was not included in the complications. We classified the procedures into LH and non-LH groups to determine the effects of different types of procedures. The surgical procedures of non-LH group were more versatile and heterogeneous in content. The LH group comprised LAVH, laparoscopic modified radical hysterectomy (LMRH),[16] and staging surgeries (LAVH and bilateral pelvic lymph node dissection [BPLND]). We also compared this study (conducted from January 2000 through February 2006) with our previous study (conducted from December 1992 through November 1999) for a follow-up comparison at different study phases.

Statistical methods

Student's t test was used to determine statistical difference of patient age and body mass index (BMI). The χ^2 testing was used to determine the relationship between nominal variables, such as overall and individual categories of complications, in which a p value less than .05 was considered statistically significant. The incident rate with a 95% CI for each complication was compared between this study and our previous study by 2-tailed χ^2 testing. If there were more than 20% of expected values less than 5, Fisher's exact test was used to accommodate small expected cell frequencies.

Table 1 Main procedures for 4307 operative gynecologic laparoscopies

Main procedure	No.	%
LAVH	2174	50.5
Total or partial SO	1436	33.3
Ectopic pregnancy surgery	315	7.3
Electrocoagulation for endometriosis and/or pelvic adhesiolysis	149	3.5
Myomectomy	79	1.8
Ovarian drilling	41	1.0
Uterine or vaginal suspension	33	0.8
LMRH	31	0.7
LUNA	22	0.5
Tuboplasty	21	0.5
Staging surgery	6	0.1
Total	4307	100.0

LAVH = laparoscopic-assisted vaginal hysterectomy; LMRH = laparoscopic modified radical hysterectomy; LUNA = laparoscopic uterosacral nerve ablation; SO = oophorectomy and/or salpingectomy.

Results

During the study period, 4711 women undergoing gynecologic laparoscopic procedures were recruited into this study. Among them, 404 patients undergoing only diagnostic laparoscopic procedures for chronic pelvic pain or infertility workup were excluded. The mean age of these patients was 40.5 ± 11.7 years (95% CI 40.1–40.8). The mean BMI was 22.9 ± 4.1 (95% CI 22.5–23.4). The patients undergoing more than 1 procedure were categorized according to the principal procedure. The principal procedures for these 4307 laparoscopies were summarized in Table 1. The laparoscopic procedures included LAVH in 2174 cases (50.5%), total or partial oophorectomy or salpingectomy (SO) in 1436 cases (33.3%), ectopic pregnancy surgery in 315 cases (7.3%), electrocautery for endometriosis or pelvic adhesiolysis in 149 cases (3.5%), myomectomy in 79 cases (1.8%), ovarian drilling in 41 cases (1.0%), uterine or vaginal suspension in 33 cases (0.8%),[11,17] LMRH in 31 cases (0.7%),[16] laparoscopic uterosacral nerve ablation in 22 cases (0.5%), tuboplasty in 21 cases (0.5%), and staging surgery (LAVH and BPLND) in 6 cases (0.1%). Thirty-four injuries in 31 cases happened and required salvage procedures in our study period. They accounted for an overall major complication rate of 0.72% (31/4307). Among them, 3 cases with multiple injuries were as follow: (1) LAVH with bladder and vaginal stump hematoma; (2) SO with bladder and ileal perforation; and (3) LAVH with bladder and vaginal stump abscess. The complications were classified into 7 categories. The clinical manifestations of individual injury types, locations of injuries, time of recognition, initial procedure, methods of treatment and outcome were listed (Table 2). The BMIs of the patients with or without complications were not significantly different, mean 23.7 ± 4.5 (95% CI 21.8–25.5), versus 22.9 ± 4.1 (95% CI 22.8–23.0), respectively (p = .306).

Table 2 The clinical manifestations of individual types of injury, time of recognition, initial procedure, methods of treatment and outcome

Complications (no.)	Recognition (no.)	Initial procedures (no.)	Treatment and outcome
Bladder (n = 13)*†‡			
	Intraoperative (n = 4)	LAVH (n = 4)*	Repair vaginally (n = 4); one vesicovaginal fistula required repetitive repair 3 months later
	Intraoperative (n = 2)	LAVH (n = 1), Burch (n = 1)	LSC primary repair
	Intraoperative (n = 6)	LAVH (n = 4), SO (n = 2)†	Laparotomy primary repair
	14 days (n = 1)	LAVH (n = 1)‡	Repair of vesicovaginal fistula vaginally
Bowel (n = 7)†			
Stomach	Intraoperative (n = 2)	Diagnosis (n = 1), LAVH (n = 1)	Mini-laparotomy primary repair
Ileum	Intraoperative (n = 2)	Diagnosis LSC (n = 1), SO (n = 1)	Laparotomy for primary repair (n = 1) or segmental resection and anastomosis (n = 1)
Ileum	8 days (n = 1)	SO for TOA (n = 1)†	Ileostomy
Colon and ileum	24–48 hours (n = 1)	SO for TOA (n = 1)	Ileostomy, tube colostomy, prolonged hospitalization (60 days); necrotizing fasciitis, colocutaneous fistula, ileostomy, multiple repair surgeries
Colon and ileum	3 days (n = 1)	SO for TOA (n = 1)	Laparotomy right hemicolectomy, ileostomy, colostomy
Internal bleeding (n = 3)			
Bladder base or unknown origin	<24 hours (n = 2)	LAVH (n = 1), SO (n = 1)	LSC electrocoagulation for hemostasis or for diagnostic purpose
Ovarian bed	2 days (n = 1)	SO (n = 1)	LSC electrocoagulation for hemostasis
Vaginal stump hematoma or abscess (n = 4)*†	<24 hours (n = 1)	LAVH (n = 1)*	Laparotomy repair of stump hematoma
	5 days (n = 1), 14 days (n = 1)	LAVH (n = 2)	Repair of stump hematoma vaginally
	6 days (n = 1)	LAVH (n = 1)‡	Drainage for abscess
Ureter (n = 3)	Intraoperative (n = 1)	LMRH + BPLND (n = 1)	LSC repair and double-J stent
	Intraoperative (n = 1)	LAVH (n = 1)	Ureteroscopy and double-J stent failed; PCN, AP, reinsertion of double-J due to ureteral fistula
	8 days (n = 1)	LAVH (n = 1)	Ureteroscopy and double-J stent
Major vessel (n = 3)	Intraoperative (n = 2)	LAVH (1), SO (n = 1)	Laparotomy for primary repair of right common iliac artery laceration
	Intraoperative (n = 1)	SO (n = 1)	Laparotomy for primary repair of inferior vena cava laceration
Trocar hematoma (n = 1)	<24 hours (n = 1)	Electrocoagulation for endometriosis (n = 1)	LSC inspection and trocar site primary closure

AP = anterograde pyelography; BPLND = bilateral pelvic lymph node dissection; LAVH = laparoscopic-assisted vaginal hysterectomy; LSC = laparoscopy; LUNA = laparoscopic uterosacral nerve ablation; PCN = percutaneous nephrostomy; SO = oophorectomy and/or salpingectomy; TOA = tubo-ovarian abscess.
Staging surgery including LAVH and BPLND.
*Multiple injuries: bladder and vaginal stump hematoma.
†Multiple injuries: bladder and ileal perforation.
‡Multiple injuries: bladder and vaginal stump abscess.

Urinary bladder injuries occurred in 13 cases (0.30%); 10 of them were in LAVHs. There were dense adhesions between the urinary bladder and vagina because of previous cesarean sections or fibrosis process after conization. Twelve cases with bladder injury were recognized during surgery by visualizing the bladder mucosa, or Foley bal-

loon, the spillage of dye instilled into urinary bladder, or a substantial amount of gas in the urine bag. The diagnosis was further confirmed by injection of methylene blue dye via urethral Foley catheter. They were successfully repaired with 3-0 chromic catgut via double-layered sutures vaginally (4 cases), laparoscopically (2 cases) or by laparotomy (6 cases) according to operators' preference. Only 1 of these 12 patients, who had development of vesicovaginal fistula, received fistulectomy for definite procedure. The remaining 11 patients recovered uneventfully after Foley catheter retained for 7 more days after surgery. The one with unrecognized bladder injury was noted to have urine leakage from the vagina 2 weeks after surgery. Vesicovaginal fistula, which was confirmed by cystography, required transvaginal fistulectomy for definitive treatment.

Ureteral injuries were found in 3 cases (0.07%) undergoing either LAVH or LMRH. Two cases were detected during surgery. The first one was successfully treated with laparoscopic repair and double-J ureteral stent insertion. In the second case, however, ureteroscopy with ureteral stent insertion was tried several times but failed. Thereafter, percutaneous nephrostomy and anterograde pyelography with ureteral double-J stent insertion were performed to treat the ureteral fistula on the next day. The third case was detected on postoperative day 8 with urinary ascites (urinoma) caused by urine leakage into the intraperitoneal cavity. Ureteroscopy with double-J stent insertion was performed. The patient recovered well after double-J stent retention for 3 months.

Bowel injuries occurred in 7 cases (0.16%). The 2 gastric perforations happened during the first trocar insertion after pneumoperitoneum. They were attributed to either trocar placement at too vertical an angle or inadvertent hyperinflated stomach during endotracheal intubation, respectively. Both cases were repaired immediately by mini-laparotomy without incident. There were 5 cases with small or large bowel injuries: 3 with isolated ileal injuries, the other 2 with combined small and large bowel injuries. Three of these 5 cases were tuboovarian abscess with or without appendicitis. The fourth was initially diagnosed as suspected ovarian tumor torsion before surgery, which turned out to be a T-cell lymphoma as the definite diagnosis. The fifth was a case of dermoid cyst of the ovary. The injury happened during removal of the surgical specimen from the endobag by Kelly clamp accidentally. For the clinical courses of these 5 cases, 2 of 3 with isolated ileal injuries were recognized during surgery and underwent laparotomy with primary repair or segment resection and anastomosis of ileum without any further sequelae. The third case was recognized 8 days after surgery and underwent ileostomy uneventfully. However, both of the cases with combined small and large bowel injuries were recognized after surgery, underwent multiple repair procedures, and had grave outcomes. One patient had received ileostomy and tube colostomy for the first repair procedure followed by prolonged hospitalization (60 days) with serious complications. Necrotizing fasciitis and colocutaneous fistula happened thereafter, which required multiple operative procedures. The other patient underwent right hemicolectomy, ileostomy, and colostomy.

One hundred twenty-four patients (2.88%) received postoperative blood transfusion because of internal bleeding as a consequence of surgery-related blood loss. Another 3 cases (0.07%) needed additional repair procedures for hemostasis or definitive diagnosis. The preoperative laboratory results of these cases showed normal prothrombin time and activated thromboplastin time. The patients did not have coagulopathy nor did they receive anticoagulants. Two of the cases were recognized within 24 hours after surgery and underwent repeated laparoscopy for internal bleeding check-up. One was found to have a bladder base bleeding and underwent electrocoagulation for hemostasis; whereas there was no obvious bleeding source being recognized in the other case. The third one with delayed ovarian bed bleeding was recognized 2 days after surgery. The patient received repeated laparoscopy with electrocoagulation for hemostasis without further incident. Ovarian bed and bladder base were the bleeding sources after partial oophorectomy and LAVH, respectively. Vaginal stump or colpotomy wound hematoma or abscess happened in 4 cases (0.09%). Vaginal stump hematoma or colpotomy wound hematoma (3 cases) happened within 24 hours, 5 days and 14 days in postoperative phase. Bleeding ceased after resuturing either transvaginally or by laparotomy. Pelvic abscess occurred in 1 patient who underwent incision and drainage through vaginal approach uneventfully.

Major vessel injuries occurred in 3 cases (0.07%). All of them happened during the introduction of the first 10-mm trocar; the injuries were recognized when blood gushed out of the retroperitoneum or a retroperitoneal hematoma appealed. The procedure was switched to laparotomy with compression of the hematoma and bleeding site immediately. A cardiovascular surgeon was consulted immediately for a definitive suture. Two injuries were in the right common iliac artery, the other was in the inferior vena cava. The laceration site was repaired by continuous sutures with 6-0 Prolene. One trocar site hematoma (0.02%) received trocar site primary closure. There was no herniation in the umbilical trocar site or other ancillary trocar sites demanding repair of the abdominal fascia.

The difference of overall and individual complication rates were repaired between the LH and non-LH groups. The demographic parameters of these patients in the LH group were older and higher BMIs, as compared with the non-LH group (both $p < .001$), because of their individual disease characteristics (Table 3). The overall complication rate of the patients with repair procedures was not significantly different in the LH group and non-LH group (0.77% vs 0.67%, $p = .695$). However, bladder injuries happened more commonly in the LH group (0.59% vs 0.14%, $p = .032$). Bowel injury happened more commonly in the non-LH group, although it was not significantly different (0.05% vs 0.29%, $p = .113$). There was no significant

Table 3 The complication rate of the LH group compared with the non-LH group

	LH* (2211)		Non-LH (2096)		
	Mean ± SD	95% CI	Mean ± SD	95% CI	p
Age (yrs)	46.6 ± 8.9	46.2–47.0	33.8 ± 10.7	33.3–34.3	<.001
BMI	24.5 ± 4.2	24.3–24.6	21.8 ± 3.7	21.7–22.0	<.001
Type	No.	%	No.	%	p
Overall 31 (34)	17 (19)	0.77	14 (15)	0.67	.695
Bladder and ureter (16)	13	0.59	3	0.14	.016†
Bowel (7)	1	0.05	6	0.29	.063‡
Bleeding (6)	2	0.09	4	0.19	.441‡
Others (5)	3	0.14	2	0.10	1.000†
Blood transfusion	53	2.46	71	3.51	.052†

BMI= body mass index.
χ^2 test (†) or Fishers' exact test (‡) was used to evaluate the nominal variables.
*Nineteen injuries happened among 17 LH group, which comprised LAVH, LMRH, and staging surgeries.

difference in internal bleeding (p = .944) and others (p = .952). Higher postoperative transfusion rate tended to occur in the non-LH group, although the difference was not statistically significant (p = .052). We further compared the complication rate with that of our previous study.[8] The overall complication rate of this study (0.72%, 31/4307) decreased significantly as compared with in a previous study (1.59%: 24/1507; p = .005) (Table 4). However, there was no significant difference among the individual injury types, including bladder, ureteral, and bowel injury; internal bleeding; vaginal stump hematoma; or abscess.

Discussion

Despite advanced technology and experience, laparoscopic complications remain a major cause of significant morbidity.[18] The complexity of the surgical procedures also potentiates the higher risk of complications.[2] This is a follow-up study with 2 study phases between years 2000 to 2006 and years 1993 to 1999. The decreasing tendency of the overall complications during different time intervals demonstrates that laparoscopic surgery is highly experience-dependent. The accumulation of surgical experience and the aids of preventive maneuvers reduced the complication rate significantly.

Urinary bladder injury was the most common complication in much of the literature, as well as in our series. It happened more commonly in the LH group because of the closeness of the bladder to the cervix and frequent history of cesarean sections. Fortunately, all but one of our patients with bladder injury were recognized during surgery and repaired vaginally, laparoscopically, or by laparotomy without incident. Early recognition with an immediate repair procedure overcomes further sequelae.[19] However, repetitive repair for the vesicovaginal fistula is mandatory if the

Table 4 Types of major complications and its comparison between this study and previous study[8]

	This study (n = 4307)			Previous study[8] (n = 1507)			
Complication	No.	%	95% CI	No.	%	95% CI	p
Overall	31 (34)*	0.72	0.51–1.02	24	1.59	1.07–2.36	.005†
Bladder injury	13	0.30	0.18–0.51	6	0.40	0.18–0.87	.601‡
Bowel injury	7	0.16	0.08–0.33	5	0.33	0.14–0.77	.204‡
Internal bleeding	3	0.07	0.02–0.21	0	0.00	0.00–0.25	.573‡
Vaginal stump	4	0.09	0.03–0.23	3	0.20	0.07–0.59	.385‡
Ureter injury	3	0.07	0.02–0.21	4	0.27	0.11–0.69	.079‡
Major vessel injury	3	0.07	0.02–0.21	1	0.07	0.01–0.38	1.000‡
Trocar site hematoma	1	0.02	0.00–0.13	0	0.00	0.00–0.00	1.000‡
Ileus	0	0.00	0.00–0.00	2	0.13	0.04–0.48	.067‡
Abscess	0	0.00	0.00–0.00	2	0.13	0.04–0.48	.067‡
Hernia	0	0.00	0.00–0.00	1	0.07	0.01–0.38	.259‡

χ^2 test (†) or Fisher's exact test (‡) was used for statistical analysis.
*Thirty-four injuries happened among 31 patients. The overall complication rate is calculated as 31/4307 (0.72%).

first procedure fails. It has been suggested to recognize the vesicocervical space by retaining the fluid or instilling the dye into the urinary bladder[20] or by observing the gas leakage into the urine bag during surgery. In addition to these preventive maneuvers, we inserted a bladder retractor via the urethral meatus into the bladder cavity to identify the uterovesical space, especially in cases with dense fibrotic adhesion.[21] The bladder retractor with an oval-shaped tip can mobilize the bladder and counteract with the uterine mobilizer to expose the vesicouterine space at an adequate distance, which was not achieved easily with standard laparoscopic techniques.[21]

Ureteral injuries in gynecologic laparoscopy usually are not recognized during surgery; only those patients with persistent abdominal or flank pain, abdominal distention, and fever may raise suspicions during the postoperative phase.[22] Those ureteral injuries recognized during surgery usually can be resolved by a double-J ureteral stent with or without the assistance of ureteroscopy. If the initial repair fails, percutaneous nephrostomy and anterograde ureteral double-J stent is a backup procedure to avoid a subsequent ureteral fistula. Once ureteral injury was detected in a late postoperative period after the formation of ureteral fistula, ascites with urine content (urinoma) might complicate the situation. Although our late-recognized case (on postoperative day 8) was successfully repaired by ureteroscopy with double-J ureteral stent without further incident, laparotomy for end-to-end anastomosis is usually necessary in the cases with complete transection, ligation or electrothermal injury-induced ischemic necrosis. In our series, ureter identification and uterine artery preligation may account, at least in part, for the low ureteral injury rate (0.07%), as compared with the general reported rate (2.8%; 70/2,491).[23] Our procedure, as well as retrograde umbilical ligament tracking method,[24] for uterine artery ligation can prevent excessive bleeding from uterine vessels and ureteral thermal injury, especially in huge uterine size.[14] The proximity of the ureter to the uterosacral ligaments must be carefully managed during the manipulations in the related surgical field. A high index of suspicion and prior visualization or retroperitoneal dissection of the ureter, will be helpful in decreasing ureteral injury.[22] It has been suggested that the selective use of preoperative intravenous pyelography in those patients with huge uterine nodules of 12 cm or larger or rectovaginal endometriotic nodules larger than 3 cm may prevent nonreversible loss of renal function.[25] If uterus size was a concern, we used a helical incision for vaginal removal of large uteri as a preventive procedure.[26]

Bowel injuries happened during the entry of abdominal cavity and were more commonly in the non-LH group in our study. Obesity has been considered by some gynecologists to be a relative contraindication to operative laparoscopy.[27] There is still some controversy over obesity and complications. The most significant is difficulty in establishing pneumoperitoneum, because of abdominal wall thickness and preperitoneal fat.[10] Our data, as well as other reports, revealed similar morbidity in the patients with different BMIs.[10] Although gastric injury is a rare complication, it may be encountered after several trials of endotracheal intubations. Inadvertent esophageal intubation can cause gas to inflate the stomach and displace the hyperinflated stomach as low as the periumbilical area. Nasogastric intubation for decompression is helpful to prevent gastric injury for those cases with distended stomach. In addition, the entry of the trocar at a steep angle into the abdominal cavity after pneumoperitoneum might account for the injuries. The angle of trocar insertion was adjusted according to the degree of obesity.[28] The distance between anterior abdominal wall and sacral promontory is shorter in thin patients. Therefore the force required to introduce the trocar often is less than anticipated, and thus a controlled angle entry is essential.[28] No single insertion technique is universally safe and divorced from complications in establishing pneumoperitoneum. Several techniques, including a well-executed open technique with use of digital pressure and local adhesiolysis[29] or adjuvant instruments, such as optic access trocar,[30] can be offered as a suggestion for reducing injuries.

The small intestine, especially the ileum, is most frequently injured and this happens more commonly during pelvic adhesiolysis. It is followed by large intestine injury, which happens more commonly during the dissection of the cul-de-sac.[9] Isolated small intestine injuries may not cause clear or rapid symptoms and abnormal laboratory values, whereas colon injury with or without combined ileal injuries has grave outcomes. The degree of peritonitis depends on the amount of spillage and length of time between perforation and exploration. Although repair by laparotomy may be the safest way to manage these injuries, single- or double-layer repairs via laparoscopic-assisted transvaginal approach or total laparoscopic intracorporeal techniques and copious irrigation might be also satisfactory.[31] Bowel injury caused by direct trauma or electrothermal injury has different clinical courses and histopathologic findings. Symptoms of bowel perforation after electrical injury usually arise 4 to 10 days after the procedure, whereas symptoms of traumatic perforation usually occur within 12 to 36 hours.[32–34] Most electrothermal injuries, more common in the large bowel, are unrecognized during surgery and lead to long-term sequelae. It may occur insidiously because of stray current, insulation failure, or capacitive coupling, in addition to direct, active electrode injury.[33] As for the timing of detection, a recent review article revealed that 66.8% (167/250) were during (154 cases) or within 48 hours after surgery (13 cases). However, there was still more than 10% unrecognized until the third postoperative day or later.[9]

In our series, some identifiable risk factors associated with bowel injuries were emergency, non-scheduled surgeries, tuboovarian abscess, or uncertain preoperative diagnosis. The original injury severity, such as multiple injuries, happened more commonly in managing tuboovarian abscess, especially combined with appendicitis. They had grave outcomes with prolonged hospitalizations and de-

manded multiple salvage procedures. Proper bowel preparation or nasogastric tube decompression is recommended when bowel risk is anticipated. The dexterity improvement, hand/eye coordination, and the knowledge of the mechanism of electrosurgical injury is important in recognizing and reducing potential electrosurgical complications.[33]

Major vessel injury can result from inadequate pneumoperitoneum or mishandling of the trocar. In addition, procedures on very thin females or premature Trendelenburg position may lead to higher risk. It has been emphasized that that more than half of the complications are related to the entry technique in laparoscopy.[2] Informative signs of vascular injury include significant hypotension, tachycardia, blood emanating from the retroperitoneum, the appearance of retroperitoneal hematoma, and pooling of blood in the upper abdomen. Therefore, alertness, timely repair procedures, and the availability of cardiovascular surgeons can prevent catastrophes. Careful and thorough examination is mandatory in cases with major vessel injury because of the simultaneous trauma of other intraperitoneal organs.[7,35] The delayed-type bleeding with repair procedures happened either in bladder base, ovarian bed, vaginal stump, or colpotomy wound. It occurs because of inadequate hemostasis or temporary occlusion by the pneumoperitoneal pressure and the steep Trendelenburg position. Hemostasis that appears adequate before closure because of the Trendelenburg position, high intraabdominal pressures, and relative hypotension may change once the patient resumes an upright position. An "under-water" inspection with Ringer's lactate solution or a low-pressure pneumoperitoneum was proposed as a better observation.[36] Pelvic or vaginal stump abscess may be caused by incomplete irrigation of the preexistent infectious microorganisms in the pyosalpinx or subclinical pelvic infection.

No incision hernia happened in our series. There was also no significant postoperative intestinal obstruction occurred in our series. Early ambulation, as well as early fluid intake followed by soft diet was encouraged in our patients 8 hours after discharge from the postoperative recovery facility. This may help to decrease postoperative ileus. Careful observation without surgical intervention is usually sufficient in cases with transient postoperative intestinal obstruction.[7] The laparoscopic team staff should be cautiously alert to early manifestations of peritonitis during the observation period for 3 to 5 days. Exploratory laparotomy is indicated for patients with persistent symptoms.

Conclusion

The overall complication rates, but not each individual category, decreased significantly in this study period as compared with the previous study period. It further confirms that laparoscopic surgery is highly experience-dependent. Bladder injury happened more commonly in the LH group; whereas bowel injury happened more commonly in the non-LH group. The manifestations of bowel injury were highly variable and individualized. The severity of original injury and timing of recognition accompanied with adequate salvage procedures can affect clinical outcome. Early recognition of injuries, preferably during surgery and early alertness to postoperative warning signs during the observation period, followed by immediate treatment are crucial to reduce catastrophic consequences.[33] With the accumulation of surgical experience and the aids of preventive maneuvers, the complication rate can be reduced significantly.

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