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ORIGINAL ARTICLE

Urologic complications of laparoscopic radical hysterectomy and lymphadenectomy

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Abstract
Introduction and hypothesis The purpose of this study was to evaluate the intra- and postoperative urologic complications and management in patients with cervical or endometrial cancer treated with laparoscopic radical hysterectomy and lymphadenectomy.
Methods We retrospectively reviewed the medical records of 146 patients with cervical or endometrial cancer who underwent total laparoscopic radical hysterectomy with lymphadenectomy between August 2002 and April 2011. The intra- and postoperative urologic complications were analyzed.
Results Double ureteral stents were inserted prophylactically in 13 patients (8.9 %), 2 of whom had postoperative urologic complications. Nine patients (6.2 %) had postoperative urologic complications. Of four patients with ureterovaginal fistulas, two were treated conservatively with cystoscopic placement of ureteral stents and two underwent ureteroneocystostomies. Vesicovaginal fistulas occurred in two patients, both of whom underwent vesicovaginal fistula repairs. One patient noted to have a bladder injury intraoperatively had a laparoscopic repair, and one patient noted to have a ureteral injury postoperatively was treated conservatively with cystoscopic placement of ureteral stents.
Conclusions Iatrogenic lower urinary tract injuries during laparoscopic radical hysterectomy are relatively common complications. Intraoperative prophylactic ureteral stent insertion and the early detection of urologic complications postoperatively is advised for patients who undergo laparoscopic radical hysterectomies.

Keywords Laparoscopic radical hysterectomy · Cervical cancer · Endometrial cancer · Urologic complications

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Introduction

Urinary tract injuries are a common complication of gynecologic surgery because the female urinary tract is anatomically close to the reproductive tract and the two are related embryologically [1]. Approximately 75 % of all ureteral injuries occur during gynecologic surgery. The rate of urinary tract injuries is up to five times greater during laparoscopic hysterectomies than abdominal hysterectomies [2]. A meta-analysis of 27 trials showed that the odds ratio of urinary tract injuries during laparoscopic hysterectomies relative to abdominal hysterectomies is 2.61 [3]. A high rate of urinary tract injuries during laparoscopic hysterectomies has been observed due to the high learning curve [4, 5].

The overall incidence of urologic complications during radical hysterectomy is higher than other gynecologic surgeries [6–8]. The occurrence of fistulas also tends to be higher after radical hysterectomy than other gynecologic surgeries. In previous studies, urologic complications after laparoscopic radical hysterectomy (LRH) have been reported to be between 1 and 4 %. Torres-Lobaton et al. [9] reported a 2 % incidence of vesicovaginal fistulas in patients after radical hysterectomy. Vesicovaginal and ureterovaginal fistulas have been

reported to develop in 0.9–2 % of patients after radical abdominal hysterectomy [10].

Laparoscopic management of gynecologic cancers has been developed and LRH with pelvic lymphadenectomy in early cervical cancer is gradually becoming a common practice. The benefits of laparoscopic surgery include a smaller incision, better visualization, fewer adhesions, less blood loss, and shorter recovery time compared with laparotomy. However, LRH has not been widely used by gynecologic oncologists because of the technical difficulties, the high learning curve, and concerns of surgical morbidity, such as urinary tract, bowel, and great vessel injuries. Among the complications, urinary tract injuries can have major personal, financial, and social costs. Despite many advantages of laparoscopic surgery, excessive urinary tract injuries has impeded worldwide acceptance.

In the current study we retrospectively reviewed the incidence, diagnosis, and treatment of urinary tract injuries during the intra- and postoperative periods in patients who underwent LRH.

Materials and methods

Between August 2002 and April 2011, 146 consecutive patients with cervical or endometrial cancers underwent LRHs at the National Cancer Center in Korea. This study was approved by the Institutional Review Board of the National Cancer Center. All of the surgeries were performed by one of the authors. The inclusion criteria were cervical cancer patients with International Federation of Gynecology and Obstetrics (FIGO) stages IA–IIA and patients with endometrial cancer who were suspected to have cervical involvement preoperatively. The patients with a history of radiation and neoadjuvant chemotherapy were excluded.

LRH was performed based on a modification of the Nam et al. [11] procedure. Advanced bipolar devices, such as LigaSure®, Harmonic scalpel®, and Enseal®, were used. Patients with >1 high-risk factor or >2 intermediate-risk factors after LRH received adjuvant radiotherapy or chemoradiotherapy. High-risk factors included positive lymph nodes, parametrial involvement, and positive vaginal resection margins, and intermediate-risk factors included tumor >4 cm in size, lymphovascular space invasion, and deep stromal invasion (>two thirds).

When a ureteral injury was suspected, but not confirmed intraoperatively, double pigtail ureteral stents (Endo-Sof, Cook Urological, Spencer, IN, USA) were inserted prophylactically under cystoscopy by a urologist. A urethral catheter was typically left in place for 5–7 days postoperatively. Intermittent catheterization, timed voiding, and indwelling urethral catheters were performed in the patients who had urinary retention postoperatively.

The intra- and postoperative urologic complications were analyzed. An indigo carmine leakage test or analysis of the creatinine level from vaginal fluid or Jackson-Pratt (JP) drainage was performed when urologic complications were suspected. The urologic consultation, operative record, progress notes, cystoscopic findings, and urologic imaging [retrograde pyelography, renal sonography, and computed tomography (CT) urography] were reviewed.

The mean value ± SD of the two groups was compared using Student's *t* test. For skewed data, the median value (maximum, minimum) of the two groups was compared using the Mann–Whitney U test. Nominal variables were analyzed by Fisher's exact test or the χ^2 test. The power for each complication and operative time was analyzed with SAS software, version 9.1 (SAS Inc., Cary, NC, USA). Data were entered into Microsoft Excel and analyzed with SPSS statistical software, version 12.0 (SPSS Inc.). P values < 0.05 were considered significant for all statistical tests.

Results

Table 1 shows the patient demographic data. There were 134 patients with cervical cancer and 12 patients with endometrial cancer. Of patients with cervical cancer, 96 were squamous cell carcinomas and 26 were adenocarcinomas. The mean age was 48.4±10.7 years, and the mean body mass index (BMI) was 23.7±3.0 kg/m^2. The mean number of resected lymph nodes was 19.3±7.6. The median operative time was 305 min (range 165–590 min). The median estimated blood loss was 400 ml (range 50–1,000 ml).

The LRH to abdominal radical hysterectomy conversion rate was 2.7 % (4/146). A bladder injury was recognized intraoperatively and successfully repaired under laparoscopy in one patient. A ureteral stent was prophylactically inserted laparoscopically under cystoscopy in 13 patients (8.9 %) by a urologist. In 12 patients, no definite leakages were detected, but the possibility of a ureteral injury, such as a defect in ureteral adventitial tissue, was suspected. A ureteral injury from monopolar electrocautery was confirmed in one patient. Two patients experienced postoperative urologic complications, which were diagnosed as ureterovaginal fistulas.

The incidence of postoperative urologic complications was 6.2 % (9/146). Four patients had ureterovaginal fistulas. Vesicovaginal fistulas occurred in two patients. One patient had hydronephrosis and one patient had a ureteral injury, which were treated with ureteral stent insertion under cystoscopy. One bladder injury was treated with a Foley catheter (Fig. 1). Most patients who have postoperative voiding difficulties improved with intermittent catheterization and timed voiding; however, urologic consultations were needed in seven patients.

Table 1 Demographic data of patients who underwent LRH (*N*=146)

	Cervical cancer (*N*=134)	Endometrial cancer (*N*=12)	Total	*P* value
Age (years), mean	48.2±10.8	53.2±8.4	48.4±10.7	0.139[a]
BMI (kg/m^2)	23.7±3.0	23.9±3.6	23.7±3.0	0.256[a]
Previous abdominal surgery				
0	97	11	108 (74.0 %)	0.186[b]
1	21	1	22 (15.1 %)	0.694[b]
≥2	16	0	16 (11.0 %)	0.362[b]
Parity (*N*)	2.5±1.3	2.5±0.9	2.5±1.3	0.278[a]
Histology				
Squamous cell carcinoma	96	1		
Adenocarcinoma	26	10		
Adenosquamous carcinoma	7	0		
Other	5	1		
FIGO stage				
IA	39			
IB1	89			
More than IB2	6			
Lymph nodes (*N*)	18.5±7.1	28.5±6.5	19.3±7.6	0.810[a]

[a]Using Student's *t* test

[b]Using Fisher's exact test

The symptoms, diagnostic sequence, and treatment of urologic complications postoperatively are summarized in Table 2. A watery vaginal discharge (*N*=6) was the most common presenting symptom, followed by an increase in the output from the JP drain (*N*=2). One patient experienced flank pain.

To diagnose the urologic complications, intravenous indigo carmine leakage tests were performed in four patients. The vaginal discharges were determined for creatinine in two patients; the level of creatinine was 47 and 116 mg/dl. The creatinine level in the JP drainage was determined in two patients who had profuse discharge from the JP drain (20 and 55.5 mg/dl). CT urography as a confirmatory study was performed in eight patients. Kidney sonography and pelvic CT were performed in one patient (case 7) with flank pain.

Two of four patients with ureterovaginal fistulas were conservatively treated with cystoscopic placement of ureteral stents, two of whom were treated with ureteroneocystostomies. Two patients with vesicovaginal fistulas underwent

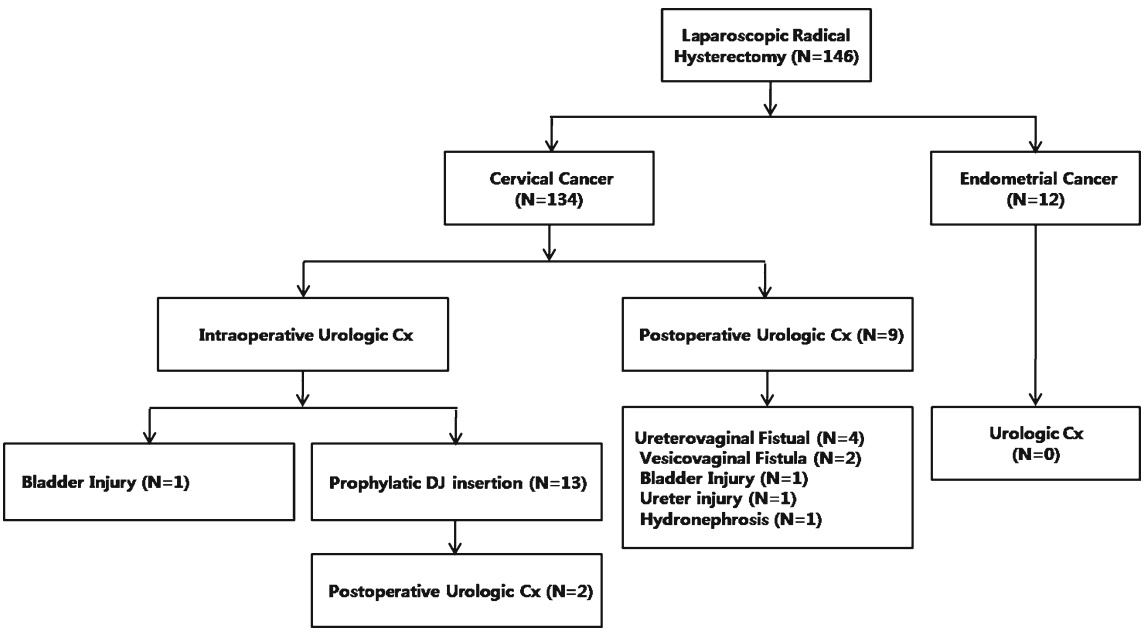

Fig. 1 Post- and intraoperative urologic complications of LRH

Table 2 Summary of urologic complications noted during postoperative care

Case	Age (years)	BMI	Type of complication	Symptom	Diagnosis sequence	Time from surgery to detection (days)	Site	Treatment
1	52	21.7	Vesicovaginal fistula	WVD	Indigo carmine test (+) → CT urography	14	Bladder post wall	Vesicovaginal fistula repair
2	65	27.5	Vesicovaginal fistula	WVD	Indigo carmine test (+)	8	Bladder post wall	Vesicovaginal fistula repair
					→ CT urography			L ureteroneocystostomy
3[a]	49	23.2	Ureterovaginal fistula	WVD	Vagina Cr ↑	12	Both distal ureter	R urinoma removal
					→ CT urography			R ureteroneocystostomy
4	67	25.8	Ureterovaginal fistula	WVD	Indigo carmine test (−) → CT urography	6	R distal ureter	R DJ insertion
5[a]	56	26.5	Ureterovaginal fistula	WVD	Vagina Cr ↑	10	R distal ureter	R PCN →
					→ CT urography			R ureteroneocystostomy
6	40	23.9	Ureterovaginal fistula	WVD	Indigo carmine test (+) → CT urography	10	R distal ureter	R DJ insertion
7	75	21.6	Hydronephrosis	Flank pain	Kidney sonography → Pelvic CT	15	L distal ureter	L DJ insertion
8	47	24.1	Bladder injury	JP drain ↑	JP drain Cr ↑→ RGP → CT urography	3	Medial to R UV junction	Urethral catheter insertion
9	53	26.5	Ureter injury	JP drain ↑	JP drain Cr ↑ → CT urography	5	L distal ureter	L DJ insertion

WVD watery vaginal discharge, *Cr* creatinine, *L* left, *R* right, *PCN* percutaneous nephrostomy, *RGP* retrograde pyelography, *UV* ureterovaginal

[a] The prophylactic DJ catheters were inserted during surgery

vesicovaginal fistula repairs. The patients who had ureteral injuries and hydronephrosis were conservatively treated with ureteral catheter insertion. One patient with a bladder injury was conservatively treated with an indwelling urethral catheter for 2 weeks.

Discussion

The incidence of urinary tract injuries during pelvic surgery is reported to range from 0.5 to 1.5 %. Bladder injuries are usually more common than ureteral injuries [12]. The formation of genitourinary tract fistulas after LRHs is generally thought to be a complication of iatrogenic injury to the urinary tract. The risk is reported to be higher in women undergoing hysterectomies at >50 years of age [13]. LRH can be categorized as a risk factor based on the high learning curve, technical skills required, and age. Gilmour et al. [2] reported that intraoperative cystoscopy reduces the occult ureteral injury rate, and thus occult injuries occur more often than expected. In the current study, the incidence of urinary tract injuries detected after LRH was 6.85 % (10/146), which was comparable to other studies (Table 3).

The incidence of urologic complications during LRH is higher than any other gynecologic surgical procedure, which may be due to the wide dissection required during surgery and the distortion of the normal pelvic anatomy by mass, such as cervical cancer. The limited field of vision during laparoscopy is the most important cause of urinary tract injuries. Risk factors, such as a history of radiation exposure, previous surgery, and combined endometriosis and pelvic adhesions can affect the incidence of urinary tract disease. A preoperative indwelling ureteral stent is recommended when there is a strong suspicion of urologic complications. Although some authors suggest routine intraoperative cystoscopy to screen for undiagnosed urinary tract injuries [14], it is not cost-effective to perform cystoscopy in all patients. Visco et al. [15] reported that routine cystoscopy is cost-effective when the rate of ureteral injury exceeds 2 % in patients with laparoscopically assisted vaginal hysterectomy. In LRH, the rate of urologic complications ranged from 1.3 to 16.7 % [20–31]. Whether routine cystoscopy is worthwhile in LRH is unknown and a subject for future research. However, routine cystoscopy could be applied to the patients who underwent LRH considering the rate of urologic complications in LRH.

It is important to identify the peristalsis of the ureter during surgery. Dye injection such as methylene blue and indigo carmine or cystoscopy is recommended when it is difficult to identify the patency of the ureter. There is much controversy as to whether or not preoperative ureter catheter insertion should be performed in patients treated with LRH

Table 3 Literature review of urologic complications in cervical cancer patients with LRH and lymph node dissection

Authors	Year	Patients (*N*)	Incidence (%)	Intraoperative complications[a] (*N*)	Postoperative complications[b] (*N*)	Total urologic complications (*N*)
Spirtos et al. [20]	2002	78	3.8	2	1	3
Pomel et al. [21]	2003	39	7.7	1	2	3
Obermair et al. [22]	2003	39	5.1	0	2	2
Ramirez et al. [23]	2006	18	5.6	1	0	1
Li et al. [24]	2007	90	6.7	4	2	6
Ghezzi et al. [25]	2007	50	12	4	2	6
Puntambekar et al. [26]	2007	248	3.2	4	4	8
Xu et al. [27]	2007	317	4.7	5	10	15
Lee et al. [28]	2007	76	1.3	0	1	1
Chen et al. [29]	2008	295	9.8	6	23	29
Malzoni et al. [30]	2009	77	1.3	0	1	1
Lee et al. [31]	2011	24	16.7	1	3	4
The current study		146	6.8	1	9	10

[a]Intraoperative complications included bladder injury, ureteral injury, ureterovaginal fistula, and vesicovaginal fistula

[b]Postoperative complications included bladder injury, ureteral injury, ureterovaginal fistula, vesicovaginal fistula, ureteral stenosis, and urinary tract infection. Urinary retention was excluded

because the ureter can be identified grossly by exploring the retroperitoneal area during radical hysterectomy, although the catheter straightens the ureters and offers clear visualization through the peritoneum. Monopolar cautery should be used cautiously near the urinary tract. Small injuries caused by monopolar cauterization can be easily overlooked [16]. If there is a suspicion of a urinary tract injury, intraoperative cystoscopy or intravenous dye injection should be performed.

In the current study, ureteral stents were inserted prophylactically under cystoscopy in patients with suspected urinary tract injuries intraoperatively, although we did not confirm urinary tract injuries. We evaluated outcomes in 13 patients who underwent prophylactic ureteral stents. Although ureteral tissue defects, ureteral ligation, and electrocautery injuries were not recognized and definite leakage was not found, the possibility of a ureteral injury induced by extensive dissection or injury of ureteral adventitial tissue was suspected. Two of the patients had ureterovaginal fistulas postoperatively. Initially, both patients were treated conservatively. The urethral catheter was removed on postoperative day 82 in case 3. A follow-up abdominopelvic CT scan revealed markedly increased fluid collection in the abdomen and pelvis, measuring 7.6×19.0 cm. The possibility of a urinoma was suggested. Removal of the urinoma and a right ureteroneocystostomy were performed on postoperative day 136. Percutaneous nephrostomies were performed in the other patient (case 5) on postoperative day 27 due to persistent vaginal leakage. However, the leakage continued and a right ureteroneocystostomy was performed on postoperative day 191.

One patient (case 7) who was diagnosed with hydronephrosis had flank pain. A ureteral catheter was inserted and acute nephritis was suspected clinically. However, the flank pain persisted in spite of antibiotics and the possibility of ureteral obstruction by a hematoma was suggested. A follow-up kidney ultrasonography showed resolution of the hydronephrosis and the symptoms were relieved. The ureteral injury can lead to extra- or intraperitoneal accumulation of urine, followed by vaginal leakage. A urinoma developed in a patient (case 3) who was treated conservatively.

Unfortunately, most urinary tract injuries are diagnosed postoperatively. Only 7 % of ureteral injuries are detected intraoperatively [2]. In the current study, all urinary tract injuries, except one, were detected postoperatively. Vesicovaginal fistulas are detected due to urine leakage from the vagina and can be accompanied by fevers, chills, and flank pain. In the current study, the indigo carmine test was performed or the creatinine level in vaginal secretions was measured. Then, cystoscopy and CT urography were performed to confirm the urinary tract injury and identify the precise location of the injury. An indigo carmine test was widely used to detect urinary tract injuries in the early 1990s, but imaging studies with contrast media are now more widely used. When ureteroperitoneal fistulas are suspected, CT is useful [17]; however, a CT scan as an initial study may show false-negative results in a patient with minimal injuries.

Vesicovaginal fistulas were detected in two patients. The base of the bladder is the most common site of injury resulting in a vesicovaginal fistula [8]. Immediate detection of a vesicovaginal fistula is important to reduce the failure rate of primary fistula repair [7]. Vesicovaginal fistulas can be repaired by the transvaginal route with a high success rate and minimal morbidity. For fistulas involving upper urinary tract injuries, the vaginal route is insufficient and abdominal repair is necessary.

The precise mechanism underlying fistula formation remains uncertain. Based on animal experiments, placement of a suture through the bladder during closure of the vaginal cuff after hysterectomy, as an isolated event, is not associated with formation of a postoperative vesicovaginal fistula [18]. Monopolar cautery during laparoscopic hysterectomy is associated with postoperative vesicovaginal fistulas [16]. Meticulous dissection of ureters and cautious use of monopolar cautery are required to prevent urologic complications.

LRH carries an inherent risk of injury to adjacent structures, especially injuries to the urinary tract (including the ureter). Patients who undergo LRHs are at greatest risk for urinary tract injuries because the majority of such patients with cervical cancer are older and smoke cigarettes, in addition to the risks associated with the surgical technique [19]. Intraoperative injuries of the ureter and the bladder, as well as the development of fistulas in the postoperative period, may influence all aspects of the quality of life. Disclosure of potential surgical risks and informed consent is an important component of the preoperative procedure.

To minimize the risk of urinary tract injuries, understanding pelvic anatomy and sufficient training is essential. It is desirable to use gauze instead of monopolar cauterization to mobilize the bladder away from the cervix before opening the tunnel of the ureter. Use of bipolar coagulation for bleeding control is preferable around the ureter. Both ureters should be carefully inspected before the end of surgery. If a ureteral injury is suspected, placement of a temporary ureteral stent under cystoscopy may prevent a urinary tract injury. However, not all urinary tract injuries can be prevented using ureteral stents. Careful postoperative care is mandatory to detect urinary tract injuries and regular urologic clinical follow-up in patients with ureteral stents is needed.

Conflicts of interest None.

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