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Ureteral catheter placement for prevention of ureteral injury during laparoscopic hysterectomy

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Abstract

Aim: Ureteral injury is among the most devastating complications of gynecologic surgery. Estimated incidence of ureteral injury during laparoscopic hysterectomy is 2.6–35 times (0.2–6.0%) that in abdominal hysterectomy. We investigated preoperative ureteral catheter (UC) placement as a way to prevent ureteral injury in laparoscopic hysterectomy.

Methods: Clinical records of 94 women who underwent laparoscopic hysterectomy between February 2006 and January 2007 in Yazaki Hospital, Kanagawa, Japan, were reviewed retrospectively. Thirty-four patients between February and June 2006 underwent the surgery without ureteral catheterization and 60 patients between July 2006 and January 2007 underwent surgery with ureteral catheterization. Clinical outcomes were statistically compared between the two groups.

Results: The average time required for catheter insertion was 9.35 min. The ureter in which the catheter was placed was visualized clearly. In one patient, whose left ureter was deviated by a massive myoma, catheter insertion was not possible. No complications arose from catheter placement except for minor complaints including low back pain, urinary discomfort, and transient hamaturia. While one injury occurred in a patient without ureteral catheterization (1/34), no ureteral injury occurred in any patient with ureteral catheterization (0/60). Operative time, total blood loss, and hospital stay were not significantly different between the two groups.

Conclusions: UC placement is simple, helping to prevent ureteral injury during laparoscopic hysterectomy and enhancing safety of this procedure.

Key words: cystoscopy, laparoscopic hysterectomy, ureteral catheter, ureteral injury.

Introduction

The most commonly performed gynecologic operation worldwide is hysterectomy.[1] In the US, 600 000 women undergo some type of hysterectomy each year, with 37% of women 65 years old having had a hysterecotmy.[2,3] Three approaches have been used to perform hysterectomy: abdominal hysterectomy (AH), vaginal hysterectomy (VH), and laparoscopic hysterectomy (LH). LH has been divided into three subtypes according to the method used to secure and divide the uterine artery. In laparoscopically assisted hysterectomy (LAVH), the uterine vessels are secured vaginally, while LH refers to laparoscopic division of the uterine vessels. The procedure is termed total laparoscopic hysterectomy (TLH) when surgery involves no transvaginal component and the vaginal vault is sutured laparoscopically.[4,5]

Although more than 70% of hysterectomies are performed by laparotomy, advances in endoscopic gynecologic surgery during the late 1980s and early 1990s have led to a patient preference for LH over AH.[6]

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Advantages of LH over AH include less scarring, less postoperative pain, shorter hospital stay, and patients return to normal activities sooner.[7,8]

However, as the new technology has been embraced, increased risks of complication has been noted.[9] Major sites of potential injury during LH include the great vessels, intestines, and urinary tract (bladder or ureter). Among the latter, ureteral injuries are particularly troublesome.[10] Urinary tract injury from gynecologic surgery can have major personal, financial, and societal costs. In Canada, 17% of non-obstetric litigation in gynecologic surgery has been reported to involve urinary tract injuries.[11]

Introduction of LH was followed by a number of reports of ureteral injuries, with estimated incidence at 0.2–6.0%.[12–15] In particular, several reports have compared incidence of urinary tract injuries between LH and AH. Harkki-Siren *et al*.[16] reported that in Finland the rate of ureteral injuries associated with LH was 35 times that of AH. In a systematic review of 47 observational studies, Glimour *et al*.[10] concluded that the rate of urinary tract injury was up to 5 times greater in LH than in AH. The Cochrane Database Systemic Review in 2006[17] calculated from a meta-analysis of 27 trials that the odds ratio of incidence in LH relative to AH was 2.61 (95% CI 1.22–5.60). With any new technique, safety as well as clinical efficacy is a highly important consideration.[18] Accordingly, despite many advantages of LH, excess occurrence of ureteral injury in LH has impeded its worldwide acceptance.[8,19]

Thus, prevention of ureteral injury is of paramount importance in LH. Since July 2006, we introduced preoperative ureteral catheterization (UC) under cystoscopic guidance in all patients who undergo LH at our institution because the most important cause of high ureteral injury risk during LH is due to the greater difficulty with identifying the ureteral course. The catheters straighten the ureters and offer clear visualization through the peritoneum without invasively exploring the retroperitoneal area. We feel that UC has enhanced safety and ease of all procedures performed during LH. The present report describes UC in LH and presents an evaluation of its usefulness.

Materials and Methods

We retrospectively studied 94 patients undergoing LH between February 2006 and January 2007 in the Department of Gynecology at Yazaki Hospital, Kanagawa, Japan. The patients' ages ranged from 36 to 74 years with a mean of 50.1. Indications for LH were: uterine myoma in 67% (weight range from 90 to 2410 g), adenomyosis in 8%, and other conditions in 25% which included atypical endometrial hyperplasia, dysfunctional uterine bleeding, and endometriosis. All LH between February 2006 and June 2006 were performed without UC ($n = 34$), and those between July 2006 and January 2007 were done with UC ($n = 60$). Clinical outcomes (patients' age, operative time, total blood loss, uterine weight, hospital stay, and incidence of ureteral injury) were assessed between cases with and without UC using Student's *t*-test. All patients and family members gave consent for UC and LH after receiving all pertinent information about the procedures.

Surgical technique

Ureteral catheterization

Patients were given endotracheal general anesthesia and placed in the lithotomy position. A cystoscope (HOPKINS Telescope, 4 mm; angulation, 70° [model K27005CA] together with a 22 Fr outer tube [model K27026B]) (both from Karl Stortz, Tuttlingen, Germany) was inserted into the urinary bladder. After filling the bladder with normal saline via the cystoscope, interureteric folds and the two ureteral openings were identified. After careful insertion of a guide wire into one opening, a Tigertail flexible-tip UC system (diameter, 6 F; length 70 cm) (C. R. Bard, Murray Hill, New Jersey, USA) was advanced rostrally along the guide wire for a length of 15 cm (Fig. 1). The guide wire was then removed. Another guide wire and catheter were inserted similarly into the contra lateral opening. Each catheter was firmly fixed to the thigh to prevent dislodgement from the ureter during the operation. A 14 Fr Foley catheter was then placed in the bladder.

A uterine manipulator (Ethicon, Division of Johnson & Johnson, Piscataway, NJ, USA) was inserted into the uterine cavity for effective control of the position of an enlarged uterus. A 10 mm laparoscope was inserted within an umbilical trocar sleeve through a vertical intraumbilical incision. One 5 mm trocar sleeve was then placed in the supra-pubic area and two more laterally on each side to the rectus abdominalis muscle and inferior epigastric vessels. The entire abdominal cavity then was inspected.

Laparoscopic hysterectomy

LH was performed as described in textbooks.[5,7,20,21] All LH was carried out as TLH, which is associated with significantly less major morbidity, including ureteral

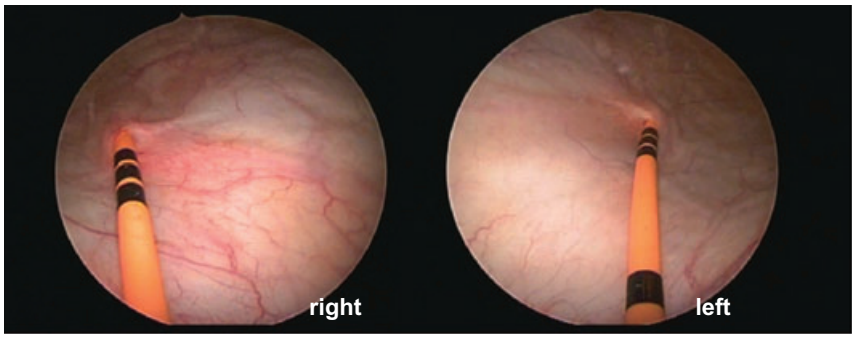

Figure 1 Insertion of Tigertail flexible-tip catheters into both ureteral openings. Three black lines on the catheter indicate a 15-cm distance from the tip.

injury and bladder injury, and reduces the need to convert to laparotomy rather than LAVH.[5] The round ligaments were firstly dissected using bipolar forceps and a cavity between anterior and posterior broad ligaments was opened. The infundibulopelvic ligaments (when oophorectomy was indicated) or the utero-ovarian ligaments (when ovarian preservation was possible and desired) were ligated with 2–0 silk or coagulated with bipolar forceps. The vesico-uterine peritoneal fold and the bladder were freed from the uterus and upper vagina. The ascending branch of the uterine artery was carefully identified and dissected after ligation with 2–0 silk. After dissection of the cardinal ligament, a colpo probe vaginal fornix dLineator (Apple Mecidal, Marlborough, MA, USA) was placed in the vagina, and the anterior cervicovaginal junction and lateral fornices were identified. Then the vaginal wall was dissected in a circular motion with a monopolar needle. The uterus was morcellated if necessary and removed via the vagina. The vaginal vault and retroperitoneum were sutured with 0-Monoclyl (Ethicon, Division of Johnson & Johnson, Piscataway, NJ, USA) vaginally. During procedures, full awareness of the ureteral course was maintained. A dilute indigo carmine solution was then administered intravenously. When drainage of this blue dye appeared from both ureteral catheters, the laparoscope and all trocars were removed and all incisions were closed with 3–0 Vicryl (Ethicon). After abdominal radiography in the operating room to ensure correct insertion of both ureteral catheters and absence of intraperitoneal foreign bodies, the catheters were removed (Fig. 2).

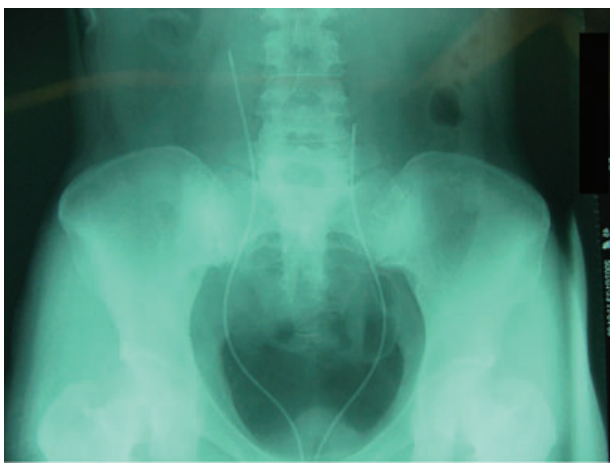

Figure 2 Postoperative abdominal radiograph. The depth of insertion for each catheter is different since the catheters were advanced and retracted during the operation to confirm the ureteral course.

Results

All procedures were successfully completed using the laparoscopic approach. Bilateral UC required 5–14 min (mean 9.4). No ureteral injury occurred in any of the cases. In one case, a catheter could not be advanced into the left ureter due to a massive myoma, involving the left broad ligament pressing upon the left ureter causing a sharp angulation, which precluded advancement of the catheter. Apart from this unilateral placement failure, no major complications were associated with UC.

Postoperative asymptomatic hematuria was observed in 12 patients (20%) and all were cleared by postoperative day (POD) three. Four patients (6.7%) complained of urinary discomfort and pain after surgery, with full resolution by POD seven. One patient (1.7%) complained of lower back pain on the left side that persisted for approximately 1 week postoperatively. It was unclear whether this pain was related to UC.

The comparison of clinical outcomes between LH cases with and without UC is shown in Table 1. While

Table 1 Comparison of clinical outcomes between laparoscoptic hysterectomy without ureteral catheter (from February 2006 to June 2006) and with ureteral catheter (from July 2006 to January 2007)

Clinical characteristic	Without UC ($n = 34$)	With UC ($n = 60$)	Significance*
Age (years)	50 ± 9.1	49 ± 8.0	$P = 0.913$
Operative time (min)	181 ± 39	168 ± 51	$P = 0.187$
Total blood loss (ml)	360 ± 279	285 ± 276	$P = 0.208$
Uterine weight (g)	255 ± 162	262 ± 174	$P = 0.839$
Hospital stay† (days)	4.7 ± 2.0	4.3 ± 0.7	$P = 0.133$
Ureteral injury (No.)	1	0	$P = 0.182$

*Student's *t* test was used for calculating the *P*-value. †Hospital stay was calculated taking day 1 as the first day following the hysterectomy. All data given expect for number of ureteral injury are mean ± standard deviation (95% CI). UC, ureteral catheterization.

no ureteral injury was observed in the group with UC, there was one case of ureteral injury in the group without UC, which required ureteroneocystostomy. In all parameters, no significant differences were noted between the two groups.

Discussion

Lower urinary tract injury is always a risk during gynecologic surgery because of anatomic proximity and embryologic relationship between the reproductive and lower urinary tracts.[10,22] Undoubtedly, the greatest likelihood of ureteral injury during laparoscopic gynecologic surgery occurs in patients undergoing LH.[22,23] Overall, incidence of ureteral injury is estimated at 0.03–2.0% for AH, 0.02–0.5% for VH, and 0.2–6.0% for LH.[12–15] Although such figures for ureteral injury could be interpreted as rather low, they translate into a substantial number of ureteral injuries given the large numbers of hysterectomies performed annually.[15]

Uterine myomas or adhesions due to endometriosis often distort the lower urinary tract and obscure its relationships, causing difficulty for surgeons in identifying and isolating the ureter along its course. Even without such pathology, anatomic variation involving the urinary tract can increase injury risk. Thus, knowledge of the normal and variant anatomic courses of the ureter through the pelvic wall, combined with surgical skills, is a key to reducing risk of injury during surgery.[7]

The safest way to secure the isolation of both ureters is by exploring the retroperitoneal area, as performed in pelvic lymphadenectomy for malignant disease such as cervical and ovarian cancer. However, such laparoscopic exploration requires particularly refined surgical skill and in itself may lead to excessive bleeding, prolonged operating time, and even ureteral injury. Alternatively, Koh *et al*.[7] described a simple procedure with creation of a 'window' overlying the anterior and posterior broad ligaments, used to inferolaterally displace the areolar tissue in which the ureter is embedded. However, such a window allows for visualization of the ureteral course within a limited range only.

More than a decade ago, some authors advocated routine intraoperative cystoscopy as screening for ureteral and bladder injuries.[14,24] However, evidence supporting this procedure has been considered insufficient. While this examination should prevent sequelae from undiagnosed lower urinary tract injuries, it is not considered sufficiently cost-effective for widespread use.[10,15] Early postoperative ureteral jet ultrasonography, which has sensitivity of 100% and specificity of 90.9% for detecting complete ureteral obstruction,[25,26] can provide early detection of urinary injuries, but cannot prevent ureteral injury.

Some reports concluded that increased surgical skill decreased the complication rate.[22,24,27] Indeed, Wattiez *et al*.[28] reported a significant reduction in urinary tract injury, with a 2.2% ($n = 695$) incidence during their first 6 years of experience and only a 0.9% ($n = 952$) incidence in a later series, concluding that the most important factor in avoiding urinary tract injury in LH is experience. However, immediately applicable measures are needed for prevention of ureteral injuries in addition to accrual of experience. We have found preoperative UC to be a simple and effective solution.

The technique of UC does not require extensive experience or specific skill and is easy for a surgeon to master. The Tigertail catheter possesses sufficient elasticity to straighten the ureteral course and can correct many deviations to ensure safety during each step in LH. A ureter containing a UC bulges against the peri-

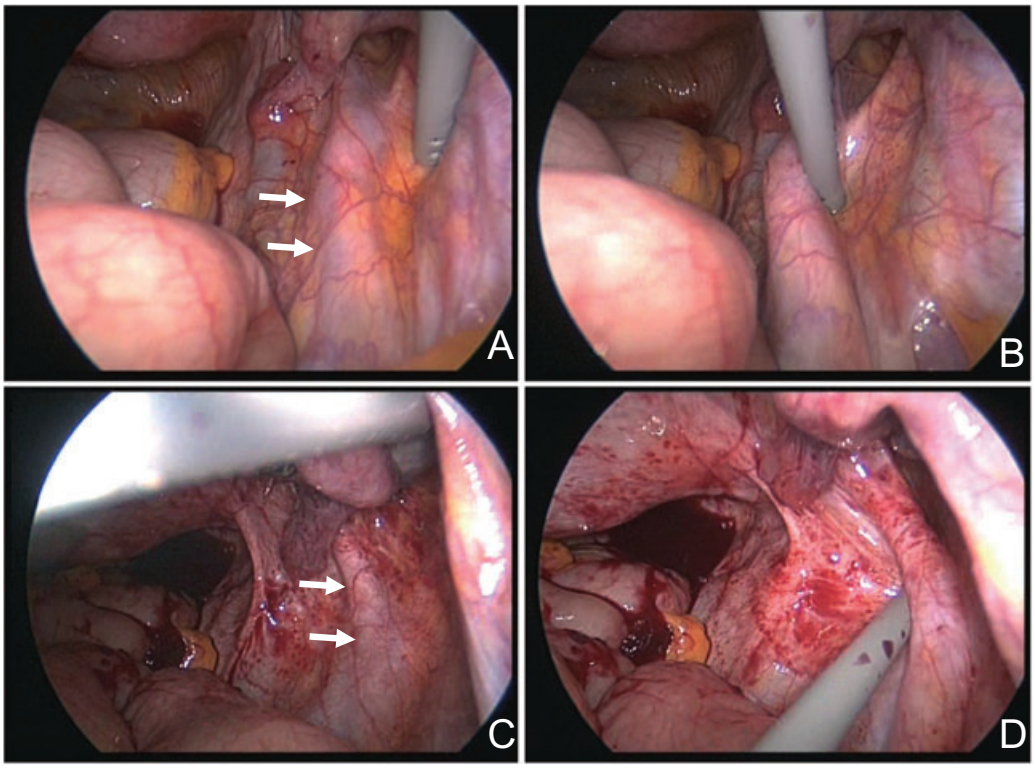

Figure 3 Intraoperative identification of the ureteral course. (a,c) The ureteral catheter straightens the ureter (arrows) and causes it to bulge from retroperitoneum. The catheter's tiger-tail pattern is visualized through the ureteral wall. (b,d) When the retroperitoneum is pushed upon by forceps, the elasticity of the ureteral catheter may be felt, clearly identifying the whole ureteral course.

toneum, permitting identification of the entire course (Fig. 3a,c). Even when the retroperitoneum is edematous and the ureteral course is not clearly visualized, the elastic properties of the catheter help to determine the ureteral course (Fig. 3b,d).

Permanent damage can usually be avoided if ureteral injury is diagnosed at the time of surgery, but unfortunately most ureteral injuries are diagnosed postoperatively.[13] Gilmour *et al*.[10] reported that only 7% of ureteral injuries in LH were detected intraoperatively. In a Taiwanese study, the mean postoperative delay to diagnosis and treatment of ureteral injuries was 11.3 days (range 0–44).[22] We have avoided such injuries to date with UC but, should they occur, the bright orange color of the catheter within the ureter should be readily apparent, identifying the site of injury immediately.

Since no patients with bilateral ureteral patency at the time of operation were found to have a ureteral injury later,[15] the emergence of indigo carmine dye from ureteral orifices provides confirmation of ureteral patency and assurance that injury has not occurred, UC provides easier confirmation than intraoperative cystoscopy because the operator does not need to setup the instruments for cystoscopy during surgery and then wait for the spill of the dye.

To avoid injury of renal pelvis and calices by the ureteral catheter, the tip should remain inside the ureter between ureteropelivic junction and renal pelvis. For this reason, we think that depth of 15 cm from the ureteral opening is adequate. Although not observed in our series, potential complications of UC include postoperative cystitis or pyelonephritis. Ureteral mucosal injury with hematuria has been transient and did not require treatment. In the single case in which the catheter could not be inserted into one ureter, the left ureter proves to be displaced and kinked by a massive myoma involving the broad ligament. In such instances, effort at insertion must be terminated to avoid ureteral perforation by forceful advancement.

While there was one ureteral injury in a patient without UC (1/34), no injury occurred in patients with

UC (0/60). Although there is no statistical significance between these two groups, this result indicates efficacy of UC for prevention of ureteral injury. Furthermore, the case of the injury led us to introduce UC afterwards. Both mean operative time including UC and mean total blood loss were also improved in groups with UC (though not significant). Less time was required for identification of the ureteral course in cases with UC, probably resulting in shorter operative time and less blood loss. The other possibility is that the operator's surgical skill had been improved during the period.[22,24,27,28]

The cost of UC, as with postoperative cystoscopy, might be criticized.[15,22] However, modestly increased cost is of minimal concern considering the seriousness of the injuries prevented. The operator's comfort and their safety towards total awareness of the ureteral course during LH is a paramount concern.

In conclusion, UC is a simple and effective way to avoid ureteral injury in LH. Placement is usually completed within 15 min and is easily mastered. The procedure causes no major complications and UC should notably reduce the risk of LH-related injury.

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