

A Review of Lower Urinary Tract Injuries

Michelle Quinones, MD; Peter S. Finamore, MD

Due to their proximity to the female reproductive organs, the ureter and bladder are at risk for injury during gynecologic surgical procedures. When such an injury occurs, it is accompanied by potentially serious morbidity, cost, and a high risk of litigation.

The evolution of pelvic surgical procedures has been influenced by uncommon but potentially devastating injuries to the lower urinary tract (bladder and ureters). There are several studies in the literature that have attempted to estimate the incidence of lower urinary tract injuries (LUTI) during gynecologic surgery. Many of these studies have tried to determine if the route of surgery (vaginally, abdominally, or laparoscopically) affects the incidence of LUTI. The majority of these studies are retrospective, primarily because LUTI is a rare event.

This review will focus on the literature regarding the incidence, diagnosis, and management of injuries to the distal ureter and bladder.

ANATOMY

The ureter can be divided into 2 segments: abdominal and pelvic. The abdominal ure-

ter runs along the anterior surface of the psoas muscle and posterior to the ovarian vessels. At the pelvic brim, the pelvic ureters enter the posterior pelvis lateral to the sacrum. Subsequently, the ureters cross anterior to the inferior iliac arteries and course medially along these vessels and their branches. The ureters then pass beneath the uterine artery and into the paracervical tissue. Finally, the ureters course anteriorly toward and over the vaginal fornix to enter the bladder.^{1,2}

The ureter consists of an inner mucosal layer, followed by a smooth muscle layer and an outer adventitial layer. The ureters' blood supply is obtained from each blood vessel it traverses. The abdominal ureters' blood supply enters from the medial aspect, while the blood supply is lateral for the pelvic ureters.¹

Common sites of injury to the ureter include at the level of the cardinal ligament, the dorsal aspect of the infundibulopelvic (IP) ligament near or at the pelvic brim, and the lateral pelvic sidewall above the uterosacral ligament.¹ In gynecologic surgery, the most common site of ureteral injury is in the lower third of the ureter.³ A 10-year review of ureteral injuries in a community hospital by Goodno et al reported that the most common site of injury was in the region of the uterine artery and the parametrium.⁴

Types of intraoperative ureteral injuries include crushing, suture ligation, transection, avulsion, devascularization, and thermal.¹ Some of these injuries may be recognized intraoperatively, while others belated. Delayed recognition of LUTI results from not correctly identifying either the damage or the type of injury at the time of the surgery.⁵ For example, thermal or devascularizing injuries may not be seen at

FOCUSPOINT

LUTI is a rare but major cause of morbidity in pelvic surgery patients.

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the time of the surgery, but they affect ureteral patency postoperatively.

INCIDENCE

Overall, the incidence of LUTI has not been well established, but it is estimated that in benign gynecologic surgery, bladder injury rates range from 0.3 to 6.0 per 1,000 hysterectomies with or without bilateral salpingo-oophorectomy; ureteral injuries range from 0.2 to 7.3 per 1,000 surgeries.⁶

Approximately 600,000 hysterectomies are performed every year, which makes it the most common gynecologic surgical procedure.⁷ Hysterectomy is also the most common surgical procedure that leads to LUTI. Vakili and colleagues compared total abdominal hysterectomy (TAH), total vaginal hysterectomy (TVH), and laparoscopic hysterectomy (LH) and found no difference in the rates of ureteral injuries among types of hysterectomy (2.3% vs 1.4% vs 0%, respectively; $P = .527$). Bladder injuries were likewise not different among hysterectomy approaches (2.5% vs 6.3% vs 2.0%, respectively; $P = .123$), although a higher trend was appreciated with TVH associated with anti-incontinence surgery.⁸

Many of the retrospective reviews that were done to calculate the incidence of LUTI report that these injuries occur more frequently with LH versus TAH.^{5,9-12} Johnson and colleagues reported a significantly higher incidence of all urinary tract injuries (bladder and ureteral injuries) in LH versus TAH. Ureteral injuries alone in these 2 groups were underpowered (LH, 1 in 78; TAH, 1 in 492), and they could not determine if there is a significant difference.¹⁰ Since the incidence of LUTI is so rare, these retrospective reviews are frequently underpowered to determine if the difference in rates are statistically significant.

Multiple research studies have intended to determine the advantages of minimally invasive surgery in the past decade.¹³ A lower rate of intraoperative and postoperative complications is one of the proposed advantages of these surgeries. Cardenas-Goicoechea et al compared the visceral injury rate between the robotic-assisted and laparoscopic-assisted approach to hysterectomy in patients who underwent surgical staging for endometrial cancer.¹⁴ During the



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study period, bowel injuries occurred in 2% of 102 robotic-assisted cases. No urinary tract injuries were reported in this group.

In the laparoscopic-assisted approach, 6 urinary tract injuries and no bowel injuries were reported out of 173 cases. The researchers suggested that the 3-dimensional imaging of the robotic system allows for better visualization of the ureters, which may decrease the risk for urinary tract injuries. This was a small series most likely not powered adequately to determine differences between bowel and urinary tract injuries. More data are needed to determine the rates of urinary tract injuries and other complications related to robotic surgeries.

DIAGNOSIS

The most important factor in identifying LUTI intraoperatively is a high index of suspicion. During surgery, different methods are used to inspect the ureter and bladder. Some surgeons only perform gross examination of the lower urinary tract. Ureteric peristalsis alone does not equal ureteric patency, as a damaged ureter will continue to demonstrate peristalsis. According to one prospective study, peristalsis persisted in 5 out of 6 ureteric injuries.⁷ Additional methods to evaluate the lower urinary tract are

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available: for example, bladder instillation of methylene blue dye, intravenous indigo carmine, ureteric stents, and/or cystoscopy.

Intraoperative detection of LUTI leads to immediate intervention and reduced morbidity. The role of routine intraoperative cystoscopy is controversial. According to a systematic review by Gilmour et al, universal cystoscopy has been associated with a higher intraoperative detection rate of injuries: 47 of 53 (89%) ureteral and 59 of 62 (95%) bladder injuries.⁶ Studies in which routine cystoscopy was not performed showed lower rates of intraoperative detection of injury: 21 of 305 (7%) ureteral injuries and 195 of 450 (43%) bladder injuries. The rates may have been underestimated because injuries may have become symptomatic later and presented to a different center for care. Based on this and other studies, the use of intraoperative cystoscopy appears beneficial in the recognition of these injuries.^{6,15}

About 50% of Canadian gynecologists reported using intraoperative cystoscopy for the detection of LUTI following gynecologic surgery. The paucity of use was driven by lack of training; this suggests that cystoscopy training should be incorporated in residency programs.¹⁶

Postoperative evaluation for possible LUTI includes a contrast-enhanced CT scan and a complete intravenous urogram (IVU). Both methods may show contrast extravasation from the ureter, urinary ascites, urinoma, and even partial or complete obstruction if an injury is present.^{17,18} In cases where distinction between partial versus complete transection cannot be determined, retrograde pyelography may be crucial to patient management.^{2,18} Some patients with ureteral injuries that are recognized postoperatively may have elevated creatinine, which makes performing these studies problematic.

MANAGEMENT

Traditionally, ureteral injuries are repaired via laparotomy, but laparoscopic repair is increasingly performed. Successful laparoscopic ureteral repair over a stent after partial or total transection have been reported.¹⁹⁻²¹ The appropriate reconstructive procedure for LUTI depends on the location of the injury, degree of devascularization, and amount of global tissue damage. Stent

placement over certain defects may be sufficient, while larger lesions would require stent placement and repair.¹⁹

Following a total transection of the distal third of the ureter, the main concern is a jeopardized blood supply. The best corrective surgical approach is a repair by ureteroneocystotomy over a ureteral stent.

The procedure begins by tying off the distal segment of the ureter that is attached to the bladder.^{2,22} Next, distend the bladder with saline through a urethral catheter, and make a 1- to 2-cm transverse incision over the bladder on the same side as the injury. The detrusor muscle is then divided until the bladder mucosa has been identified. The bladder mucosa is incised sharply and everted with multiple interrupted 5-0 chromic sutures.

Starting at the apex, the distal end of the ureter is sutured to the bladder using 4-0 or 5-0 vicryl sutures. The remaining nonapical sutures may incorporate detrusor muscle. Before the anastomosis is complete, a 6-FR ureteral stent should be placed to rest the ureter proximal to the renal pelvis. The detrusor muscle should then be loosely reapproximated over the anastomosis to avoid ureteral obstruction.

If the injury is not distal enough to allow the proximal ureter to be brought to the dome of the bladder without tension, a psoas hitch may be required.^{2,21} The bladder is mobilized in the space of Retzius, and the contralateral superior vesical artery is ligated to facilitate bladder mobilization.

A cystotomy in the bladder dome is performed and should extend for at least half the circumference of the bladder. The dome of the bladder is then elevated above and lateral to the iliac artery on the psoas major muscle, and the proximal ureter is freed enough to allow a tension-free anastomosis. Next, the dome of the bladder is fixed to the tendon of the psoas minor muscle or directly to the psoas major muscle with 4 to 6 interrupted 2-0 nonabsorbable monofilament sutures without entering the bladder lumen. The cystotomy is repaired in right angles to the way it was opened. The repair should be in 2 layers: the urethelium and the detrusor muscle in a running suture.

The ureter is reimplanted into the bladder by ureteroneocystotomy, as previously discussed. A percutaneous catheter (ie,

bulb drain or Jackson-Pratt drain) near the anastomotic site may be left in place for 3 to 10 days to prevent urine collection. A Foley catheter should drain the bladder for at least 10 days to allow a proper healing environment. The ureteral stent should remain for 6 to 8 weeks. Follow-up studies after removal of the stents should be done to ensure a fully repaired urinary tract.

The repair of a thermal injury requires resection of the damaged segment, followed by repair of the remaining healthy ureter with the appropriate technique, depending on the location of the injury. If the distal ureter was injured, a ureteroneocystotomy with or without a psoas hitch will suffice.

In the case of ureteral ligation recognized intraoperatively, remove the suture and assess tissue viability. Passage of a ureteral catheter can attest to patency. In cases of minor ligation or crush injuries, a ureteral stent placed for approximately 6 weeks may be enough to avoid long-term complications.²⁰ In the postoperative setting, a percutaneous nephrostomy may be performed to permit evaluation of the ureter by injecting contrast.

CONCLUSION

LUTI is a rare but major cause of morbidity in patients undergoing pelvic surgery. It is also of great concern to physicians because of the potential for medicolegal actions if an injury does occur. Proper technique and special attention should be paid to the structures involved with these types of procedures.

Cystoscopy should be used more often during hysterectomy. Its accurate diagnosis has led to a higher detection rate of injuries in the urinary tract. Indeed, the best way to defend both the patient and practitioner against these complications is by thoroughly investigating the patient's pelvic anatomy during dissection and repair, as well as utilizing available tools to safeguard against incidental iatrogenic complications.

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