



Review article

The diagnosis and management of ureteric injury after laparoscopy

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ABSTRACT

The number of ureteric injury cases has increased in gynecological surgery. We reviewed the literature concerning the incidence of ureteric injury and the recognition and management of the ureteric injury with the controversy of delayed management of ureteric injury. To reduce the morbidity of ureteric injury, gynecologists should be aware of and familiar with the pelvic wall anatomy, the site that is most susceptible to injury. They should also have knowledge about the prevention and management of ureteric injury.

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Introduction

Ureter injuries are associated with an incidence of 0.1–1.5% for benign procedures and up to 5% for oncologic procedures in gynecologic surgery¹; 30–45% of injuries are diagnosed intraoperatively and 55–70% of injuries are diagnosed postoperatively.^{2,3} Pelvic surgery is a very common cause of iatrogenic ureteral injury.^{4,5} The estimated incidence is 0.5–3%, and one-third of these cases were not identified or corrected during the surgery.⁶ Symptoms of ureter injury may be detected by hematuria, cystoscopy, or direct exploration of the ureter. During the past decade, laparoscopic-aided treatment of ureteral injuries such as the removal of a suture or stricture, laparoscopic-guided stent insertion and suturing for ureteral laceration, laparoscopic reanastomosis over a stent, and most recently ureter reimplantation have become feasible.^{4,7–10}

Anatomy of the ureter

Surgeons must be familiar with the pelvic anatomy and the relationship between the ureter and the pelvic organs to prevent

ureteric injury in an operation near the pelvic area. Ureters are retroperitoneal tubular structures, approximately 25–30 cm long, that extend from the kidney to the bladder and lie on the anterior surface of the psoas muscle and cross over the iliac vessels. The most important areas in pelvic surgery are the sites of the ureter where it is most susceptible to trauma. The first area of concern during routine salpingectomy is the pelvic brim where the ureter approaches the pelvis beneath the insertion of infundibulopelvic ligament as it is crossed anteriorly by ovarian vessels. The right ureter then enters the pelvis by crossing over the external iliac artery while the left ureter crosses over the common iliac artery where the ureter lies medial to the branches of the anterior division of the internal iliac artery and lateral to the peritoneum of the cul-de-sac. The second area of concern during routine abdominal hysterectomy is the midplane of the pelvis where the ureter crosses anteriorly of the uterine artery and tunnels into the cardinal ligament at approximately 1.5–2 cm lateral to the cervix near the internal cervical ostium and vaginal fornices as it enters into the trigone of the bladder.

The ureter is composed of three layers: an inner layer that is composed of transitional epithelium; a middle layer of circular and smooth muscle; and an outer layer of adventitial sheath. The outer layer of the ureter contains all of the unique blood supply, which comes from the contribution of the renal artery, ovarian artery, common iliac artery, and aorta. It is important for surgeons to

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maintain the blood supply of the outer layer of the ureter during the dissection of the ureter.^{11,12}

Ureteric injury in gynecological surgery

The intraoperative diagnosis of ureteric injury remains a challenge. Early recognition and repair of damage to the urinary tract are essential for optimal patient outcome and for preventing late consequences (e.g., renal damage and genitourinary fistulae).¹³ Symptoms of a late diagnosis of ureteric injury are usually nonspecific and include abdominal or flank pain, fever, nausea, hematuria, and watery vaginal discharge. Early postoperative diagnosis of ureteric injury typically occurs 7–10 days after surgery.^{5,14}

Intraoperative diagnosis

An early diagnosis of ureteral injury is difficult, despite an intraoperative assessment of hematuria and cystoscopy. Hematuria is typically absent on presentation, as described in several series,^{15–21} and range 23–45%; however, 33% of patients without other urologic injuries have a normal urinalysis.²²

The routine use of intraoperative cystoscopy for patients undergoing major gynecological surgery has been proposed as a secondary preventive measure for urinary tract injury. This procedure appears to reduce the rate of urinary tract injuries discovered postoperatively. The role of cystoscopy in several types of procedures (e.g., hysterectomy, prolapsed repair) is unclear; however, surgeons should be vigilant, especially if a procedure is difficult or complicated.

Gilmour et al²³ used intraoperative cystoscopy and diagnosed intraoperatively 47 (89%) of 53 ureteric injuries and 59 (95%) of 62 bladder injuries; however, for surgeries performed without routine intraoperative cystoscopy, they diagnosed intraoperatively 21 (7%) of 305 ureteric injuries and 195 (43%) of 450 bladder injuries. Cystoscopy allows visualization of the ureteric orifices and urine jets, and rules out obstruction, if it is performed after the operation. Insertion of a stent by cystoscopy can reveal the location of an injury and may give an idea of the approximate height of the ligation. Intravesical and/or intravenous dye can be useful in diagnosing the integrity of the lower urinary tract by coloring the urine. For intravesical use, methylene blue or sterile infant formula can be administered by instilling the dye into the bladder through the bladder catheter. Leakage of the dye into the operative field primarily confirms the presence of a bladder injury. Indigo carmine solution (usually 2.5 mL of a 0.8% solution) is the most common solution used for intravenous dye administration.^{24,25}

Postoperative recognition

Ureteric injury is usually overlooked intraoperatively, even in laparoscopic surgery. Soong et al²⁶ revealed that nearly all bladder injuries are diagnosed during surgery, but ureteric injury is not. In their study, they could only detect four (50%) of eight injuries during the surgery, but 29 (96.7%) of 30 bladder injuries.

Unrecognized ureteral injury should be suspected postoperatively if a patient experiences the following signs and symptoms, which should prompt evaluation for urinary tract injury (i.e., leakage of urine from the vagina or abdominal incision, costovertebral angle pain, oliguria or anuria, hematuria, persistent abdominal pain, or distension with or without ileus and fever).

An intravenous pyelogram (IVP) may be performed as an emergency procedure or on an outpatient basis. This procedure can miss small lesions and detect only 14–20% of penetrated lesions.²⁷ An IVP may also miss distal lesions, which may be

confounded by the contrast medium in the bladder. A computer tomography (CT) scan is not beneficial in evaluating ureter injury, whereas a CT scan with delayed contrast would help in detecting an injury.^{28,29}

Timing of the management of a ureteric injury

The time to manage ureteric injury depends on the length of the ureteric injury, its etiology, associated injuries, the time of its discovery, and its location. Lee and Symmonds³⁰ noted that the timing of the operation depended on the overall clinical assessment of the nature and extent of the injury and the general condition of the patient.³¹ The rationale of waiting 3–6 months is to allow edema to subside, tissue planes to be reestablished, and any fistulae to become smaller before attempting a repair. Ku et al³² suggest that the outcome of an early repair is no better than the outcome of delayed intervention, and that all iatrogenic ureteric injuries should not be repaired immediately by reconstructive surgery. However, their intervention method is only percutaneous nephrostomy drainage, ureteral stent placement, or both. By contrast, from the urologist point of view, the intraoperative ureteric injury suspected and intraoperative repair was needed immediately. It is true that intraoperative recognition and repair is preferred to postoperative diagnosis and subsequent correction because the procedure usually avoids the morbidity, cost, and inconvenience of a second operation. Delayed diagnosis worsens outcome,³³ but Png et al data is based on the open method. De Cicco et al support laparoscopy as the method of choice for ureteral repair in gynecological surgery, based on 608 cases of iatrogenic ureteral injury of which 57 patients were managed by laparoscopy and 551 patients were managed by open surgery or stent placement only. The overall outcome was similar after repair by laparotomy or by laparoscopy; the repair was uneventful in 52 (91.3%) of 57 women after treatment by laparoscopy versus 481 (90.4%) of 532 women after treatment by laparotomy. The delay of treatment did not make any difference in outcome.^{34,35}

Management of the ureteric injury

Iatrogenic ureteric trauma can result from various mechanisms such as ligation or kinking by a suture, crushing from a clamp, partial or complete transection, thermal injury, or ischemia from devascularization. Stenosis can be the consequence of obstruction' in the event of devascularization of the ureteral wall, a subsequent leak could develop.³⁶ A minor crush or needle injuries can be managed conservatively provided that the integrity and viability of the ureter have not been compromised and peristalsis and adequate perfusion are present with no urine leak.

Ureter stenting

Ureter stenting is a choice in ureter laceration. The recommended amount of time for which the ureter should be stented in such situations varies in the literature and ranges 2–6 weeks in case reports.^{26,28,36} Laceration is a partial opening of the ureter, and includes pinpoint defects and wider openings. For blind stenting (i.e., the uretic defect is < 2.5 cm) and for failure, laparotomic reimplantation has been used to repair ureter lacerations because suturing is too risky for possible stenosis. Png and Chapple³³ suggested that 49% of all ureteric perforations should be treated with 6 weeks of internal stenting; 89% of their patients showed no evidence of obstruction during a follow up lasting 1–20 years with an average of 8.5 years. Approximately 50% who had successful stenting ultimately required laparoscopic repair.

Laparotomy management

In the traditional laparotomy concept, an injury below the pelvic brim (i.e., the lower 3rd) is indicated for ureteroneocystostomy (i.e., reimplantation); and an injury above the pelvic brim is indicated for ureteroureterostomy (i.e., reanastomosis). In delayed ureteric reimplantation, the ureter distal to the lesion is often embedded in inflamed and fibrous tissue for which it is impossible to perform a reanastomosis of the ureter. The ureteroneocystostomy procedure with the Boari flap is the best choice for direct reimplantation.^{36,37} Reanastomosis may still be a realistic treatment option in the event of postoperatively detected iatrogenic lower ureteral injuries with the distal ureteral stumps preserved and identified on retrograde pyelography.³⁸ Reanastomosis has a higher complication rate.^{39,40} Challenges for pelvic reanastomosis in the open method are the technical difficulty in performing a precise dissect, and debriding the distal ureter stump; it is also time-consuming. Key points of pelvic reanastomosis include saving the blood supply of the ureter, a tension-free repair, debridement, and it is water-tight with a stent. In laparoscopic repair, reanastomosis can achieve these goals more easily and precisely. Uneventful outcome of stenting and laparoscopic repair of ureteral lesions in gynecological surgery has been reported by De Cicco et al.³⁵

Laparoscopic management

Achieving a tension-free, well vascularized, water-tight anastomosis is critical to the success of this ureteral reconstruction.⁴¹ The laparoscopic approach can provide better visualization and allow the performance of more delicate procedures. Seideman et al.⁴¹ report that 45 patients underwent successful laparoscopic ureteral reimplantation (53% with ureteroneocystostomy and 47% with the Boari flap), and low morbidity at intermediate term follow up (postoperative complications occurred in 2 of the 45 patients).

Simmons et al.⁴² compared laparoscopic ($n = 12$) and open ($n = 34$) ureteroureterostomy, ureteroneocystostomy, and Boari flap procedures that were performed from January 1999 to November 2005. The laparoscopic repair of benign ureteral stricture disease is effective and feasible. The open surgical group in comparison to the laparoscopic group had greater operative blood loss (258 mL vs. 86 mL, respectively; $p = 0.002$) and a longer hospital stay (median, 5 days vs. 3 days, respectively; $p = 0.001$). The overall complication rate in the open group and laparoscopic group was 15% and 8%, respectively ($p = 0.225$). Ureteral patency had been successfully reestablished in all 12 (100%) patients in the laparoscopic group at a mean follow up of 23 months. In the open group, patency was achieved in 30 (96%) patients at a mean follow up of 43 months. No significant difference was found in patency success ($p = 0.544$) or the duration of follow up ($p = 0.098$) between the two groups.⁴²

Conclusion

It is essential to diagnose ureteral injury as soon as possible to improve the surgical outcome of a repair. Every surgeon can incur an injury, even in the best experienced hands; hence, to reduce the morbidity of the ureteric injury, it is important to become familiar with the pelvic wall anatomy, which is the location that is most susceptible to injury, and have knowledge about the prevention and management of ureteric injury. Ureteric injuries during gynecological surgery may be primarily attributable to the urgent, abrupt, and stressful nature of the surgery with bleeding rather than other issues such as scar tissue from a previous surgery.

The management of ureteric injuries must depend on their nature, extent, location, patient's condition, and time of discovery.

All ureteric injuries that are discovered intraoperatively must be repaired at the same time, although it is usually overlooked because the symptoms are nonspecific. A delay in diagnosis can be treated with a similar surgical outcome as a direct repair performed at the same time of a surgical procedure. Laparoscopic ureteroureterostomy management should be the gold standard method of ureter repair, and ureterocystostomy should be the second choice if a primary reanastomosis is impossible.

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