Iatrogenic ureteric injuries: approaches to etiology and management

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Injury to the ureter is a risk of any pelvic or abdominal surgery, including laparoscopy and ureteroscopy. The morbidity associated with such injury may be serious, resulting in increased hospital stay, compromise of the original surgical outcome, secondary invasive interventions, reoperation, potential loss of renal function and deterioration of the patient's quality of life. Management of ureteric injuries, in conjunction with frank and open dialogue with the patient, can lead to an optimal outcome. For ureteral ligation, removal of the suture and assessment of ureteral viability are recommended, with surgical correction if necessary. For partial transection primary closure is suggested over stent placement. For uncomplicated upper- and middle-third ureteral injury ureteroureterostomy is the procedure of choice. For injuries above the pelvic brim several procedures are available: ureteroureterostomy, ureteroileal interposition and nephrectomy. For injuries below the pelvic brim ureteroneocystostomy is recommended with a psoas hitch or Boari bladder flap. To decrease the incidence of iatrogenic ureteral injury, a sound knowledge of abdominal and pelvic anatomy is the best prevention. If the proposed operation is likely to be close to the ureter, the ureter should be identified at the pelvic brim. If the dissection is likely to be difficult, preoperative intravenous pyelography and placement of a ureteral catheter may help in identifying and protecting the ureter.

Toute intervention chirurgicale dans la région pelvienne ou abdominale, y compris la laparoscopie et l'urétéroscopie, risque de provoquer une lésion de l'uretère. La morbidité associée à cette lésion peut être sérieuse, allonger le séjour à l'hôpital, compromettre le résultat original de l'intervention chirurgicale, obliger à pratiquer des interventions effractives secondaires, entraîner une nouvelle intervention, causer une perte de fonction rénale et détériorer la qualité de vie du patient. Conjuguée à un dialogue franc et ouvert avec le patient, la prise en charge des lésions à l'uretère peut déboucher sur un résultat optimal. Dans un cas de ligature de l'uretère, on recommande d'enlever la suture, d'évaluer la viabilité de l'uretère et de corriger chirurgicalement tout problème au besoin. Dans un cas de section partielle, on suggère une fermeture primaire plutôt que la mise en place d'un tuteur. Dans les cas de lésion sans complication aux tiers supérieur et intermédiaire de l'uretère, on privilégie l'urétéro-urétérostomie. Dans le cas des lésions au-dessus du bord pelvien, plusieurs interventions sont disponibles : urétéro-urétérostomie, interposition urétéro-iléale et néphrectomie. Dans celui des lésions au-dessous du bord pelvien, on recommande l'urétéro-urétérostomie avec arrimage du psoas ou lambeau vésiculaire de Boari. Afin de réduire l'incidence des lésions iatrogènes de l'uretère, une solide connaissance de l'anatomie abdominale et pelvienne constitue la meilleure prévention. Si l'intervention proposée risque de se dérouler à proximité de l'uretère, il faut identifier celle-ci au bord pelvien. Si la dissection risque d'être difficile, une pyélographie intraveineuse préopératoire et la mise en place d'une sonde urétérale peuvent aider à repérer et à protéger l'uretère.

Iatrogenic injury to the ureter is an inherent risk of any pelvic or abdominal surgery. Such an injury may cause serious morbidity that results in increased hospital stay, compromise of the original surgical outcome, secondary invasive interventions, reoperation, potential loss of renal function and significant deterioration of patient quality of life. Injuries include ligation, kinking by ligature, division, partial and complete laceration, crushing and devascularization, which are secondary to gynecologic, urologic, general surgical and vascular procedures. With the

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advent of laparoscopy and ureteroscopy in the mid-1980s, the incidence, cause and management of ureteric injuries have undergone significant changes.[1] Careful perioperative consideration, and attention to anatomic detail and anomalies of the urinary tract, can prevent many injuries.

Surgical injury to the urinary tract is most frequently reported as an obstetric complication or occurs after abdominal or vaginal hysterectomy for benign disease, radical hysterectomy for cervical malignancy, oophorectomy, bladder neck suspension or laparoscopy.[2] The rate of clinically apparent ureteral injuries ranges from 0.2% to 2.5% for routine gynecologic pelvic operation and 10% to 30% for radical procedures for malignant conditions.[3] Although injury to the ureter during laparoscopic procedures is uncommon, 38% of such injuries during laparosopy occur in the treatment of endometriosis.[4] During open pelvic operations, difficulty achieving hemostasis or attempted hemostasis without prior identification of the ureters is the most common precipitating factor.[2]

Often, iatrogenic ureteric injuries are a consequence of nonurologic procedures, usually occurring during gynecologic or general surgery. However, with the introduction of laparoscopy and ureteroscopy the pattern of these injuries has changed. Assimos, Patterson and Taylor[1] indicated that the incidence of urologic injuries increased from 4 to 23 per 10 000 between 1985 and 1989, with 7 of 10 injuries occurring during ureteroscopy.

The problem of ureteral injury during vascular surgery can be appreciated best by recognizing the intimacy of the vascular and urinary structures as they lie in the retroperitoneum, particularly in emergency situations when blood may obscure the operative field and time does not permit careful examination and dissection of all structures.

Presentation of ureteral injury

Most ureteral injuries are not noticed intraoperatively ("acutely diagnosed") but are diagnosed later. Injuries recognized intraoperatively must be treated immediately.[2] In gynecologic procedures, 70% of ureteral injuries present postoperatively.[2] Presenting symptoms and signs may include fever, nausea and vomiting, flank pain, abdominal pain, low back pain, ureterovaginal or ureterocutaneous fistulas, leukocytosis, hematuria, ileus, peritonitis and sepsis. An abdominal or pelvic mass secondary to a urinoma or an abscess may be the presenting feature. Late presentation may include hypertension secondary to obstructive uropathy. In a study by Meirow and associates,[5] the mean delay to diagnosis of 20 patients sustaining gynecologic ureteral injury during open operations was 5.6 days.

Diagnosis of ureteral injuries

Intraoperative

Ideally, a ureteral injury should be confirmed at the time it is suspected. In the past, intravenous administration of 5 to 10 mL of indigo carmine or methylene blue dye with 20 mg of furosemide would localize the injury and avert further dissection or mobilization that could compromise ureteral blood flow and healing.[2] At present, intraoperative intravenous urography is employed, using 60 mL of intravenous contrast medium and a 10-minute film to diagnose possible ureteral injury.[6] Ultimately, direct exploration may be the only way to make a definitive diagnosis. When exploring the ureter, the surgeon should identify the ureter anterior to the bifurcation of the iliac vessels and dissect distally to the area of concern. Another approach to rule out obstruction is to perform a ureterotomy and pass a ureteric catheter distally; a catheter that passes easily into the bladder indicates that there is no injury.

Postoperative

Regardless of presenting signs and symptoms, ureteral injuries identified postoperatively should be managed by a urologic surgeon. If ureterovaginal or ureterocutaneous fistula is a possibility, urinary urea nitrogen and creatinine levels should be measured. Urinary leakage is proven if these values exceed those of serum (usually more than 20 times).[7] Renal ultrasonography and computed tomography are noninvasive modalities that may reveal extrarenal or pelvic fluid collections; however, they cannot rule out ureteric injury.[2] Intravenous pyelography (IVP) and retrograde ureteropyelography are the standards to precisely identify the location and extent of injury, specifically obstruction or extravasation.[8] Occasionally, temporary percutaneous nephrostomy with contrast medium can be used to determine the site and the nature of an obstruction or a fistula.[9]

Principles of ureteral surgery for ureteral repair

In planning a surgical procedure to repair any injury to the ureter the initial step is to obtain as much information about the urinary system as necessary. Renal function should be assessed by urea nitrogen and creatinine measurements. Any history of urologic surgery or illness must be noted. Delineation of the full length of the ureter to be operated on can be accomplished by IVP, cystoscopy and retrograde ureteropyelography, and occasionally antegrade pyeloureterography, employing a percutaneous nephrostomy.

Operative techniques for ureteral repair

The major variables that guide a surgeon's approach to ureteric surgery are the time of diagnosis, and the severity and the level of the injury. Acutely diagnosed injuries require immediate surgical intervention.[2] Partial transection of the ureter may be managed by primary closure and stent placement if the tissue appears viable, although there is evidence to suggest a higher incidence of fistula and stricture formation associated with stent placement.[1–9] Ureteral ligation is best managed by removing the suture and assessing ureteral viability. Observation or endoscopic placement of a stent may suffice.[1] If the ureter is not viable or if the degree of injury is severe, then definitive surgical correction is warranted.

For uncomplicated upper- and middle-third ureteral injury, ureteroureterostomy is the operative procedure of choice.[10] The most common anastomotic technique is spatulation, using sutures of 4-0 or 5-0 absorbable suture material.[6] The anastomosis is carried out over a double-J stent. The stent serves to align the area of the anastomosis, provide a mould around which ureteral healing can occur, prevent extravasation by diverting the urine past the anastomosis and alleviate obstruction from postoperative edema.[8] The success rate for ureteroureterostomy is more than 90%.[11]

Other options for repair of ureteral injuries above the pelvic brim include transureteroureterostomy, ureteroileal interposition and nephrectomy.[2] A transureteroureterostomy, in which the proximal injured ureter is brought across the midline and anastomosed to the ureter on the other side, may be used in adults for reconstruction when ureteral length is insufficient for anastomosis to the bladder.[12] Success rates of up to 97% have been reported.[13] Nevertheless, many surgeons may be reluctant to subject an otherwise normal urinary tract on one side to possible injury and complication, especially when successful alternative treatments are available. For repair of extensive proximal ureteric injuries in which a defect cannot be bridged by other methods or in which the bladder is unsuitable for reconstruction, ileal interposition can be used with satisfactory results in selected patients.[14] Finally, when the opposite kidney is normal and the patient is too old or too ill to undergo reconstruction, nephrectomy may be appropriate.[6]

For injuries below the pelvic brim, ureteroneocystostomy is the method of choice, often coupled with a psoas hitch or Boari bladder flap, because the precarious nature of the vascular supply of the distal ureter does not allow for primary anastomosis.[1,2] The psoas hitch is indicated whenever a gap exists in the distal ureter that prevents direct reimplantation of the ureter into the bladder. This technique is simple and based on the fact that distortion of the bladder does not usually interfere with function and gains the surgeon 3 to 5 cm of additional ureteral length.[6] The success rate of ureteral reimplantation with a psoas hitch is more than 95% in both adults and children.[15] If the ureteral defect is larger, a Boari bladder flap will gain up to 15 cm of length, allowing a tension-free anastomosis.[16] Although the number of patients who have been treated with a Boari flap is small, the reported results are good when well-vascularized tissue is used.[14] Finally, renal descensus, by which the kidney is dissected free, displaced inferiorly and fixed to the iliac fossa, can be useful to gain enough length to bridge a gap or to decrease tension on a ureteral repair.[17]

Some patients with ureteral injuries diagnosed postoperatively may respond to endourologic therapy. If the injury is incomplete, an attempt can be made to place a double-J stent, in either a retrograde or an antegrade fashion, which may allow adequate healing without open repair. Dowling, Corriere and Sandler[18] reported a 73% success rate for percutaneous nephrostomy, with or without ureteral stenting, in 27 patients with iatrogenic ureteric injuries. Patients in whom endourologic therapy fails or who are not candidates for this approach on the basis of the extent of injury (i.e., complete transection) require open repair by a technique previ-

Table I

Outcomes of Canadian Medical Protective Association Litigation, 1985 to Present

Outcomes	No. of cases
Complaint dismissal	20
Out-of-court settlement	18
Judgement in favour of defendant	3
Judgement in favour of plaintiff	1
Total	42

Source: Canadian Medical Protective Association

Table II

Procedures During Which Iatrogenic Ureteric Injury Occurred That Progressed to Litigation, 1985 To Present

Procedure	No. of cases
Abdominal hysterectomy	19
Vaginal hysterectomy	5
Oophorectomy	8
Abdominal perineal resection	1
Bladder neck suspension	1
Cesarean section	2
Ureteral calculi surgery	4
Vascular	1
Laparoscopy for treatment of endometriosis	1
Total	42

Source: Canadian Medical Protective Association

ously mentioned.[1] In the majority of patients, open repair in the early postoperative period is definitive, despite the presence of postoperative inflammation.[19] In some patients with significant infection, percutaneous nephrostomy drainage for temporary urinary diversion, followed by delayed reconstruction, may be appropriate.[18]

Litigation and ureteral injury

Most ureteric injuries do not proceed to litigation. To avoid litigation, a frank and open discussion with the patient is always the best approach when injuries to the ureter occur. Assimos, Patterson and Taylor[1] reported an overall incidence of ureteral injuries of 11 per 10 000 in one series for 1989. Statistics on litigation from the Canadian Medical Protective Association for 1985 to the present are provided in Tables I and II.

Prevention of ureteral injury

Ureteral injuries can cause serious morbidity, resulting in a complicated postoperative course, compromise of the final surgical outcome and reoperation, and could cause permanent patient disability. Preoperative IVP has never reduced the incidence of ureteral injury in gynecologic surgery, nor has the placement of ureteral catheters preoperatively been an effective method of avoiding ureteral injury.[20–23] However, if a difficult dissection is anticipated and there exists a real risk of ureteral injury, preoperative IVP and placement of ureteral catheters may facilitate the surgeon's identification and protection of the ureter. A sound knowledge of abdominal and pelvic anatomy is most important in the prevention of iatrogenic injury to the ureter. Should the operative field be close to the ureteral path, the ureter should be identified at the pelvic brim, as it crosses the iliac vessels, and the ureteric course can be determined and subsequent injury thus prevented.[22,24]

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