

Prevention and management of ureteric injuries

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Ureteric injury is one of the most serious complications of gynaecological surgery with important medico-legal considerations. This review is aimed at understanding the anatomy of the ureter, sites of ureteric injuries, types and causes of injury, simple preventive measures and management.

The incidence of ureteric injury varies from 0.42–5.00% in benign conditions (Drake et al, 1998), but it can be as high as 30% for operation for malignancies (Elabd et al, 1997). The ureter is vulnerable because of its proximity to the female genital tract and can be injured during gynaecological operations (abdominal, vaginal or laparoscopic). It can also be involved in the gynaecological disease process and deviated from its normal course because of disease.

One third of ureteric injuries are diagnosed intra-operatively. Late diagnosis can be serious leading to severe morbidity and loss of renal function. The focus of this article is on ways to prevent ureteric injuries, and, in cases of inadvertent injuries, how the surgeon should manage the complications.

ANATOMY OF THE URETERS

Familiarity with the courses of the ureters is of utmost importance to every gynaecological surgeon. Each ureter is about 25–30 cm in length and traverses retroperitoneally from the renal pelvis to the bladder. The two main components, abdominal and pelvic ureters are almost equal in length. The abdominal portion lies on the anterior surface of the psoas muscle, descending posterolaterally as they cross over the iliac vessels to the pelvic inlet. They are crossed anteriorly by the ovarian vessels as they approach the pelvis.

Within the pelvis each ureter lies in the loose areolar tissue, on the lateral wall close to the internal iliac artery in front of the sacroiliac joint. It can be visualized beneath the peritoneum throughout its course, along the lateral wall of the true pelvis. The ureter passes beneath the uterine artery about 1.5 cm lateral

to the cervix at the level of the internal os. It passes medially over the anterior vaginal fornix before entering the wall of the bladder, just above the trigone.

The ureter receives its blood supply from multiple sources, which gives it preferential healing capabilities following injury. Care must be taken during dissection to prevent injury to the blood supply. As the blood supply to the upper and middle portion is from its medial side, ureteric exploration is best done from the lateral margin, whereas the blood supply to the pelvic ureter is principally from the lateral side, therefore dissection should be along its medial side.

SITES AND CAUSES OF URETERIC INJURY

Ureteric injury is mostly unilateral, 5–10% of cases being reported as bilateral. Some studies, have shown a predominance of left sided injuries (Mattingly et al, 1978; Blandy et al, 1991); however, as Sampson mentioned in 1904, even in the absence of pathology, injury to either ureter is just as common.

The ureters are most likely to be injured at the following sites in the pelvis:

- At the pelvic brim during ligation of the infundibulopelvic ligaments, as the ureter lies beneath the insertion of the ligament
- At the base of the broad ligament, where the ureter passes beneath the uterine artery
- Beyond the uterine vessels as the ureter passes through its tunnel in the cardinal ligament at the level of the internal cervical os
- At the anterolateral fornix of the vagina as the ureter enters the bladder, i.e. the intramural portion near the insertion into the trigone

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- Along the lateral pelvic sidewall just above the uterosacral ligament
- Over the iliac vessels on the pelvic sidewall during lymph node dissection.

Opinions vary as to the most common site of ureteric injury whether it is proximal at the pelvic brim or in the distal ureter during ligation of the uterine arteries (Mattingly et al, 1978; Te Linde et al, 1997). The consensus is that distal ureteric injury is more common but, as already mentioned, the ureter can be injured at any location in a number of different ways, as described below.

Intra-operative injury to the ureter may result from ligation with a suture, crushing because of misapplication of a clamp, electrical, thermal or laser energy, and from the application of a linear stapler during laparoscopic surgery. Any of these injuries can result in partial or complete transections. Angulation with secondary obstruction (partial or complete) has also been reported. Ischemia with avascular necrosis occurs when periureteric tissues carrying the blood supply has been stripped or diathermized.

What are the risk factors associated with ureteric injury?

Although no identifiable risk factors are found in most patients, any condition disrupting the normal anatomy of the ureter increases the likelihood of injury. For example, large ovarian masses, fibroid uterus, endometriosis, pelvic

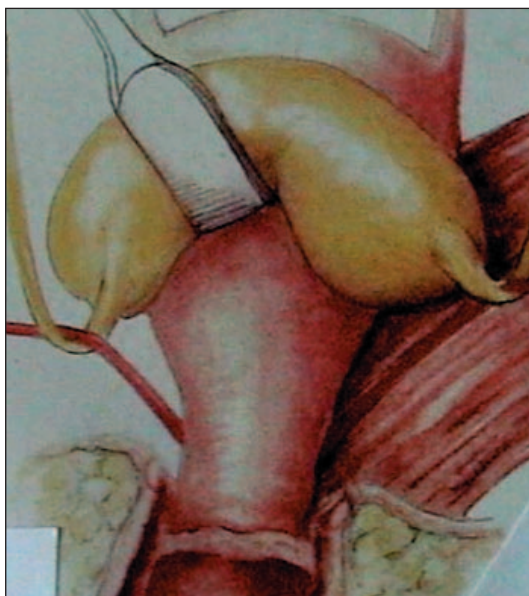


Figure 1. The ureter (in yellow) being crossed by the uterine artery (in red), the classic 'water under the bridge' description', showing the need to develop adequate vesico-uterine space during vaginal hysterectomy owing to the closeness of the ureters

inflammatory disease, previous pelvic surgery, history of pelvic irradiation, pelvic malignancies, congenital abnormalities (ureteric duplication, megaureter, and ectopic ureter/kidney).

Two large retrospective studies (Goodno, 1995; Liapis et al, 2001) reviewed the incidence of ureteric injuries and its associated risk factors. Pelvic malignancies were present in 44% of the cases with ureteric injury. It is noteworthy that almost half of all the injuries had no identifiable risk factors and occurred in the so-called 'simple' hysterectomy (Goodno et al, 1995).

PREVENTION OF URETERIC INJURY

Primary prevention

Primary prevention, i.e. prevention of injury before it occurs, is most important. It should not be difficult provided the gynaecologist understands the anatomy of the ureter along with its involvement in the disease process and the surgery.

Firstly, prevention begins preoperatively with a careful evaluation of the patient's gynaecological disease and recognition of the risk to the ureter with the planned surgical procedure. Secondly, by using the skills described in the following sections, most ureteric injuries can be prevented, although a very skilful surgeon can still inadvertently injure the ureter, albeit on rare occasions.

In abdomino-pelvic surgery, an adequate incision must be made for exposure of important structures in the pelvis and, if in any doubt, the ureters should be traced before clamping the tissues. Blind clamping should be avoided. Adequate mobilization of the bladder and the use of the intrafascial technique for hysterectomy in benign pelvic disease are useful techniques to avoid injury (Sakellariou et al, 2002). Ureters should be clearly identified in the pelvis particularly in areas where they are most susceptible to injury, which can be extremely difficult in endometriosis, pelvic inflammatory disease, and with broad ligament/cervical fibroids.

During vaginal hysterectomy, adequate vesico-uterine space should be developed to protect the ureters from surgical clamps and sutures. This is achieved by downward traction on the cervix and counter traction upward beneath the bladder (*Figure 1*). The surgeon should clamp, cut and ligate only small bites of paracervical and parametrial tissue adjacent to the uterus. Sutures should be placed carefully in the uterosacral ligament during posterior culdoplasty to avoid a kink or obstruction of the ureter. In anterior colporrhaphy, placing sutures

too deeply or too laterally during plication of the bladder should be avoided, because the distance between the surgeon's needle and the ureter in the upper third of the vagina during anterior colporrhaphy is only about 0.9 cm, as shown by Hoffmeister (1982) using fluoroscopic imaging.

In laparoscopic surgery, if the ureter cannot be visualized, retroperitoneal dissection to locate the ureter will help to decrease the incidence of injuries. Electrocoagulation of the bleeding points around the uterosacral ligament should be avoided and better controlled by sutures or clips. In laparoscopic assisted vaginal hysterectomy, application of staples across the uterine artery and cardinal ligaments can be difficult and are better ligated vaginally.

Aids to primary prevention

Ureteric stent

The benefit of inserting a ureteric stent before surgery is still debated by many authors. In a retrospective study by Kuno et al (1998), prophylactic ureteric catheterization was not found to statistically affect the rate of injury. Bothwell et al (1994) found a 1% risk of iatrogenic injury to the ureter and concluded that, although catheters do not decrease the incidence, they may be of help in the intra-operative detection of ureteric injury. Lighted ureteric stents have become popular in advanced laparoscopic surgery but are of limited value in the presence of masses and dense adhesions (Low et al, 1993).

Imaging

Preoperative imaging in the form of intravenous pyelography (IVP) or contrast enhanced computed tomography (CT) scan has been advocated by some authors especially where distortion of the anatomy or previous urinary tract compromise is suspected.

In a retrospective study of hysterectomy for benign diseases by Piscitelli et al (1987), the incidence of ureteric injury did not vary in the IVP and the non-IVP group. Abnormal IVP findings were associated with uterine size of 12 weeks or greater, and adnexal mass of 4 cm or more. Endometriosis, pelvic inflammatory disease, uterovaginal prolapse and previous intra-abdominal surgery were not associated with an increased prevalence of abnormal findings, therefore limiting the use of such techniques. Despite this, many surgeons still feel that a preoperative knowledge of the lower urinary tract anatomy in selected cases help to avoid injuries.

Secondary prevention

Secondary prevention involves recognition of the injury intraoperatively, with immediate repair which can help in reduction of serious post-operative morbidity and loss of renal function. It is important to keep in mind the timeless statement of Higgins (1967): 'the venial sin is injury to the ureter, the mortal sin is failure of recognition'.

DIAGNOSIS

Intra-operative

Only one third of ureteric injuries are recognized intra-operatively. Any suspicion of injury should be clarified, with evaluation of the nature and severity of the injury and dealt with intra-operatively. Presence of peristalsis does not always guarantee full viability as avascular necrosis may become evident later. Intravenous fluorescein and Woods lamp can be used if devascularization is suspected (Drake et al, 1998). The proximal ureter may be dilated in case of distal obstruction. Dye test with intravenous phenazopyridine hydrochloride (pyridium), indigo carmine or methylene blue can be used to identify the location of injury.

There is no consensus whether cystoscopy should be performed after all gynaecological surgery. In a review article by Gilmour et al (1999), the incidence of ureteric injury was found to be higher in eight studies with routine intra-operative cystoscopy with or without dye test. Up to 90% of the injuries were detected and treated successfully. Cystoscopy has the disadvantage of increased operating time with extra training and skill also required. It does not guarantee recognition of all ureteric injuries, because non-obstructive, partially obstructive or late injuries, secondary to

TABLE 1.
CLINICAL PRESENTATIONS OF
URETETIC INJURIES

Symptom	Time of presentation
Fever	0–21 days
Loin or flank pain	0–21 days
Adynamic ileus	0–7 days
Peritonitis/ascites	0–7 days
Lower abdominal/pelvic mass	21–42 days
Fistulas	0–30 days
Anuria	< 24 hours
Asymptomatic (7%)	Incidental finding

ischaemia or avascular necrosis, can be missed. It is justified along with a dye test whenever there is any concern of ureteric damage.

Postoperative

The remaining two thirds of ureteric injuries are diagnosed post-operatively. A high degree of suspicion is necessary for early diagnosis, as unilateral injury can easily be missed. The clinical presentations are listed in *Table 1*.

Fever and loin pain are common presentations. The loin or flank pain is caused by hydronephrosis. Some patients present with urinary ascites, swinging pyrexia and adynamic ileus or peritonitis. Urinomas can also develop with abdominal distension, or fistula may arise later on. In addition, unilateral injury can be asymptomatic. Anuria develops in cases of bilateral ureteric obstruction.

Investigations

The main diagnostic investigations are ultrasound examination of the abdomen/pelvis and intravenous urography. Retrograde and antegrade ureterogram/nephrostogram (*Figure 2*), CT scanning with or without contrast, double



Figure 2. Nephrostogram (PA view) showing dye in the nephrostomy tube and the right ureter down to the pelvic brim (at the level of the sacroiliac joint, junction of the middle and distal third of the ureter) but not beyond.

dye test and cystoscopy are also helpful. In selected cases, analysis of fluid from drains, cyst or ascitic wound collection shows presence of urine. Full blood count, urea and electrolytes might show some abnormality.

MANAGEMENT

The aim of management is preservation of renal function and restoration of anatomical continuity. The approach to ureteric repair depends on the cause, location/extent, and the time the injury is recognized.

Intra-operative period

Minor and major injuries diagnosed intra-operatively are managed according to the algorithm in *Figure 3*, with over 90% cure rate. Ureteric stent may be sufficient in case of crush injury with minimal trauma. When the trauma is more extensive, because of the risk of devascularization, the area involved is better excised and anastomosis or reimplantation of the ureter performed. Ureteric stent is usually removed after 3–6 weeks (*Figure 4*), followed by an IVP to confirm ureteric patency.

Postoperative period

The management remains slightly controversial when ureteric injury is diagnosed post-operatively. The two decisions required are early versus late intervention and minimally invasive versus open surgical repair (Aslan et al, 1999).

Minor injuries can be managed by antegrade or retrograde stent placement, which was successfully achieved in about one third of cases in different studies (Elabd et al, 1997; Sakellariou et al, 2002). Successful endoscopic management using stenting with or without balloon dilatation requires minimal loss of ureteric segment (less than 2 cm for strictures), some continuity of the ureteric wall and early intervention (within 4 weeks) after the injury to achieve a cure rate of up to 88%.

In cases of major injuries the principles guiding ureteric repair are detailed in the flow chart (*Figure 3*). For most major injuries, a nephrostomy tube is commonly inserted while awaiting definitive surgery in order to preserve renal function. When minimal invasive treatment fails, open repair is necessary after an interval, once the inflammation has subsided. In ureterovaginal or uretero-uterine fistulas, stent placement with continuous bladder drainage for up to 6 weeks may be sufficient to allow healing (Chang et al, 1987).

Occasionally, a fistula may stop draining spontaneously which may be caused by forma-

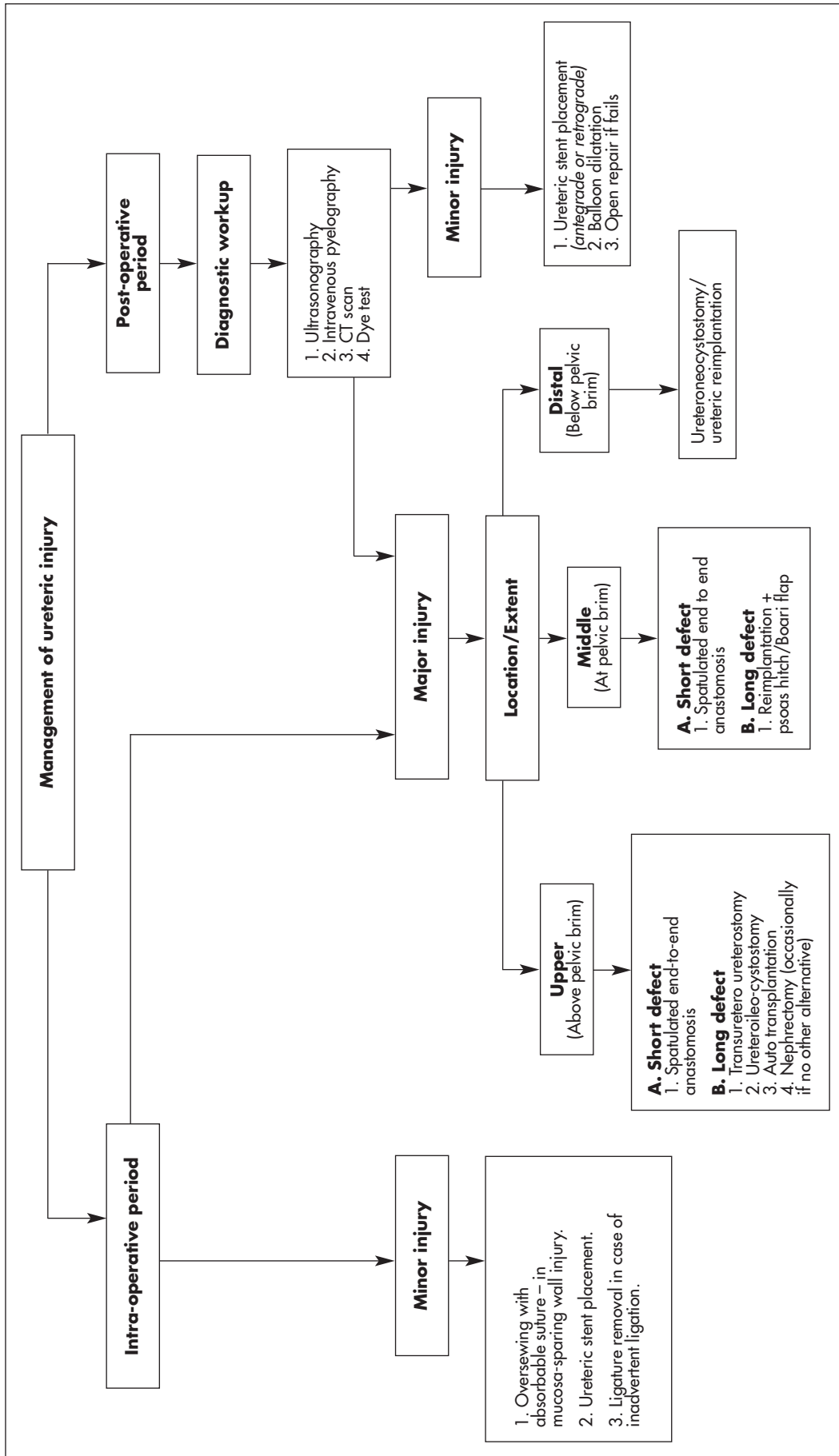


Figure 3. Flow chart detailing management of ureteric injuries.

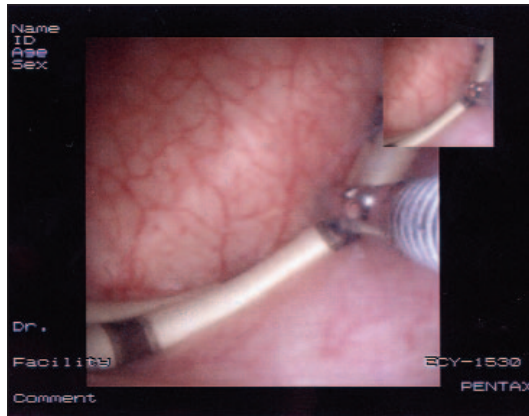


Figure 4. Ureteric stent being removed by flexible cystoscopy.

tion of stricture rather than healing. This needs immediate attention to preserve renal function. All patients will need regular clinical and radiological follow-up as ureteric stricture can sometimes develop even after a year following repair.

MEDICO-LEGAL

Over the years the medico-legal aspect of ureteric injuries has increasingly become a major area of concern. Brudenell (1996) reported a number of cases in which the legal view was of negligence on the part of the gynaecologist involved, with payment of considerable amount of compensations. The common finding in these cases was that the anatomical knowledge of the ureter and the possible variations from its normal course is of utmost importance during surgery.

CONCLUSIONS

Iatrogenic injury to the ureter may complicate any gynaecological operation (abdominopelvic, vaginal or laparoscopic). Careful planning for any surgery is necessary with analysis of the

KEY POINTS

- Anatomy of the ureters and the areas where the ureter is susceptible to injuries should be kept in mind during every surgery performed.
- Ureters may be deviated from their normal course during a disease process or from congenital abnormality.
- Studies of pre-operative intravenous pyelography (IVP) or intra-operative ureteric stent have not shown any significant differences in the incidence of injury.
- High degree of suspicion and early investigation is essential for early diagnosis.
- Early treatment can reduce morbidity of the patient and save kidney function.
- The type of treatment and timing should be individualised; there is a place for endoscopic management and early repair.

associated risk factors to prevent such injury. Early diagnosis and treatment is important to save renal function and decrease morbidity.

Intra-operative suspicion of injury should be investigated and treated with expert help. Once diagnosis is made post-operatively, depending on the type, site and duration of injury, treatment should be planned accordingly. There is a place for conservative management and most surgeons prefer early repair. Long-term follow up is necessary to detect late complications. **HM**

Conflict of interest: None

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