Urological complications following gynaecological surgery

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Abstract

Iatrogenic urological injuries during gynaecological surgery can have devastating consequences and significant long-term sequelae. Timely recognition of injury and appropriate investigation and treatment, whether in the acute or delayed setting, are vital in reducing the potential impact of subsequent complications to both patient and doctor. In this review, we will describe the aetiology, diagnosis and management of ureteric, bladder and urethral injuries in both the acute and delayed setting, with a special focus on urogenital fistulas in women in order to facilitate a better understanding of what can be done to minimize iatrogenic injury to the urinary tract and the optimal management of these complications when they do occur.

Keywords iatrogenic disease; intraoperative complications; urinary fistula; vaginal fistula

Introduction

Iatrogenic injury to the urinary tract is a potential complication of all surgical procedures performed in or around the retroperitoneum and the pelvis. Gynaecological surgery in particular carries an inherent risk of such damage due to the anatomical proximity of the urinary and reproductive tracts in women. This, coupled with expansion of laparoscopic and robotic surgery, has widened the range of causes of iatrogenic injury. Doctors involved in surgery with inadvertent iatrogenic urinary tract injury may experience significant financial and personal costs consequent to high litigation rates. Timely recognition of injury and appropriate investigation and treatment, whether in the acute or delayed setting, are paramount in reducing the potential impact of subsequent complications to both patient and surgeon.

In this review, we will describe the aetiology, diagnosis and management of ureteric, bladder and urethral injuries in both the acute and delayed setting, with a special focus on urogenital fistulas in women in order to facilitate a better understanding of what can be done to minimize iatrogenic injury to the urinary tract and the optimal management of these complications when they do occur.

Ureteric injury

Due to their close proximity to vital abdominal and pelvic organs, the ureters are highly susceptible to iatrogenic injury in any abdomino-pelvic surgical procedure, whether gynaecological, obstetric, general surgical or urologic. Iatrogenic ureteric trauma is the most common cause of ureteric injury, comprising an estimated 75% of cases. Early recognition is vital as a mismanaged or unrecognized ureteric injury may lead to significant complications including abscess, urinoma, ureteric stricture, urinary fistula, and renal loss.

Incidence

Gynaecological surgical procedures are the commonest cause of iatrogenic ureteric injury and usually produce damage to the lower third of the ureter. Since the inception of laparoscopic surgery in the 1960s and robotic surgery in the 1990s, the incidence of ureteric injuries has risen. The incidence of ureteric injury has been estimated at 0.03–2% after abdominal hysterectomy, 0.02–0.5% after vaginal hysterectomy, 0.02–0.6% after laparoscopic-assisted vaginal hysterectomy, and 1.7–3% after urogynaecological surgery. There remains a paucity of data regarding ureteric injury rates following robotic assisted surgery. In contrast to open surgery, in which at least one third of ureteric injuries are recognized immediately, far fewer injuries are immediately identified at laparoscopy. Therefore, a high index of suspicion, particularly during laparoscopic or robotic surgery, is very important.

Aetiology

Iatrogenic ureteric injury can result from a wide variety of mechanisms including ligation or kinking with a suture, sharp incision and transection (partial or complete), crushing from a clamp, thermal injury, or ischaemia from devascularisation.

Risk factors

Risk factors for ureteric injury include both patient and surgical factors. The distal ureter is intimately related to the female genital tract throughout its course in the pelvis. It enters the pelvis, crossing over the iliac vessels and descends in close proximity to the ovary on the pelvic sidewall. In the deep pelvis, it passes under the uterine artery, then lies approximately 1 cm lateral to the uterosacral ligament and then passes just lateral to the cervix and fornix of the vagina.

Patient risk factors are any that obscure tissue planes, distort pelvic anatomy and reduce visualization of urinary tract structures. These risk factors include; obesity, pelvic irradiation, urinary tract abnormalities (e.g. duplex kidney) (Figure 1), prior pelvic surgery, endometriosis, large pelvic mass or uterus and fibroids.

Surgery for malignancy, laparoscopic hysterectomy and advanced pelvic reconstructive surgery also confer higher rates of ureteric injury. Some studies have postulated that increased experience of the surgeon correlates with a decreased frequency of ureteric injury.

It is important to note that ureteric injuries resulting from gynaecological surgery often occur in patients with no identifiable risk factors and in cases that surgeons describe as routine and uncomplicated, and where pelvic anatomy was normal.

Prevention

Avoidance of ureteric injury is dependent on detailed anatomical knowledge. During oophorectomy or hysterectomy the ureter is

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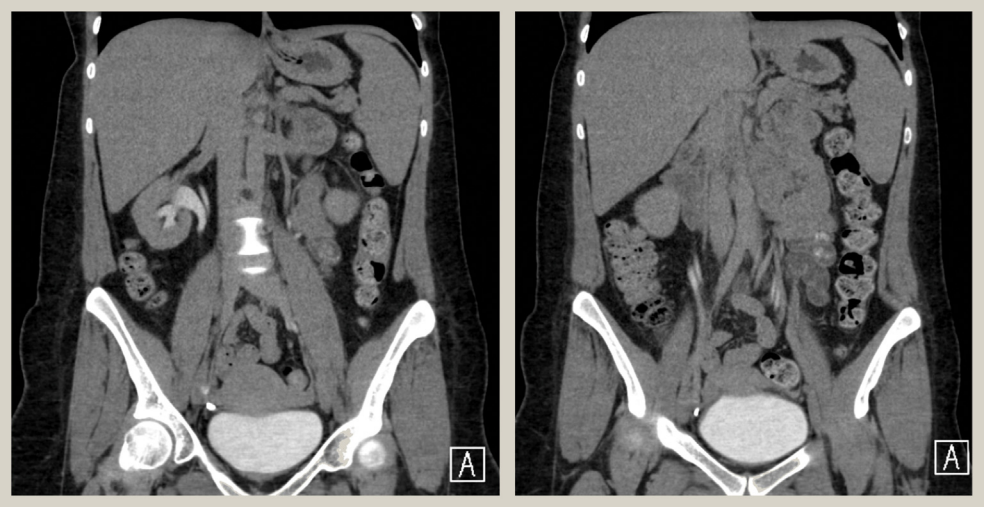

Figure 1 Sequential coronal CT images of patient with bilateral duplex collecting systems.

most likely to be injured during: ligation of the uterine vessels, ligation of the ovarian vessels and closure of the vaginal cuff angles. Generous exposure, careful tissue handling and an understanding of all potential anatomical variations are paramount.

While routine prophylactic placement of ureteric stents may not ensure injury prevention and is not cost effective for all cases it may be useful in cases where pelvic anatomy is obscured or distorted, such as a large pelvic tumour or excision of severe endometriosis. Stents also help to identify a ureteric injury when it does occur.

Cystoscopy after intravenous administration of indigo carmine or methylene blue has been advocated to ensure ureteric integrity via the absence of haematuria and the presence of bilateral ureteric jets. Reports on its benefit are mixed with one study suggesting it missed more injuries than it detected and another claiming that it increased detection rates from 30 to 96%. It is not currently a cost effective strategy although it has been estimated to become cost saving in benign gynaecologic operations at about a threshold iatrogenic ureteric injury rate of 1.5–2%.

Diagnosis

A high index of clinical suspicion is essential to diagnose these injuries. While some are diagnosed intraoperatively, the diagnosis in the majority - up to 80% - is delayed. It is postulated that this may be due to several factors including difficulty visualizing the retroperitoneal ureter and delayed thermal damage which initially appears normal on direct visualization or cystoscopic evaluation.

The presentation of ureteric injuries after gynaecological surgery is time and aetiology dependent. Initial symptoms may be subtle and presentation may be delayed for up to two years following surgery. In very delayed presentations, ureteric injury may not be recognized until an obvious fistula or stricture has been established. During the first few weeks after gynaecological surgery, signs and symptoms that should prompt evaluation for ureteric injury include: unilateral or bilateral flank pain, haematuria/oliguria/anuria, leakage of urine from the vagina or abdominal incision, nausea with or without vomiting, ileus, fever and/or abdominal pain or distension.

Patients who present weeks, months or even years later may present with flank pain or sepsis consequent to the development of a ureteric stricture or with vaginal leakage consequent to the formation of a ureterovaginal fistula. Patients may also present with deteriorating renal function. In one series examining insurance claims following ureteric injury in gynaecological and obstetric surgery 34/136 patients developed chronic kidney dysfunction of the ipsilateral kidney, 22 of whom had no remaining function in the affected kidney. Nephrectomy was necessary in 12 out of whom 7 had their ureteric injury diagnosed more than a month after their original operation.

CT urography is generally the diagnostic imaging modality of choice, and is useful in ruling out any additional concomitant injuries. Absence of contrast material in the distal ureter on delayed CT images is diagnostic of a complete ureteric transection. Other CT signs of missed ureteric injuries include localized fluid collections (urinoma), ascites, hydronephrosis and contrast medium extravasation. If an ureterovaginal fistula is large and well established, the upper tracts may appear completely normal but urine may be seen opacifying the vagina before the post void image (Figure 2).

A dye test may be of some value in differentiating between a ureterovaginal and vesicovaginal fistula if there is concern re ongoing urinary leakage (see below). A cystogram may also be useful to exclude a concomitant vesicovaginal fistula (VVF), but it generally will not demonstrate a ureterovaginal fistula unless there is preexisting vesicoureteric reflux. In more delayed presentations a radio-labelled isotope scan such as a technetium-99m labeled MAG3 or DTPA renogram may be useful to determine the degree of renal obstruction and the split function of each kidney.

Placement of a percutaneous nephrostomy with antegrade nephrostogram (Figure 3) or cystoscopy and retrograde studies are generally considered the gold standard of diagnosis. They may also facilitate concomitant stent placement as outlined below.

Management

Management of iatrogenic ureteric injuries is dependent on the nature and location of the injury and on the timing of its

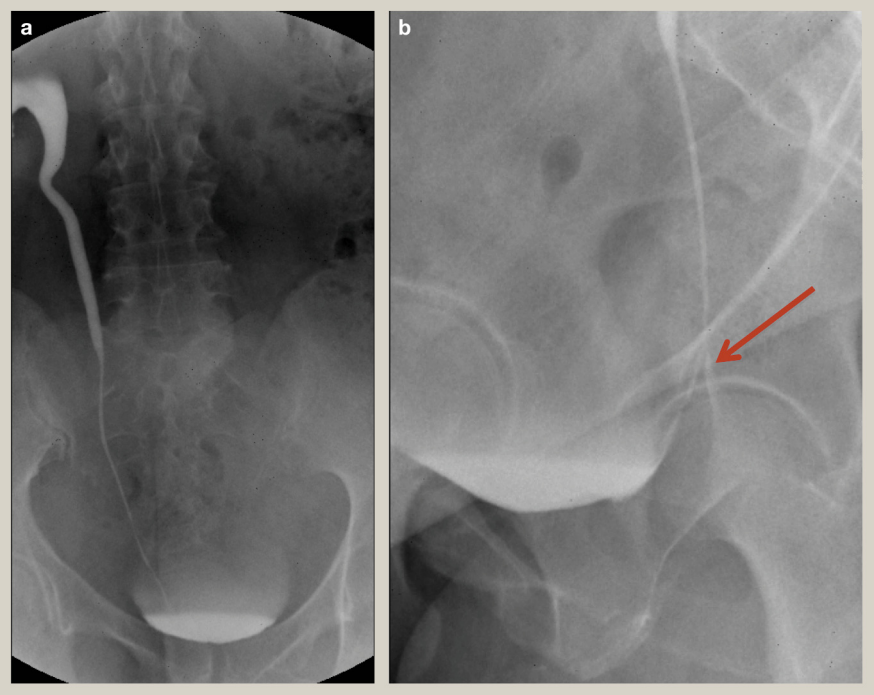

Figure 2 Antegrade nephrostogram images demonstrating essentially normal upper tracts but extravasation of contrast from the ureter into the vagina on the lateral view (image 2).

recognition. If suspected intraoperatively, consultation with an appropriately skilled urologist is necessary if the operating surgeon is inexperienced with stent placement or with primary or advanced ureteric repair.

Generally, if an injury is recognized early during an open, laparoscopic or robotic procedure, it should be repaired at the same sitting. Immediate diagnosis of ligation injuries can be managed by de-ligation and stent placement. Intraoperative stent placement may be sufficient, particularly for partial or suspected thermal injuries. If this is not possible, primary repair (e.g. ureteroureterostomy, ureteroneocystostomy) may be attempted if minimal tissue loss. When more extensive damage is present, or in the case of delayed diagnosis, more advanced surgical repair in the form of a psoas hitch, Boari flap, autotransplantation, bowel interposition or nephrectomy may be required.

The approach for patients with a delayed recognition of a ureteric injury is controversial, with some advocating stent placement (either antegrade or retrograde) or urinary diversion with a percutaneous nephrostomy as a first line treatment, while others perform a primary repair as soon as possible. Endoscopic realignment utilizing one or more stents for complete ureteric transections has been used with success in the immediate post-operative period (2–6 days after surgery). Endoscopic treatment of small ureterovaginal fistulae and strictures is effective and safe in selected cases, but deferred surgical repair is often necessary based on location and the degree of injury.

Bladder injury

The bladder is the most frequently injured organ during gynaecological surgery. While a significant amount of bladder lacerations are recognized and repaired intraoperatively, delayed recognition of bladder injuries can have devastating consequences, most notably with the occurrence of vesicovaginal fistulae (VVF) and more rarely, vesicouterine fistulae.

Incidence and aetiology

Urologists themselves are responsible for a significant amount of these bladder injuries with rates of bladder perforation during transurethral resection of bladder tumours reported to be as high as 58% in one case series. The European Association of Urology Guidelines on Iatrogenic Trauma have compiled the reported incidence of bladder perforation during various procedures and these are detailed in Table 1 below.

It is more difficult to determine the actual incidence of VVF, with the WHO estimating that there are more than 130,000 new cases of obstetric genitourinary fistula each year globally and that 2 million women currently live with untreated fistulae in sub-Saharan Africa and Asia. In well-resourced countries, most fistulae occur after hysterectomy for benign disease. In the United Kingdom, one study described an incidence of VVF of 0.12% following all types of hysterectomy. One large systematic review described 2055 urogenital fistulae occurring in industrialised countries. They found that 46.2% were associated with simple abdominal hysterectomy and hysterectomy by any route was implicated in 62.7% of all fistulae and 75.4% of the 1710 fistulae resulting from surgery.

Aetiology

Bladder injuries during gynaecological surgery generally occur due to direct injury during surgery and are often recognized at the time or in the immediate post-operative period. Unrecognised cystostomy near the vaginal cuff intraoperatively during a hysterectomy may result in formation of a pelvic urinoma, with

Figure 3 Antegrade nephrostogram demonstrating tapering of distal right ureter consistent with right ureteric stricture posthysterectomy.

Incidence of bladder perforation during various procedures

Procedure	%
Caesarean delivery	0.0016–0.94
Laparoscopic sterilization	0.02
Diagnostic laparoscopy	0.01
Laparoscopic hysterectomy (benign)	0.5–2.0
Vaginal hysterectomy (benign)	0.44–6.3
Abdominal hysterectomy (benign)	0.73–2.5
Laparoscopic sacrocolpopexy	1.9
Burch colposuspension	1.0–1.2
Synthetic midurethral slings (all)	6.0–6.6
• Transobturator route	0–2.4
• Retropubic route	3.2–8.5
Pubovaginal sling	2.8
Transvaginal mesh surgery	1.5–3.5
Anterior colporrhaphy	0.5

Table 1

ultimate drainage out through the vaginal cuff and potential fistula formation. As with the ureter, more subtle causes of bladder injury may include thermal, clamp or crush injury or suture placement through the bladder. This may occur particularly following hysterectomy if there is a suture placed through both the bladder and vaginal wall during closure of the vaginal cuff or an attempt to control pelvic bleeding by suture ligation. The blood supply may be compromised to the affected tissue with subsequent necrosis and eventual tissue breakdown.

Risk factors

Any scenario in which there is reduced exposure or visibility in the pelvis such as is the case with large pelvic masses, obesity, haemorrhage or malignant disease can increase the risk of iatrogenic bladder injury. Risk factors for bladder injury at the time of open or laparoscopic hysterectomy include previous laparotomy or Caesarean section, endometriosis, malignancy and concomitant anti-incontinence of pelvic organ prolapse surgery.

Diagnosis

As with ureteric injuries, a high index of suspicion must be maintained at all times. Intra-operatively suggestive signs of bladder injury on direct inspection include extravasation of urine, visible bladder laceration, appearance of the bladder catheter, clear fluid in the surgical field, and blood and/or gas in the urine bag during laparoscopy. Intra-operative cystoscopy may aid in confirmation of injury and also facilitate inspection of the integrity of the ureteric orifices.

Signs of bladder injury in the post-operative period may include haematuria, oliguria, sepsis, urinary leakage from the wound, increasing serum creatinine, lower abdominal pain, ileus or peritonitis. CT cystography is the gold standard for diagnosis and for evaluating differential diagnosis of other causes of abdominal pain (Figure 4). Cystoscopy may directly visualize perforation and assess integrity of the ureteric orifices.

VVFs generally present with constant painless urinary drainage per vagina after urethral catheter removal or 1–3 weeks later. It is important to rule out other causes of incontinence, particularly if the patient presents weeks or months after the initial insult. Vaginal examination is paramount. Recently formed fistulae may appear as a small erythematous area of granulation tissue or a visible hole. In women with post hysterectomy fistula, the fistula is typically located in the upper third of the vagina or at the vaginal cuff as can be seen in Figure 5.

Although urine leakage may be seen during clinical examination, particularly with a larger fistula, smaller fistulae can be more difficult to appreciate and an examination under anaesthesia (EUA), dye test and cystoscopy is appropriate. Classically a three swab dye test is performed with the patient awake or at the time of cystoscopy and EUA. Methylene blue or indigo carmine is instilled into the bladder via a catheter or cystoscope and three clean pieces of gauze placed in the vagina. Blue staining on the swab closest to the vaginal apex indicates a VVF, whereas a swab, which is damp with clear fluid, may indicate a ureterovaginal fistula. If the swab closest to the introitus is stained blue, this may indicate inadvertent staining from the examiner's gloves, urethral overflow or an urethrovaginal fistula.

Cystoscopy allows for assessment of the bladder for residual injury and fistula detection. It also allows characterization of the

Figure 4 CT urogram demonstrating normal upper tracts and vesicovaginal fistula.

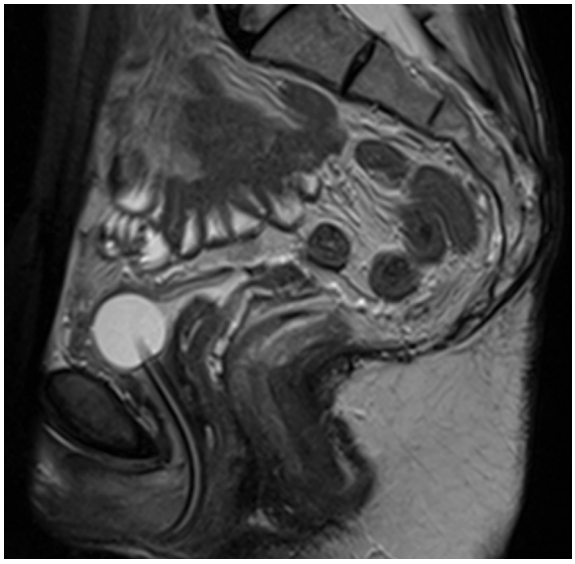

Figure 5 Status posthysterectomy is noted. A wide fistula is apparent between the posterior bladder wall, above the level of the ureteric orifices, and upper third of the anterior vagina.

site of fistula and its proximity to the ureteric orifices, which facilitates surgical planning. Retrograde studies at the time of cystoscopy or CT urography allow assessment of ureteric integrity and exclusion of upper tract pathology. Magnetic resonance imaging (MRI) can also be useful to delineate the fistulous tract and aid in surgical planning.

Management

The approach to repair of a bladder injury depends upon the site, type, and severity of injury. Perforations recognized intraoperatively may be a closed in one or two-layers with absorbable sutures. Postoperative bladder drainage is recommended for at least 7–14 days and a cystogram to exclude contrast extravasation and confirm patency of repair prior to catheter removal is advised. Injuries at laparoscopy may be repaired laparoscopically if it is a small injury, the ureters or bladder neck are not compromised and there is adequate expertise, view and exposure. In one recent systematic review 34.9% of intraoperatively recognized bladder injuries were repaired with laparoscopic suturing.

Intraoperative recognition of bladder injury appears to be quite high with one large recent cohort reporting a delayed rate of repair of only 1.7%. If a delayed diagnosis of bladder injury is made, it is important to distinguish whether the injury is extra- or intraperitoneal. For extraperitoneal bladder injuries, a period of catheterization is usually sufficient. While controversial, small case series suggest that small intraperitoneal bladder injuries may be amenable to conservative management with prolonged catheter drainage or bilateral percutaneous nephrostomy. However, the gold standard for intraperitoneal injury remains operative repair.

Management of vesicovaginal fistula

The goal of treatment of VVF is the cessation of urinary leakage and restoration of normal urinary function. Early referral to a high volume fistula centre should be made as the first attempt at repair often has the highest chance of closure and this can be performed via the vaginal route in the majority. In some instances, particularly for small fistulae, a trial of conservative management with urethral or suprapubic catheterization may be successful. In one UK series, Hilton et al. demonstrated spontaneous successful fistula closure following 6–8 weeks of catheterization in 24 patients (6.9% of total).

The timing of surgical repair is contentious and is generally delayed owing to delayed presentations or referral to specialist centres. Repair of VVF post gynaecological surgery is often delayed at least 6–12 weeks to allow granulation to dissipate and to optimize the chance of successful repair.

The route of operative repair is also an area of contention in modern fistula surgery and is generally determined by both surgical and patient factors. For post hysterectomy fistulae, the fistula is generally sited between the vaginal vault and the posterior bladder wall (peri-trigonal). This is generally accessible via a vaginal approach and success rates of 90–100% have been reported via this route. Similar success rates have been described via a transabdominal route and this is preferred if concomitant ureteric re-implantation is required or in those with very large fistulae requiring bladder augmentation at time of repair or where a transvaginal approach has previously failed. While the above factors often influence the choice of approach, the approach utilised is generally the one in which the individual surgeon has the most experience. In the well resourced setting however, those who can only offer one route of repair should for the sake of their patients and their defense fees refer on to centres offering all routes of repair. Successful laparoscopic and robotic-assisted VVF repairs have also been reported. With these

approaches, the same principles as for an open transabdominal approach apply: namely separation of the vagina from the bladder and interposition of well vascularized tissue between both organs.

Nonoperable fistulae present a difficult surgical and ethical dilemma. Some large fistulae, particularly in a previously irradiated field, are best managed with urinary diversion.

Urethral injury

Iatrogenic urethral injury represents the most common mechanism of urethral trauma in modern surgical practice. Iatrogenic urethral injury may result from inappropriate catheterization, instrumentation, or surgery. Sequelae of urethral injury include stricture and urethrovaginal fistula formation.

Incidence and aetiology

While much is written about urethral injury in male patients, assessing rates of iatrogenic urethral injury in women poses a greater epidemiological challenge. Urethral stricture or defects associated with urethrovaginal fistula are rare and the most common cause of urethral damage in well-resourced countries is iatrogenic injury resulting from surgical complication.

Urethrovaginal fistula may occur as a result of surgical treatment of stress incontinence in women with bulking agents or mid-urethral tapes. Blaivas et al. describes repair of 8 urethrovaginal fistulae, which developed following mid urethral sling surgery. Fistulae have also been reported in association with urethral diverticula and their subsequent repair. They have even been reported to occur in the conservative treatment of prolapse with pessaries.

Diagnosis

Women with urethral strictures may present with acute urinary retention or more indolent urinary symptoms of hesitancy, poor flow, frequency, urgency and dysuria. Symptoms of an urethrovaginal fistula are largely dependent on its size and location. More distal fistulae may be asymptomatic or present with spraying of urinary stream. Those located at the bladder neck may present with continuous urinary leakage, whereas those located more proximally may be associated with stress urinary incontinence.

Diagnosis of urethral stricture or urethrovaginal fistula is generally made on clinical examination and with cystourethroscopy. A dye test as described above may aid in the diagnosis. MRI imaging can also be beneficial. Video urodynamics allows evaluation of urinary incontinence and in the case of fistula, allows assessment of its relationship to the bladder neck and urethra and examination for concomitant VVF.

Management

If a diagnosis of urethral trauma is made, generally a period of urethral catheterization for up to 4–6 weeks will be adequate for healing. A wide variety of female urethroplasty techniques are available and may need to be used in conjunction with repair of urethrovaginal fistulae. The surgical repair of urethrovaginal fistulae is challenging with many patients requiring concurrent or subsequent intervention for stress urinary incontinence. If the fistula is a result of a foreign body, such as a mid-urethral sling, this will generally need to be excised widely with interposition of healthy tissue or flaps if necessary.

Conclusion

In conclusion, iatrogenic gynaecological trauma can have devastating consequences and significant long-term sequelae. Prevention of these complications and maintenance of a high index of suspicion is paramount to the avoidance or timely management of these injuries. When they occur and are diagnosed late, immediate expert advice and/or referral will ease the patients and gynecologists' future path. ◆

FURTHER READING

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Practice points

- During oophorectomy or hysterectomy the ureter is most likely to be injured during ligation of the uterine or ovarian vessels and closure of the vaginal cuff angles.
- CT urography is generally the diagnostic imaging modality of choice in diagnosing ureteric injuries, and is useful in ruling out any additional concomitant injuries. Absence of contrast material in the distal ureter on delayed CT images is diagnostic of a complete ureteric transection.
- Any scenario in which there is reduced exposure or visibility in the pelvis such as is the case with large pelvic masses, obesity, haemorrhage or malignant disease can increase the risk of iatrogenic bladder injury.
- The approach to repair of a bladder injury depends upon the site, type, and severity of injury. Perforations recognized intraoperatively may be closed in one or two-layers with absorbable sutures. Postoperative bladder drainage is recommended for at least 7–14 days and a cystogram to exclude contrast extravasation and confirm patency of repair prior to catheter removal is advised.