Genitourinary Trauma

Renal Trauma

Damage to the kidney represents the most common type of urinary tract injury. Even so renal trauma is relatively uncommon, accounting for only 1.4-3.25% of trauma cases [38]. Over 90% are due to blunt injury, of which approximately 90% may be managed conservatively. Initial management of the patient with renal injury follows established ATLS principles, particularly as many patients have associated injuries. Haematuria is present in 80-94% of cases [39], but its presence or absence gives little indication of the severity of injury. In fact 18-36% of patients with a major pedicle injury have no evidence of microscopic or gross haematuria [40, 41]. In those with evidence of haematuria and persistent life-threatening haemodynamic instability, immediate renal exploration is warranted. For the remainder investigation and subsequent management depends upon mechanism of injury, and the presence of gross haematuria or systemic hypotension.

Grade	Description of injury
1	Contusion or non-expanding subcapsular haematoma No laceration
2	Non-expanding perirenal haematoma Cortical laceration < 1 cm deep without extravasation
3	Cortical laceration > 1 cm without urinary extravasation
4	Laceration: through corticomedullary junction into collecting system **or** Vascular: segmental renal artery or vein injury with contained haematoma, or partial vessel laceration or vessel thrombosis
5	Laceration: shattered kidney **or** Vascular: renal pedicle or avulsion

Blunt trauma

In blunt trauma, gross or microscopic haematuria and a (lowest recorded) systolic BP of < 90mmHg is associated with a 12.5% incidence of major renal injury [42]. This figure falls to 0.2% in patients with microscopic haematuria only and no recorded evidence of shock (Miller and McAninch J Urol 1995) Thus, patients with blunt trauma require radiological imaging if they have gross haematuria, or microhaematuria and a systolic BP < 90mmHg. Exceptions include patients with major deceleration injury and children, in whom any evidence of haematuria mandates radiographic assessment. Contrast-enhanced helical CT with delayed (10mins) imaging is the gold-standard, allowing accurate classification of renal injury (see Table 4 [43]). In general the only absolute indications for surgery are life-threatening haemodynamic instability believed to arise from a renal injury, renal pedicle avulsion (grade 5 injury), or the finding of an expanding, pulsatile retroperitoneal haematoma at laparotomy. All other renal injuries may be managed conservatively initially, although a small proportion of patients with grade 3/4 injuries develop secondary haemorrhage, which can usually be managed by angiographic embolisation. Urinary extravasation (grade 4 injuries) resolves

spontaneously in 76-87% of cases [38]; persistent cases may be treated by percutaneous perinephric drainage with or without ureteric stenting. Occasionally a non-expanding retroperitoneal haematoma may be encountered during a trauma laparotomy performed for other reasons. In this situation a one-shot IVU (2mL/Kg iodinated contrast, single film at 10 mins) should be performed to exclude a renovascular (grade 5) injury and to confirm the presence of a functioning contralateral kidney. The presence of contrast in the renal collecting system implies adequate renal perfusion, obviating the need for renal exploration in approximately 30% of cases [44].

Penetrating trauma

In hemodynamically stable patients with penetrating flank trauma, any degree of haematuria mandates radiological imaging. Exploration of all penetrating renal injuries has been advocated by some, based on a higher reported incidence of secondary haemorrhage, although others have reported the safe implementation of a selective approach in haemodynamically stable patients [38]. In general, surgery is advised for haemodynamic instability, grade 4/5 injuries, and when laparotomy is performed for other reasons.

Grade V injuries

Accounts for 2-4% of all renal injuries. Even in major trauma centres rates of nephrectomy high: 67-86% in patients with major arterial injuries; 25-56% in patients with major venous injury. Therefore only attempt renovascular repair if stable and:

(i) Solitary kidney

(ii) Bilateral renal injury

(iii) Very rapid diagnosis and transfer to theatre (salvage rates negligible if < 8 hrs Cass 1989)

Endovascular techniques for intimal flaps/segmental artery injury

Approach to kidney in trauma

Midline full-length laparotomy. Lift transverse colon onto chest and small bowel out of peritoneal cavity superiorly and to right. Identify aorta and origin of IMA. Incision in midline immediately above IMA and extend to ligament of Treitz. Identification of the lateral margin of the aorta a crucial landmark. If identification difficult may need to go lateral and IMV to find lateral border of aorta. Identify and sling left renal vein. Retraction cephalad allows identification of origin or left and right renal arteries. Right renal vein may be difficult to control through this approach; may need to kocherise duodenum.

Follow-up after renal trauma

Repeat urinalysis is recommended in all patients with trauma and haematuria, irrespective of severity, to identify persistent haematuria requiring further evaluation. The incidence of renovascular hypertension and renal insufficiency following renal injury is not well-characterised, nor is the time course for development of such complications. One multi-

institutional study of 89 patients with grade 4/5 injuries reported rates of 22.4% and 4.5% for renal insufficiency and hypertension respectively [45], and it is therefore recommended that such indices are monitored indefinitely following major renal injury.

Ureteric Trauma

Ureter injury scale

Grade*	Type of injury	Description of injury
I	Hematoma	Contusion or hematoma without devascularization
II	Laceration	< 50% transection
III	Laceration	≥ 50% transection
IV	Laceration	Complete transection with < 2cm devascularization
V	Laceration	Avulsion with > 2cm of devascularization

Ureteric trauma is rare, accounting for only 1% of all cases of genitourinary trauma [46]. Approximately 75% of cases are iatrogenic, with over half occurring to the distal third of the ureter during gynaecological surgery [47]. The remainder occur during general, urological and vascular surgery. In Europe, blunt abdominal trauma accounts for the majority of remaining ureteric injuries, whereas in the United States gunshot injuries are the most common cause. Damage is identified intraoperatively in approximately one third of cases, whereupon urological specialist input should be immediately sought. Simple ligation injury can usually be managed by immediate de-ligation and ureteric stenting. Where ureteric integrity is questionable the affected segment should be resected followed by reconstruction. Satisfactory results are obtained by establishing a tension-free, spatulated anastomosis. Often this may be achieved by simple ureteric mobilisation and uretero-ureterostomy, followed by prophylactic ureteric stenting. Where this is not feasible, a number of alternative approaches are possible, dependent on location of injury (see Table 5).

Delayed diagnosis of iatrogenic ureteric injury occurs in approximately two-thirds of patients [48]; patients may present with post-operative loin pain, ileus, fever, and occasionally with a urinary leak, where elevated fluid creatinine is diagnostic of a urinary tract fistula. IVU and contrast-enhanced CT are the most appropriate first-line diagnostic modalities; where they are equivocal, retrograde pyelography (RPG) should be performed as it has been shown to be the most accurate imaging modality for establishing the presence and degree of ureteric injury [48]. Retrograde ureteric stenting is usually unsuccessful in cases of delayed ureteric injury; therefore in cases where the diagnosis is established on IVU or CT, percutaneous nephrostomy is advocated to provide temporary urinary diversion prior to definitive urinary reconstruction, as outlined in below:

Location of injury	Surgical option
Upper third	Uretero-ureterostomy Transuretero-ureterostomy Ureterocalycostomy
Middle third	Uretero-ureterostomy Transuretero-ureterostomy Boari flap and re-implantation
Lower third	Direct re-implantation Psoas hitch Blandy cystoplasty
Complete ureteric loss	Ileal interposition Autotransplantation

Ureteric defect length

2-3 cm	Ureteroureterostomy
4-5 cm	Ureteroneocystostomy
6-10 cm	Psoas hitch
12-15 cm	Boari flap

Bladder Trauma

Bladder injuries may be categorised as blunt, penetrating or iatrogenic. Injury to the bladder is identified in 1.6% of blunt abdominal trauma cases, of which 80% have an associated pelvic fracture [49]. Up to 30% will have a concomitant urethral injury. Bladder rupture is conventionally classified as intraperitoneal or extraperitoneal. Intraperitoneal rupture accounts for approximately 40% of cases. It occurs when there is a sudden rise in intravesical pressure, usually experienced following a blow to the pelvis or lower abdomen. The weakest part of the bladder is the dome, which ruptures into the abdominal cavity, leading to extravasation of urine. Extraperitoneal ruptures due to blunt trauma account for approximately 60% of cases, and are seen almost exclusively in the context of pelvic fractures. Injury is either due to a bony spicule piercing the bladder, or more commonly a tear of the bladder wall, typically on the anterolateral bladder wall. External penetrating trauma to the bladder is rare. Iatrogenic bladder trauma is more frequent, most commonly complicating hysterectomy, caesarean section and transurethral resection of bladder tumour.

The hallmark of bladder injury is gross haematuria, which is seen in 82-95% of cases [50, 51]. Additional features include an inability to void, suprapubic pain, and suprapubic tenderness. The development of ileus, abdominal distension, urinary ascites/fistula, and unexplained elevations in serum urea and creatinine, suggest intraperitoneal bladder rupture. Multiple studies have shown that passive filling of the bladder by catheter clamping following the administration of IV contrast is inadequate for the diagnosis of bladder injury: a stress cystogram is thus the investigation of choice. It is performed by gravity-filling the bladder to capacity with dilute contrast (typically 450 ml 50:50 contrast) before performing antero-posterior, oblique and post-drainage films. Filling of the retrovesical space, paracolic gutters

and outlining of intra-abdominal viscera is indicative of intraperitoneal rupture (Figure 2A). Extraperitoneal rupture is associated with characteristic 'flame-shaped areas of extravasation confined to the perivesical tissue (Figure 2B), and occasionally a so-called 'teardrop deformity' caused by a large pelvic haematoma.

Patients presenting with haematuria, an isolated pelvic fracture and a normal cystogram usually have a bladder haematoma, which is self-limiting and requires observation and catheter drainage alone. A similar management strategy is employed for a majority of patients with extraperitoneal bladder ruptures. Exceptions include patients with bladder neck or associated vaginal/rectal injuries, those undergoing open repair and internal fixation of pelvic fracture, and those in whom the indwelling catheter fails to provide adequate drainage. External penetrating injuries and blunt intraperitoneal bladder ruptures require formal surgical exploration and open repair. Small iatrogenic intraperitoneal bladder ruptures may be repaired laparoscopically where expertise is available, or alternatively may be managed by urethral catheter drainage alone, with prompt operative repair in patients who deteriorate under observation. In patients who require operative repair, absorbable sutures are mandatory to prevent the formation of subsequent bladder stones. A follow-up stress cystogram, performed at 10 days, is generally performed prior to catheter removal.

Bladder injury scale

Grade*	Injury type	Description of injury
I	Hematoma Laceration	Contusion, intramural hematoma Partial thickness
II	Laceration	Extraperitoneal bladder wall laceration <2 cm
III	Laceration	Extraperitoneal (≥2cm) or intraperitoneal (<2cm) bladder wall laceration
IV	Laceration	Intraperitoneal bladder wall laceration ≥2cm
V	Laceration	Intraperitoneal or extraperitoneal bladder wall laceration extending into the bladder neck or ureteral orifice (trigone)

Urethral Trauma

Damage to the urethra represents the second commonest form of urinary tract injury after renal trauma. It is commoner in men, where it is associated with blunt external trauma in approximately 90% of cases [52]. The male urethra is divided into anterior and posterior segments by the urogenital diaphragm. The anterior urethra, subdivided into penile and bulbar parts at the peno-scrotal junction, is relatively exposed and thus at higher risk of blunt and penetrating external trauma. Anterior urethral damage typically occurs following a blow to the perineum such as experienced during 'fall-astride' injuries. Stab wounds, gunshots, dog bites and blast injuries account for most cases of external penetrating trauma, whereas urethral instrumentation and catheterisation are common forms of iatrogenic internal trauma. Penile fracture, a rare cause of anterior urethral trauma, is separately discussed below. The

posterior urethra consists of membranous and prostatic components and is almost exclusively injured in the context of a concomitant pelvic fracture. Overall the male urethra is injured in 3.5-19% of pelvic fractures and the female urethra in 0-6% of pelvic fractures [46]. The risk of urethral injury is related to the type of pelvic fracture; unstable diametric pelvic fractures and bilateral ischiopubic rami fractures carry the highest likelihood of posterior urethral injury. Multiple classification systems have been devised, including from AAST and Goldman et al. EAU classification incorporates the best features of each:

Table 4.6: Classification of blunt anterior and posterior urethra

Classification	Description
I	Stretch injury. Elongation of the urethra without extravasation on urethrography
II	Contusion. Blood at the urethral meatus; no extravasation on urethrography
III	Partial disruption of anterior or posterior urethra. Extravasation of contrast at injury site with contrast visualized in the proximal urethra or bladder
IV	Complete disruption of anterior urethra. Extravasation of contrast at injury site without visualization of proximal urethral or bladder
V	Complete disruption of posterior urethra. Extravasation of contrast at injury site without visualization of bladder
VI	Complete or partial disruption of posterior urethra with associated tear of the bladder neck or vagina

Blood at the urinary meatus is considered the hallmark of urethral injury. It is present in 37-93% of posterior and at least 75% of anterior urethral injuries [53, 54]. Blood at the vaginal introitus is seen in 80% of female urethral injuries [55]. Other features are an inability to void, penile/perineal haematoma and a high-riding prostate. This latter feature is often difficult to assess in the acute setting, where pelvic haematoma often precludes adequate palpation of the prostate. The presence of blood at the urinary meatus mandates formal urethral imaging prior to any attempts at urethral catheterisation. Retrograde urethrography is easily performed using a 14F Foley catheter inserted into the distal urethra, with the balloon inflated using 1-2 ml of water. 20-30 ml of undiluted contrast is injected and radiographs taken in a 30° oblique position. In the absence of a significant urethral injury the urinary bladder may be catheterised. Whilst relatively easy to perform, retrograde urethrography is time-consuming and thus inappropriate for unstable patients; for these patients a supra-pubic catheter should be inserted when the bladder becomes palpable and a retrograde urethrogram performed when practicable.

The management of urethral injuries is controversial. Most surgeons believe that immediate open exploration is required for stable patients who have sustained either penetrating urethral trauma or blunt posterior urethral trauma involving the bladder neck or rectum, due to the high rate of fistula, incontinence and infection. For the remaining majority of blunt urethral injuries, there is also a consensus advocating immediate urinary diversion, primarily via the suprapubic route, to limit urinary extravasation and its associated infective complications. For patients with partial urethral injuries, retrograde urethrography is then usually performed at intervals until satisfactory healing is demonstrated. The management of the diverted patient with a complete posterior urethral disruption secondary to blunt trauma is where much of the

controversy rests, centred on the option of establishing early or delayed urethral continuity. Immediate open realignment is associated with unnacceptable rates of erectile dysfunction (44%) and incontinence (20%). The early establishment of urethral continuity, or primary realignment, takes place within 2 weeks of injury and typically involves a combined suprapubic/urethral endoscopic approach to realign the disrupted urethral ends over a stenting urethral catheter. Similar rates of incontinence (5%) and erectile dysfunction (20%) are reported for endoscopic early realignment and delayed anastomotic urethroplasty respectively. The associated stricture rate is approximately 60%, meaning that at least 40% of patients require no further surgery, and in those that do, further stricture surgery is simplified due to reasonable urethral apposition. Ultimately however, urethroplasty can be expected in up to one third of patients. Delayed urethroplasty involves prolonged suprapubic urinary diversion, usually for 3 months, during which time a urethral stricture forms at the site of injury in almost all patients, necessitating primary anastomotic urethroplasty. Proponents of this technique argue that although suprapubic catheterisation is necessary for at least three months, re-stricture rates are much lower (<10%) with this technique than with primary re-alignment [46].

External Genital Trauma

Blunt scrotal trauma

Eighty-five percent of scrotal injuries result from blunt trauma, usually associated with athletic activity [57, 58]. Injuries range from simple bruising of the scrotum, through haematocoele to overt testicular rupture. Testicular torsion and dislocation are rare but well-described complications of blunt scrotal trauma. In testicular rupture the tunica albuginea is torn with evisceration of testicular tubules, mandating urgent surgical repair. Diagnosis may be made clinically by palpation or radiologically by ultrasound. Scrotal ultrasonography is considered the most sensitive modality for detecting tunica albuginea rupture, with a reported accuracy of up to 94% [46]. Even in the absence of testicular rupture, a number of studies have shown increased rates of delayed intervention (>3 days) and subsequent orchidectomy in patients treated conservatively for haematocoele. Current guidelines therefore recommend early scrotal exploration in all cases of testicular rupture, torsion and dislocation, and in patients with large symptomatic haematocoeles [46].

Penile fracture

Penile fracture is uncommon. It occurs due to excessive bending of the erect penis, usually during vaginal intercourse. A tear of the tunica albuginea of the corpus cavernosum occurs, leading to immediate penile pain and rapid detumescence. Often an audible crack or popping sound is heard. Penile examination reveals swelling and bruising confined to the penile shaft, often described as an aubergine, or egg-plant, deformity. If Buck's fascia is torn, blood may extravasate along fascial planes into the scrotum, perineum and occasionally suprapubic areas. Associated urethral injury occurs in approximately 20% of cases [59]. In most cases

penile fracture may be diagnosed on history and clinical examination alone. MRI is the most sensitive modality for determining tunica albuginea rupture in equivocal cases [60]. Once diagnosed, management comprises prompt surgical repair. Because of the possibility of occult and partial urethral injuries, some proponents advocate routine pre-operative retrograde urethrography, whereas other believe an adequate assessment of urethral integrity may be made at operation. Surgery typically involves a distal circumferential penile incision with degloving of the penile skin to the location of injury, followed by primary repair of the tunica albuginea defect.