

Guideline of guidelines: a review of urological trauma guidelines

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Objective

To review the guidelines released in the last decade by several organisations for the optimal evaluation and management of genitourinary injuries (renal, ureteric, bladder, urethral and genital).

Methods

This is a review of the genitourinary trauma guidelines from the European Association of Urology (EAU) and the American Urological Association (AUA), and renal trauma guidelines from the Société Internationale d'Urologie (SIU).

Results

Most recommendations are guided by the American Association for the Surgery of Trauma (AAST) organ injury severity system. Grade A evidence is rare in genitourinary trauma, and most recommendations are based on Grade B or C evidence. The findings of the most recent urological trauma

guidelines are summarised. All guidelines recommend conservative management for low-grade injuries. The major difference is for haemodynamically stable patients who have high-grade renal trauma; the SIU guidelines recommend exploratory laparotomy, the EAU guidelines recommend renal exploration only if the injury is vascular, and the AUA guidelines recommend initial conservative management.

Conclusion

There is generally consensus among the three guidelines. Recommendations are based on observational or retrospective studies, as well as clinical principles and expert opinions. Multi-institutional collaborative research can improve the quality of evidence and direct more effective evaluation and management of urological trauma.

Keywords

trauma, renal injury, ureteric injury, bladder injury, genital injury

Introduction

Injury to the genitourinary tract occurs in 10% of abdominal trauma [1–3]. To aid in appropriate treatment of genitourinary trauma, several societies have released management recommendations. The SIU released a consensus statement on renal trauma in 2004 [4]. The EAU released guidelines on urological trauma (including iatrogenic urological trauma) and on paediatric urology (with a detailed trauma section) in 2014, which were updated in 2015 [5,6], and on iatrogenic urological trauma in 2012 [7]. The AUA guidelines on urological trauma were released in 2014 [1]. The AAST [8–10] has developed a grading system of organ injury severity. The present article summarises the currently available guidelines for the evaluation and management of genitourinary trauma, including the level of evidence of each recommendation (Table 1). Where applicable, the level of evidence, from which the guidelines are based, is given.

Renal Trauma

The kidney is the most commonly injured genitourinary organ [1]. It is particularly vulnerable to deceleration injuries because it is fixed in space only by the renal pelvis and vascular pedicle [11]. In the USA, >80% of kidney injury is due to blunt trauma [10]. Penetrating trauma is rare, but is associated with more severe injury [12]. Evaluation of renal trauma is based on the patient's haemodynamic status, mechanism of injury [2], physical examination, and urine analysis. Haematuria is present in 80–94% of cases [13]. Management of patients with renal trauma is guided by the AAST organ injury severity scale for the kidney (Table 2).

Evaluation of Renal Trauma

The first step in the EAU [5], SIU [4], and AUA [1] guidelines for renal trauma is evaluation of the patient's haemodynamic status (Grade A, EAU). The SIU [4] defines



Table 1 Level of evidence.

Grade	Level of evidence
A	Well-conducted RCT or exceptionally strong observational study
B	RCT with some weakness of procedure or generalisability or generally strong observational studies
C	Observational studies that are inconsistent, have small sample sizes, or have other problems that potentially confound interpretation of data
Clinical Principle	Statement about a component of clinical care that is widely agreed upon by urologists or other clinicians for which there may or may not be evidence in the medical literature
Expert Opinion	Statement, achieved by consensus of a panel, based on members' clinical training, experience, knowledge, and judgment for which there is no evidence

RCT, randomized control trial.

Table 2 AAST organ injury severity scale for renal trauma.

Grade	Description of injury
1	Contusion of subcapsular haematoma
2	Cortical laceration <1 cm deep
3	Cortical laceration >1 cm without urinary extravasation
4	Laceration into collecting system, segmental vascular injury
5	Shattered kidney, renal pedicle injury or avulsion

haemodynamic stability as a systolic blood pressure (SBP) of >90 mmHg and haemodynamic instability as a SBP of <90 mmHg. Haemodynamically stable patients with gross haematuria should undergo imaging (Grade B, AUA; Grade A, EAU). Imaging is also indicated if the mechanism of trauma suggests a renal injury, such as penetrating trauma to the flank, rib fracture, or significant flank ecchymosis. Microscopic haematuria does not warrant imaging [1] (Grade B, AUA).

Abdominal/pelvic CT with i.v. contrast with immediate and delayed images [1,4,5] is the imaging technique of choice for defining the location and severity of injury (Grade C, AUA and SIU; Grade A, EAU), provides a view of other abdominal and pelvic organs, and evaluates for pre-existing renal abnormalities [14]. Also, CT provides visualisation of the ureters and the contralateral kidney.

For AAST grade 1 or 2 injuries, conservative management, with observation, bed rest, hydration, serial haematocrit monitoring, and antibiotics, is preferred (Grade B, AUA and EAU). According to the Urological Society of Australia and New Zealand, conservative management of renal trauma includes thromboprophylaxis, antibiotics, discharge criteria, and timing for return to activity [15]. Conservative management is also recommended for grade 3 or 4 injuries (Grade B, AUA). The SIU guidelines make a specific recommendation of surgical repair for grade 3 or 4 injuries, if the patient is undergoing a laparotomy for other abdominal injuries (Grade C, SIU), while the EAU guidelines state that

grade 3 injuries should be managed expectantly (Grade B, EAU). With isolated grade 4 injuries, the EAU states that treatment is based solely on the extent of the renal injury. For grade 5 injuries, the SIU recommends exploratory laparotomy (Grade C, SIU), while the EAU only recommends renal exploration if the injury is vascular (Grade B, EAU). Contrarily, the AUA recommends observation for hemodynamically stable patients regardless of AAST grade, due to interobserver variability regarding classification of grade 4 and 5 injuries (Grade B, AUA). With the increasing evidence of excellent outcomes of conservative management for correctly classified grade 4 injuries [16,17], there have been proposals to re-classify grade 4 and 5 injuries [18,19]; this would clarify the ambiguities of defining these injuries and may allow for more successful management decisions.

Immediate intervention is mandatory for haemodynamically unstable patients (Grade B, AUA, SIU and EAU). The SIU recommends only exploratory laparotomy (Grade B, SIU) [4], while the more recent EAU and AUA guidelines discuss angioembolisation. The AUA guidelines state that angioembolisation is an option only in experienced centres (Grade C, AUA) [1]; the EAU guidelines state that angioembolisation is a first-line option in patients with active bleeding and no other indications for immediate open surgery [5]. During laparotomy for renal trauma, the EAU and AUA guidelines give the option of performing a 'one-shot' i.v. urogram (IVU) [1,5] before retroperitoneal exploration (Grade C, AUA). The 'one-shot' IVU can exclude life-threatening renal injury and confirm the existence of a contralateral functioning kidney [20].

During laparotomy, the SIU recommends retroperitoneal exploration if there is the finding of an expanding or pulsatile retroperitoneal haematoma. The SIU guidelines also recommend vascular control before opening Gerota's fascia (Grade C, SIU) and the EAU guidelines state that renal reconstruction should be attempted once haemorrhage is controlled (Grade B, EAU). However, the AUA guidelines state that the benefit of prior vascular control is inconclusive (Grade B, AUA).

Renovascular Injuries

Traumatic injuries to the renal artery and vein are uncommon but are usually associated with a patient with injuries to multiple other organs [21]. The SIU consensus statement specifies management of renal vascular injury (Grade C, SIU) [4]. Abdominal/pelvic CT with i.v. contrast with immediate and delayed images is recommended for suspected vascular injury; renal arteriography should be performed if there are findings of renal arterial thrombosis or segmental artery injuries. Revascularisation of the main renal artery is unlikely to be successful [21,22], and reconstruction should only be attempted in patients with a solitary kidney or

bilateral renal injury. Otherwise, observation is recommended. If laparotomy is being performed for other associated injuries and there was prolonged renal ischaemia or a hilar injury, nephrectomy is recommended [23]. Renal artery repair is only recommended if there is an early recognition of an incomplete injury [4,21–23]. Renal vein injuries are rare, and are difficult to identify by imaging. These injuries are usually associated with extensive bleeding and often result in nephrectomy [22].

The EAU guidelines discuss iatrogenic renal injuries, which are predominantly vascular [5,7]. Minor injuries should be treated conservatively (Grade B, EAU). Significant injury is rare, but requires immediate intervention with angioembolisation, which has excellent outcomes and lower complication rates when compared with surgery [5,24] (Grade B, EAU).

Paediatric Renal Trauma

Special consideration is made for paediatric patients. Hypotension is a rare and unreliable sign in children, so imaging becomes more important. The SIU guidelines [4] recommend that haemodynamically stable children with blunt trauma should undergo radiographic evaluation if they have gross haematuria or >50 red blood cells per high-power field on microscopic analysis (Grade C, SIU). The Paediatric EAU guidelines [5] state that although this criterion is used in many centers, there have been many reports of significant renal injuries with little or no haematuria [12]. Therefore, the EAU recommends imaging for any child who sustained an injury that is suspicious for renal trauma, with CT as the 'gold standard' (Grade B, EAU). Ultrasound is of limited value but can be used in the acute setting to reliably follow the course of a renal injury.

For paediatric renal trauma, the EAU states that non-surgical conservative management has become the standard approach, even for high-grade injuries, provided there is close clinical observation with serial imaging and re-assessments of a patient's condition (Grade B) [6]. Absolute indications for surgery include haemodynamic instability, grade 5 renal injuries, and expanding haematoma (Grade A). The SIU consensus statement adds that surgical exploration is also indicated in a changing abdominal physical examination, which is suggestive of major intra-abdominal injury (Grade C, SIU) [4].

Follow-up for Renal Trauma

The EAU guidelines recommend follow-up CT if the patient has fever, increasing flank pain or falling haematocrit level (Grade B, EAU). The EAU guidelines state that repeat imaging can be safely omitted for grade 1–4 injuries, as long as the patient is clinically stable [5]. The SIU guidelines recommend no imaging for grade 1–3 injuries, and repeat CT

36–72 h after a grade 4 injury with damage to the collecting system (Grade C, SIU) [4]. The AUA guidelines also recommend follow-up imaging for grade 4 or 5 injuries at 48 h (Grade C, AUA) [1]. Perinephric abscess formation is best managed by percutaneous drainage. Patients with renal trauma at greatest risk of hypertension are those who have grade 4 or 5 injuries. All three organisations recommend that patients with renal trauma should have periodic blood pressure monitoring after injury (Grade C, AUA, SIU and EAU). While the EAU and SIU guidelines recommend nuclear renal scan for follow-up (Expert Opinion, SIU; Grade C, EAU), the AUA guidelines recommend against routine nuclear renal scans due to inadequate benefits (Expert Opinion, AUA).

Ureteric Trauma

Ureteric trauma is the least common type of genitourinary trauma due to the small size, mobility, and protected location of the ureter. The most common cause of ureteric injuries is iatrogenic trauma [5,7], with blunt and penetrating trauma comprising less than a quarter of all ureteric injuries [25]. The lower third of the ureter is the most commonly injured location [25]. Treatment of ureteric injuries is based on severity (Table 3) and location of the injury.

Iatrogenic Ureteric Trauma

Gynaecological surgical procedures are the most common cause of iatrogenic ureteric trauma [26,27]. Iatrogenic ureteric trauma can result from ligation, compression, partial or complete transection, thermal injury, and ischaemia from devascularisation [26,28]. The diagnosis of iatrogenic ureteric trauma is often delayed, and is only recognised upon evaluation for symptoms of flank pain, urinary incontinence, haematuria, and fever. Preoperative placement of ureteric stents aid with early recognition of injury, but has not been shown to decrease the rate of ureteric injury (Grade B, EAU) [7,26]. The best method to prevent iatrogenic ureteric injury is intraoperative identification of both ureters [5,7,26–28].

The EAU and AUA guidelines [1,7] recommend (Grade C, AUA) that partial ureteric injuries (grade 2 or 3) can be repaired by primary closure over a stent. For grade 3–5 injuries, repair depends on the location of injury (Grade C, AUA and EAU). For injuries above the iliac vessels, uretero-

Table 3 AAST organ injury severity scale for ureteric trauma.

Grade	Description of injury
1	Haematoma
2	Laceration <50% of circumference
3	Laceration >50% of circumference
4	Complete tear <2 cm of devascularisation
5	Complete tear >2 cm of devascularisation

ureterostomy should be performed over a stent, if possible (Grade C, AUA). Injuries below the iliac vessels are typically repaired by re-implantation with psoas hitch and/or Boari flap (Grade C, AUA). The AUA guidelines specifically recommend against bowel interposition and auto-transplantation in the acute setting, while the EAU mention both procedures as reconstruction options for complete and extended ureteric injury.

The general principles of successful reconstruction are recommended by both the EAU and AUA guidelines: debridement and then spatulation of ureteric ends, placement of internal stent, watertight closure of reconstructed ureter, placement of a drain, and isolation of injury with peritoneum or omentum (Clinical Principle, AUA). For iatrogenic ureteric injuries that are diagnosed postoperatively, the AUA guidelines recommend attempting stent placement first, followed by percutaneous nephrostomy if stent placement is unsuccessful (Grade C, AUA) [1], while the EAU guidelines state that percutaneous nephrostomy with or without stent is used to treat these injuries.

Blunt or Penetrating Ureteric Trauma

Both the EAU and AUA guidelines recommend abdominal/pelvic CT with i.v. contrast with immediate and delayed images for diagnosis of ureteric injury (Grade C, AUA). If CT cannot be performed, alternative imaging techniques include intraoperative 'one-shot' IVU [3] and retrograde urography. For patients with associated injuries who are undergoing laparotomy, direct inspection of the ureters should be performed to evaluate for suspected ureteric trauma (Clinical Principle, AUA). Similar to iatrogenic trauma, treatment depends on the severity and location of injury. The AUA guidelines make note of the patient's haemodynamic status while undergoing laparotomy [1]. If the patient is haemodynamically stable, the traumatic ureteric injury should be repaired (Grade C, AUA). For unstable patients, temporary urinary drainage followed by delayed definitive management is recommended (Clinical Principle, AUA).

Paediatric Ureteric Trauma

For children, symptoms of a ureteric injury are often vague, so it is important to remain suspicious for potential ureteric injury after blunt abdominal trauma [6]. According to the Paediatric EAU guidelines [6], the most sensitive diagnostic test to detect ureteric injury is retrograde urography (Grade A, EAU). Minimally invasive procedures (via percutaneous nephrostomy tube drainage or ureteric stenting) are the methods of choice in treating traumatic ureteric injuries (Grade B, EAU). For partial lacerations, primary repair followed by stenting is necessary. For more severe injuries, treatment depends on the location of injury and on the amount of ureter no longer viable (Grade B, EAU).

Bladder Trauma

Bladder injuries are frequently associated with pelvic fractures [29]. As with kidney and ureteric injuries, the severity of bladder injuries is measured by an AAST organ injury severity scale (Table 4). The EAU and the AUA both recommend (Grade B, AUA and EAU) cystography for haemodynamically stable patients with gross haematuria and a pelvic ring fracture [30], or a mechanism of injury concerning for bladder injury [1,5]. Either conventional cystography or CT cystography can be used. According to the EAU guidelines, cystoscopy is the preferred method for detecting intraoperative bladder injuries and is advised after major gynaecological and retropubic sling procedures, and to diagnose a foreign body (Grade B, EAU) [5,7].

Bladder Trauma

Bladder injuries can be divided into extraperitoneal (60%), and intraperitoneal (30%). Simultaneous extraperitoneal and intraperitoneal injuries occur in 10% of all traumatic bladder injuries [31]. For uncomplicated extraperitoneal bladder injury, both the EAU and the AUA agree that urethral catheter drainage and observation is necessary, even in the presence of extensive retroperitoneal or scrotal extravasation (Grade C, AUA; Grade B, EAU) [1,5,32–34]. The AUA guidelines recommend maintaining urethral drainage for 2–3 weeks. Follow-up cystography should be performed to confirm that the bladder injury has healed (Grade C, AUA) [33]. If the bladder has not healed in 4 weeks it is appropriate to consider surgical repair.

Complicated extraperitoneal bladder ruptures are those involving exposed bone within the bladder lumen or rectal or vaginal lacerations. For these injuries, early surgical repair is indicated to facilitate healing and prevent fistula formation (Grade B, EAU) [1,5]. Surgical repair is also suggested for bladder neck injury. If the patient is undergoing surgery for repair of abdominal or orthopaedic injuries, consideration can be made for repairing an extraperitoneal bladder injury, even if uncomplicated (Grade C, AUA) [1,33,34].

Intraperitoneal Bladder Trauma

For intraperitoneal bladder injuries, both the EAU and AUA guidelines recommend surgical repair to prevent peritonitis

Table 4 AAST organ injury severity scale for bladder trauma.

Grade	Description of injury
1	Haematoma, partial thickness laceration
2	Extraperitoneal bladder wall laceration <2 cm
3	Extraperitoneal bladder (>2 cm) or intraperitoneal (<2 cm) bladder laceration
4	Intraperitoneal bladder wall laceration >2 cm
5	Intraperitoneal or extraperitoneal bladder wall laceration extending into the bladder neck or ureteric orifice

(Grade B, AUA and EAU) [1,5,33,34]. An exception is made for iatrogenic intraperitoneal bladder injuries, which can be managed with drainage, if there is no ileus or peritonitis (Grade C, EAU) [5,7]. After repair, urethral catheter drainage without suprapubic cystostomy is recommended by the AUA (Grade B, AUA).

Paediatric Bladder Trauma

The pediatric bladder is more susceptible to injury than the adult bladder because it is less protected [5]. Cystography (by either standard radiography or CT) should be performed with the bladder fully distended to evaluate the bladder for injury (Grade A, EAU). Management of intraperitoneal and extraperitoneal (both uncomplicated and complicated) is the same as in adults (Grade A, EAU). Paediatric EAU guidelines mention one difference: postoperatively, after repair of an intraperitoneal injury, a suprapubic catheter is mandatory [5].

Follow-up for Bladder Trauma

Both the AUA and EAU guidelines state that follow-up cystography should be performed after conservatively treated bladder injuries and surgically repaired complicated extraperitoneal injuries (Grade C, AUA) [1,5]. Both guidelines also mention that follow-up imaging is not necessarily required after simple surgical repair of an intraperitoneal injury (Grade B, AUA and EAU).

Urethral Trauma

Evaluation for urethral injuries is recommended for patients with blood at the meatus, with perineal or penile haematoma, who cannot void or who have had an injury that predisposes a straddle injury (Grade C, AUA) [1,5]. According to the EAU guidelines, rectal examination should be performed to exclude an associated rectal injury [5,35]. Retrograde urethrogram (RUG) is the standard method for evaluation of urethral injury (Grade C, AUA; Grade B, EAU) [1,5].

Most urethral injuries occur in male patients. For penetrating injuries to the anterior urethra, both the EAU and AUA recommend open surgical repair (Expert Opinion, AUA), except when there are other life-threatening injuries. The urethral ends are spatulated and an end-to-end anastomosis is made. If an anastomotic urethroplasty cannot be performed, typically if the disruption is >2–3 cm long in the bulbar urethra and >1.5 cm in the penile urethra, then the urethra should be marsupialised, and delayed repair with a graft or flap can occur at ≥3 months after the injury [5]. For blunt trauma to the anterior urethra, both the EAU and AUA recommend suprapubic or urethral catheter placement and delayed treatment, as the extent of injury is hard to discern (Grade B, AUA; Grade C, EAU).

Most posterior urethral injuries are due to pelvic fractures. Prompt urinary drainage should be performed, whether via suprapubic or urethral catheter (Grade C, AUA). Both the EAU and AUA guidelines [1,5] list primary endoscopic re-alignment as an option for haemodynamically stable patients (Grade C, AUA); the EAU guidelines also mention that endoscopic re-alignment can be performed if the patient is in the operating room for a different surgery. The AUA stipulates that prolonged attempts at re-alignment should be avoided to prevent delays of other important medical services (Clinical Principle, AUA) [1]. The EAU states that after a successful re-alignment, the catheter should remain in place for 4–8 weeks [5]. Haemodynamically unstable patients should have suprapubic catheter placement and delayed management (Grade C, AUA).

Primary open realignment and primary surgical repair are not recommended due to poor visualisation, the inability to accurately assess the degree of injury, and high rates of erectile dysfunction and urinary incontinence (Grade C, AUA) [1,5]. Even if endoscopic re-alignment is successful, many patients will develop posterior urethral stenosis. If re-alignment was unsuccessful and suprapubic catheter was placed, the EAU and AUA guidelines state that delayed primary urethroplasty should then be performed (Clinical Principle, AUA) no later than 14 days after the injury, when the fibrotic process has not yet begun, to avoid extended suprapubic diversion [36]. Urethroplasty can only be performed within 2 weeks of the injury if the patient has a short defect and can lie in the lithotomy position [36].

The EAU recommends treating posterior urethral distraction defects via a deferred urethral repair at a minimum of 3 months after trauma (Grade B, EAU). This delay allows time for the healing of orthopaedic injuries, absorption of pelvic haematoma, descent of the bladder and prostate to more anatomical positions, stabilisation of the scar tissue, and for the patient to be able to be placed into the lithotomy position [5,36–38]. Immediate repair for a posterior urethral distraction defect is only recommended by the EAU guidelines for a penetrating injury.

The AUA guidelines [1] state that patients with posterior urethral injury related to pelvic fracture should be monitored for complications, including stricture formation, erectile dysfunction, and incontinence (Grade C, AUA) [39]. Surveillance strategies with uroflowmetry, RUG, cystoscopy or a combination of these methods are recommended for at least 1 year (Grade C, AUA).

Female Urethral Trauma

Female urethral injuries are rare. They occur almost exclusively as a result of pelvic fractures and often occur together with bladder rupture. The EAU recommends

urethroscopy for diagnosis in female patients [5]. If the patient is stable and there is an injury to the bladder neck or proximal urethra, surgical repair of the urethra, bladder, and pelvic floor should be performed via a retropubic approach [35]. If the patient is stable and the distal urethra is injured, surgical repair should be performed transvaginally [35].

Iatrogenic Urethral Trauma

Catheter placement is the most common cause of iatrogenic urethral trauma [40]. Iatrogenic urethral injuries also occur after radical prostatectomy, pelvic radiotherapy, and other abdominopelvic surgery [40,41]. The main consequence of iatrogenic trauma is urethral stricture. False passages should be treated with urethral catheter placement if possible, while strictures should be managed endoscopically with incision or resection initially, followed by urethral reconstruction if endoscopic management fails [5,7]. The most common iatrogenic urethral trauma after radical prostatectomy is anastomotic stricture. The EAU recommends dilation or endoscopic incision as the first step in treatment [5,7].

Paediatric Urethral Trauma

As with adult urethral trauma, the recommended radiographic method for diagnostic evaluation of paediatric urethral trauma is RUG (Grade A, EAU). As many children with urethral trauma are unstable due to other associated injuries, the first step in management according to the Paediatric EAU guidelines is to provide urinary drainage [5]. Transurethral catheterisation can be performed only if the patient can still void and diagnostic evaluation is not suspicious for urethral rupture. A suprapubic catheter should be placed, otherwise. According to the Paediatric EAU guidelines, there is no singular accepted method to manage posterior urethral injuries; either immediate suprapubic drainage with late urethral reconstruction or immediate primary re-alignment can be performed (Grade C, EAU) [5].

External Genitalia Trauma

The most common injuries involving the external genitalia are penile fracture, testicular rupture, and penetrating penile injury. If there is blood at the meatus or haematuria is found in addition to external genital injury, evaluation for urethral injury should also be performed [42,43].

Penile Trauma

Blunt penile trauma may result in penile fracture. Penile fracture should be suspected if the patient reports a sudden cracking or popping sound during sexual intercourse or manipulation associated with pain and detumescence (Grade

B, AUA) [1]. If the diagnosis of penile fracture is uncertain, the AUA recommends penile ultrasound [1] followed by MRI if ultrasound is equivocal; MRI is not recommended as the first line for evaluation due to its high cost and time constraints (Expert Opinion, AUA). The EAU mentions cavernosography, ultrasound or MRI as imaging options, without specifying an optimal modality [5]. Conservative management with non-steroidal analgesics and cold compresses are recommended for subcutaneous haematoma [5]. Both the EAU and AUA recommend closure of the tunica albuginea (Grade B, AUA and EAU) [1,5] to prevent erectile dysfunction and penile curvature [2,44]. Penile fracture is associated with urethral injury in 10–22% of cases [44]. Both the AUA and EAU guidelines state that with suspected concomitant urethral injury, evaluation is performed with RUG or urethroscopy (Grade B, AUA). The EAU mentions that urethral injury should be repaired at the same time as repair of the penile fracture [5].

For penetrating penile trauma, physical examination is sufficient for evaluation. Penetrating penile injury has concomitant urethral injury in 11–29% of cases [45], and RUG may be indicated to evaluate for urethral injury [1]. The EAU recommends surgical exploration with conservative debridement and primary closure of the tunica albuginea [5,46]. If there is extensive skin loss, the EAU guidelines state that reconstruction with a full-thickness skin graft is superior to a split-thickness skin graft [5]. Animal and human bites are associated with high risk of wound infection. Besides debridement and closure, antibiotics directed according to the most common associated pathogen should be given. Choices usually include penicillin-amoxiclavulanic acid, doxycycline, a cephalosporin, or erythromycin for 10–14 days. Additionally, the rabies vaccine, hepatitis B vaccine, and/or HIV post-exposure prophylaxis should be considered [2,5].

Both the AUA and EAU guidelines make specific mention of traumatic penile amputation. The amputated appendage should be wrapped in saline-soaked gauze, placed in a plastic bag and placed in a second bag filled with ice during transport. According to the AUA, the appendage should then be re-implanted as soon as possible (Clinical Principle, AUA), while the EAU guidelines state that re-implantation may be performed within 24 h of amputation [1,5].

Scrotal Trauma

Testicular rupture is found in $\approx 50\%$ of direct blunt trauma to the scrotum [47]. Testicular rupture is characterised by scrotal ecchymosis and swelling, and difficulty in identifying the contours of the testicle on examination. The EAU guidelines recommend scrotal ultrasound for the evaluation of scrotal trauma [5]. Surgical exploration is recommended by both the AUA and EAU guidelines for suspected testis

rupture, even if imaging is equivocal (Grade B, AUA and EAU). Early scrotal exploration and testicular repair prevents complications such as ischaemic atrophy of the testis and infection [48]. After conservative surgical debridement of non-viable tissue, the tunica albuginea should be closed. Tunica vaginalis can be used for closure if primary closure of tunica albuginea is not possible (Expert Opinion, AUA). The EAU recommends conservative management for minor intratesticular haematomas with observation, non-steroidal analgesics, and ice packs [5,49]. If a major intratesticular haematoma is discovered, surgical drainage is indicated to prevent secondary infection or pressure atrophy [50]. If scrotal trauma results in skin defects, primary closure is typically possible due to the elasticity of scrotal skin [5,46]. The AUA has specific guidelines for genital skin loss or injury due to infection, shearing injury, or burn [1]. Debridement should be limited to non-viable tissue, as the

patient may need multiple reconstructive procedures (Grade B, AUA).

Female External Genitalia Trauma

The EAU has specific guidelines for female external genitalia trauma [5]. The first step in the evaluation of female external genitalia injury is consideration of sexual abuse. A physician should obtain the history, a vaginal smear to check for spermatozoa, and urine and blood analyses. The most common sign of external genitalia trauma is blood at the vaginal introitus. With an injury to the female external genitalia, imaging with ultrasound, CT or MRI should be performed to evaluate for additional injuries [5]. Primary closure of vaginal injuries is recommended to prevent fistula formation. Conservative management with non-steroidal analgesics and ice packs is recommended if there is no vaginal tear [5].

Table 5 Summary of urological trauma guidelines recommendations.

Recommendation	Level of evidence	Organisation
Renal		
Patients with gross haematuria should undergo abdominal/pelvic CT with i.v. contrast with immediate and delayed images	Grade A or C	SIU, EAU, AUA
<i>Stable patient:</i> Conservative management for grades 1, 2 injuries	Grade B	SIU, EAU, AUA
Initial conservative management for high-grade renal injuries	Grade B	AUA
Surgical repair if already undergoing laparotomy for grades 3, 4 injuries	Grade C	SIU
Exploratory laparotomy for grade 5 injuries	Grade C	SIU
Renal exploration only for vascular grade 5 injuries	Grade B	EAU
<i>Unstable patient:</i> Exploratory laparotomy. Consider angioembolisation in experienced centres	Grade B	SIU, EAU, AUA
Angioembolisation is first-line option in patients with active bleeding and no other indication for immediate open surgery	N/A	EAU
Renovascular injury – attempt revascularisation only in patient with solitary kidney or with bilateral renal injuries	Grade C	SIU
Follow-up CT for grade 4 or 5 renal injuries 36–72 h after presentation	Grade C	SIU, EAU, AUA
Patients with renal trauma should have periodic blood pressure monitoring	Grade C	SIU, EAU, AUA
Ureter		
Abdominal/pelvic CT with i.v. contrast and delayed images should be performed for stable patients with suspected ureteric injuries	Grade C	EAU, AUA
Partial ureteric injury (grade 2 or 3) – primary closure over a stent	Grade C	EAU, AUA
Complete ureteric injury – surgical reconstruction based on nature and site of damage	Grade C	EAU, AUA
In unstable patients, surgeon may manage ureteric injuries with temporary drainage, and delayed definitive repair	Clinical Principle	AUA
Iatrogenic injury diagnosed postoperatively – attempt stent placement, percutaneous nephrostomy if unsuccessful	Grade C	AUA
Iatrogenic injury diagnosed postoperatively – perform percutaneous nephrostomy with or without stent	N/A	EAU
Bladder		
Cystography (conventional or CT) should be performed in stable patients with gross haematuria and pelvic fracture	Grade B	EAU, AUA
Cystoscopy should be performed to detect intraoperative bladder injuries after major gynaecological and retropubic sling procedures, and to diagnose a foreign body	Grade B	EAU
Uncomplicated extraperitoneal injury – catheter drainage and observation	Grade B or C	EAU, AUA
Complicated extraperitoneal injury – surgical repair	Grade B	EAU, AUA
Intraperitoneal injury – surgical repair (except for iatrogenic injuries without ileus or peritonitis, managed with drainage and observation)	Grade B	EAU, AUA
Follow-up all bladder injuries with cystography, except for simple surgical repair of an intraperitoneal injuries	Grade B	EAU, AUA
Urethra		
RUG should be performed for patients with blood at the meatus, who cannot void or with straddle injuries	Grade B or C	EAU, AUA
Penetrating anterior urethral injury – immediate surgical repair	Expert opinion	EAU, AUA
Blunt anterior urethral injury – catheter drainage with surgical treatment delayed for minimum 3 months	Grade B or C	EAU, AUA
Posterior urethral injury – prompt urinary drainage via suprapubic or urethral catheter with endoscopic urinary re-alignment attempt in stable patient	Grade C	EAU, AUA
For a patient who can lie in lithotomy position and a short posterior urethral defect, perform primary urethroplasty within 14 days of injury	Clinical Principle	EAU, AUA
External genitalia		
Closure of the tunica albuginea is recommended for penile fracture	Grade B	EAU, AUA
Surgical exploration is recommended for suspected testicular rupture	Grade B	EAU, AUA

RUG, retrograde urethrogram.

Conclusion

The guidelines differ in their recommendations in a few topics. The most notable difference is with regards to the management of high-grade renal trauma, although this is probably due to ambiguities of grading renal injuries via the AAST organ injury severity scale. The 2014 AUA guidelines recommend management based on haemodynamically instability, and do not mandate exploratory laparotomy for grade 5 injuries, which is different from the 2004 SIU and 2015 EAU recommendations. While there has been a general trend towards more conservative management of renal injuries over the last decade, the EAU maintains that vascular grade 5 renal injuries require renal exploration. Additionally, the EAU guidelines state that angioembolisation is the first-line option in a specific cohort of injured patients. Further research is necessary to optimise patient selection and timing of angioembolisation for high-grade renal injuries. Additionally, the SIU and EAU guidelines mention the need for early vascular control before renal exploration or reconstruction. However, the AUA guidelines state that the benefit of this manoeuvre is inconclusive.

Despite these differences, there is generally consensus between the EAU and AUA (and SIU for renal trauma) for genitourinary trauma. The EAU makes broader recommendations, covering topics not covered by the AUA, such as female genital injury and iatrogenic trauma. Most management recommendations in genitourinary trauma are derived from Grade B or C evidence, or based on Expert Opinion or Clinical Principle (Table 5). Unfortunately, Grade A evidence is rare in these guidelines. Multi-institutional collaborative research is needed to improve the level of evidence in future guidelines.

Conflict of Interest

No conflicts of interest to disclose.

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Abbreviations: AAST, American Association for the Surgery of Trauma; EAU, European Association of Urology; RUG, retrograde urethrogram; SBP, systolic blood pressure; SIU, Société Internationale d'Urologie.