BRITISH JOURNAL OF HOSPITAL MEDICINE

Management of urological trauma associated with pelvic fractures

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Abstract

Urological trauma is frequently encountered in patients with high energy pelvic fractures and can have debilitating long-term sequelae for patients without appropriate multidisciplinary management. Anterior pelvic ring disruption causes a high incidence of bladder rupture and urethral injuries, and initial assessment requires urological tract imaging and emergent bladder drainage before subsequent surgical repair. Pelvic ring disruption requires urgent fixation and should be managed as an open fracture in the context of significant bladder and urethral injury with urinary leakage. Long-term outcomes are variable and genitourinary dysfunction is commonly reported among patients with pelvic fractures. Optimisation of patient outcomes relies heavily on collaborative management between orthopaedic and urological specialists and requires an appreciation of the anatomical intricacies of the pelvis. This article provides an overview of the British Orthopaedic Association Standards for Trauma and Orthopaedics management of urological trauma in the context of pelvic fractures.

Key words: BOAST; Fractures; Genitourinary; Pelvis; Trauma

Submitted: 6 April 2020; accepted following double-blind peer review: 26 August 2020

Introduction

Pelvic trauma is a complex emergency that is associated with high morbidity and mortality, requiring multidisciplinary input for effective management and outcome optimisation. Blunt, high energy trauma causing displacement or fracture of the pelvic ring greatly increases the risk of concomitant damage to the urogenital organs owing to the anatomical proximity of these structures within the pelvis. Therefore, it is imperative to assess patients presenting with pelvic fractures for associated urogenital injury, as this can be a significant cause of urological dysfunction and morbidity. The spectrum of urogenital injuries and complications is varied, ranging from partial posterior urethral disruption to urogenital diaphragm lacerations and severe bladder injury. It is estimated that between 25 and 29% of patients presenting with pelvic fractures will have a concurrent urinary tract injury (Andrich et al, 2007; Figler et al, 2012). Erectile dysfunction is a common and serious complication and may affect up to 30% of men with pelvic fractures (Chung et al, 2018).

The British Orthopaedic Association Standards for Trauma and Orthopaedics (BOAST) are standardised, evidence-based guidelines for the management of commonly encountered trauma and orthopaedic conditions (British Orthopaedic Association, 2016). The BOAST guideline on the management of urological trauma associated with pelvic fractures was published in August 2016, as a collaborative project between the British Orthopaedic Association and the British Association of Urological Surgeons. It is also partly based on the National Institute for Health and Care Excellence (2016) guidelines on the assessment and management of complex fractures.

How to cite this article:
Trockels A, Ahluwalia AK, Chetwood A. Management of urological trauma associated with pelvic fractures. Br J Hosp Med. 2021. https://doi.org/10.12968/hmed.2020.0151

Anatomy

The pelvis is a complex osseous structure made up of the two pairs of innominate bones (fused ilium, ischium and pubis), the sacrum and the coccyx. The innominate bones articulate anteriorly at the pubic symphysis, while posteriorly the sacrum is joined to the ilia at the sacroiliac junction. The osteoligamentous configuration of the pelvic girdle produces a biomechanically stable ring, which serves to transfer the load of the upper axial skeleton, facilitate locomotion via lower limb muscle attachments and protect sensitive peritoneal organs and viscera.

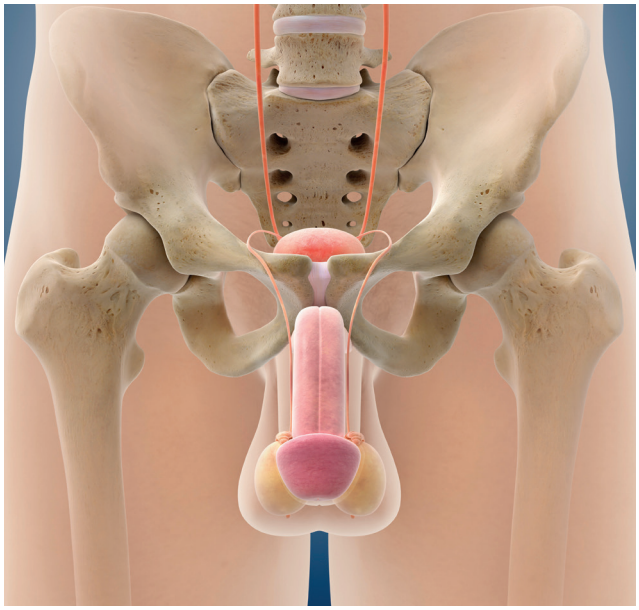

Figure 1. Pelvic anatomy of the male.

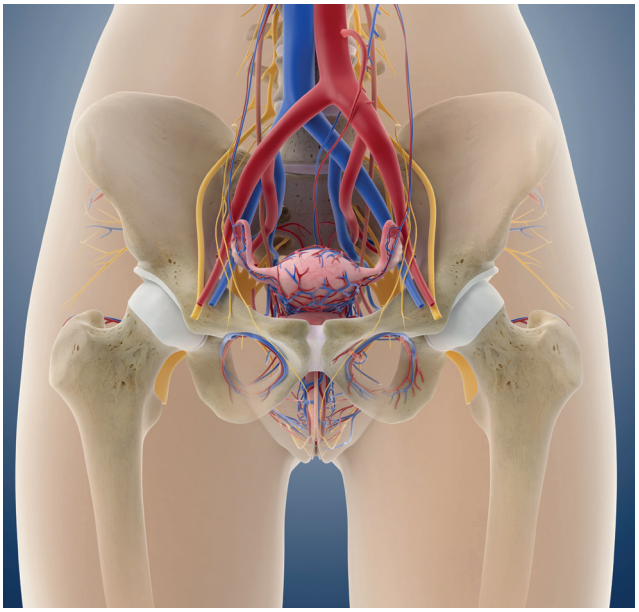

Figure 2. Pelvic anatomy of the female.

The bladder is a muscular sac which functions as the main urinary storage organ. It is located extraperitoneally and immediately posterior to the pubic symphysis. In women the anterior wall of the vagina lies posterior to the bladder, while in men the rectum lies posterior to the bladder. Inferiorly, the bladder is supported by the musculature of the pelvic diaphragm. The outflow tract of the bladder neck is contiguous with the prostate in men and is intimately anchored to the posterior pubic symphysis via the puboprostatic ligaments, while in women the bladder neck is fixed to the pubic symphysis via the pubovesical ligaments.

In men, the urethra is approximately 20 cm long (Figure 1) and divided into anterior and posterior sections, with the anterior section consisting of the penile and bulbar urethra and the posterior section comprising the membranous and prostatic urethra. The membranous section is enveloped by the urogenital diaphragm and the fixed nature of the membranous urethra in men puts the urethra at risk of urethral disruption injuries in high energy pelvic trauma. In contrast, in women the urethra is 5 cm long and transcends from the bladder neck through the perineal membrane between the labia minora (Figure 2).

Classification

The two main pelvic fracture classification systems in widespread use today are Tile's system and Young and Burgess' system, both of which use different metrics to estimate fracture severity (Burgess et al, 1990; Tile, 1996). Young and Burgess' tool classifies pelvic fractures according to mechanism of injury (Table 1 and Figure 3), while Tile's system distinguishes the severity of pelvic fracture based on pelvic ring stability (Table 2 and Figure 4). The intrinsic advantage of the Young and Burgess classification system is that it allows the orthopaedic surgeon to optimise anatomical realignment of the pelvic ring with respect to known traumatic force vectors needed to cause the classical fracture patterns described in Table 1. Tile's classification allows the stratification of the stability of pelvic fractures, which is important since severe pelvic instability is associated with a higher incidence of intrapelvic injury as well as an increased requirement for definitive surgical fixation.

Urethral disruption injuries caused by pelvic fractures are classified as partial or complete ruptures (European Association of Urology, 2020). However, lower urinary tract injuries can also be classified anatomically according to the level of the urethral disruption. Goldman et al (1997) proposed a comprehensive injury severity scale that primarily stratifies urethral injuries by anatomical description and location, which also includes injuries to the bladder base and neck. Similarly Al Rifaei et al (2001) developed a combined anatomical and functional grading system for urethral injuries that focused more specifically on posterior urethral injuries. More recently, the European Association of Urology has combined and

Table 1. Young and Burgess classification of pelvic fractures

Type	Anterior posterior compression (APC)	Lateral compression (LC)	Vertical shear (VS)
I	APC I: Symphysis widening <2.5 cm	LC I: Compression fractures of the pubic rami (superior pubic ramus and inferior pubic ramus) and ipsilateral anterior sacral ala	VS: Posterior and superior directed force
II	APC II: Symphysis widening >2.5 cm. Anterior sacroiliac joint diastasis. Disruption of sacrospinous and sacrotuberous ligaments	LC II: Rami fracture and ipsilateral posterior ilium fracture dislocation	
III	APC III: SI dislocation with associated vascular injury	LC III: Ipsilateral lateral compression and contralateral APC	

From Burgess et al (1990)

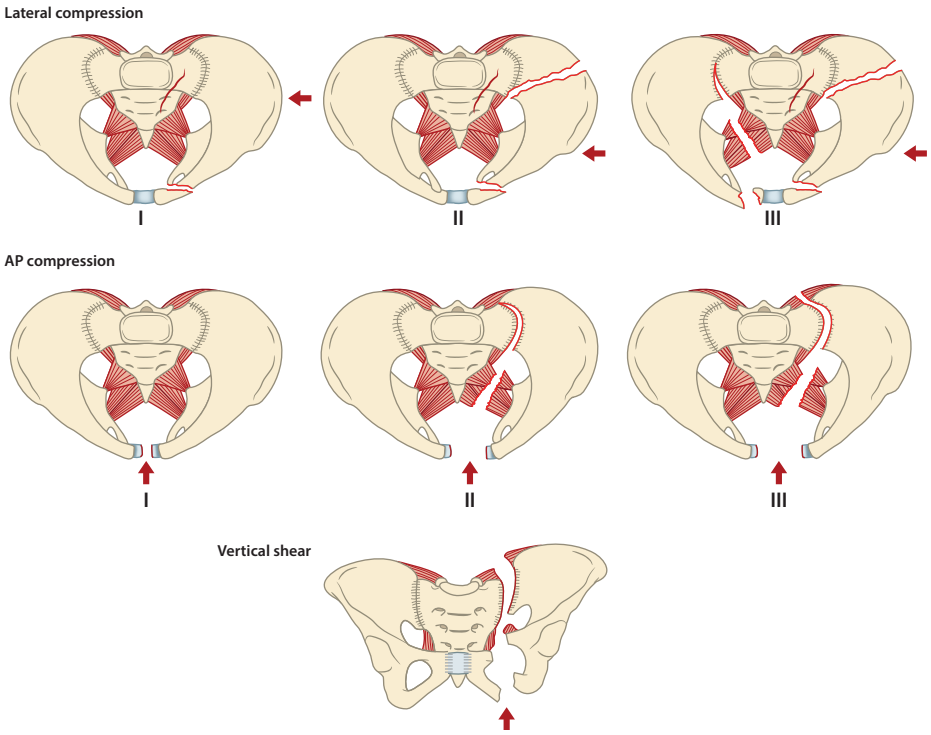

Figure 3. Young and Burgess classification of injury pattern.

improved the aforementioned systems to produce a more clinically relevant classification of blunt anterior and posterior urethral injuries (Martínez-Piñeiro et al, 2010) (Table 3).

Mechanism of injury

Pelvic ring disruption typically results from blunt, high energy trauma such as severe road traffic collisions or falls from a significant height. The most frequently encountered urological injuries in the context of pelvic trauma include urethral tears and intraperitoneal or extraperitoneal bladder rupture (Aihara et al, 2002). In this context, the incidence of extraperitoneal bladder injury is estimated at 85% and is thought to result from bony spicule perforation of the anterolateral bladder wall, while the remaining 15% of intraperitoneal bladder injury is likely caused by pathological force transmission through the symphyseal area against a full bladder (Sandler et al, 1981). Urethral disruption is more commonly encountered in men, as the urethra is anatomically more mobile in women and less susceptible to tearing. Combined sacroiliac joint diastasis and saddle fracture or Malgaigne fracture appear to significantly increase the risk of urethral injury via shearing of the bulbomembranous urethral junction secondary to pubic arch disruption, as shown by Koraitim et al (1996).

Table 2. Tile classification of pelvic fractures

Type	1	2	3
A: stable	Innominate bone avulsion or wing fracture	Stable ring fracture with intact posterior arch	Transverse sacral fracture
B: rotationally unstable but vertically stable	Open-book external rotation injury	Young–Burgess lateral compression-type internal rotation injury	Bilateral
C: rotationally and vertically unstable	Unilateral with intact contralateral side	Unilateral with incomplete contralateral side	Bilateral

From Tile (1996)

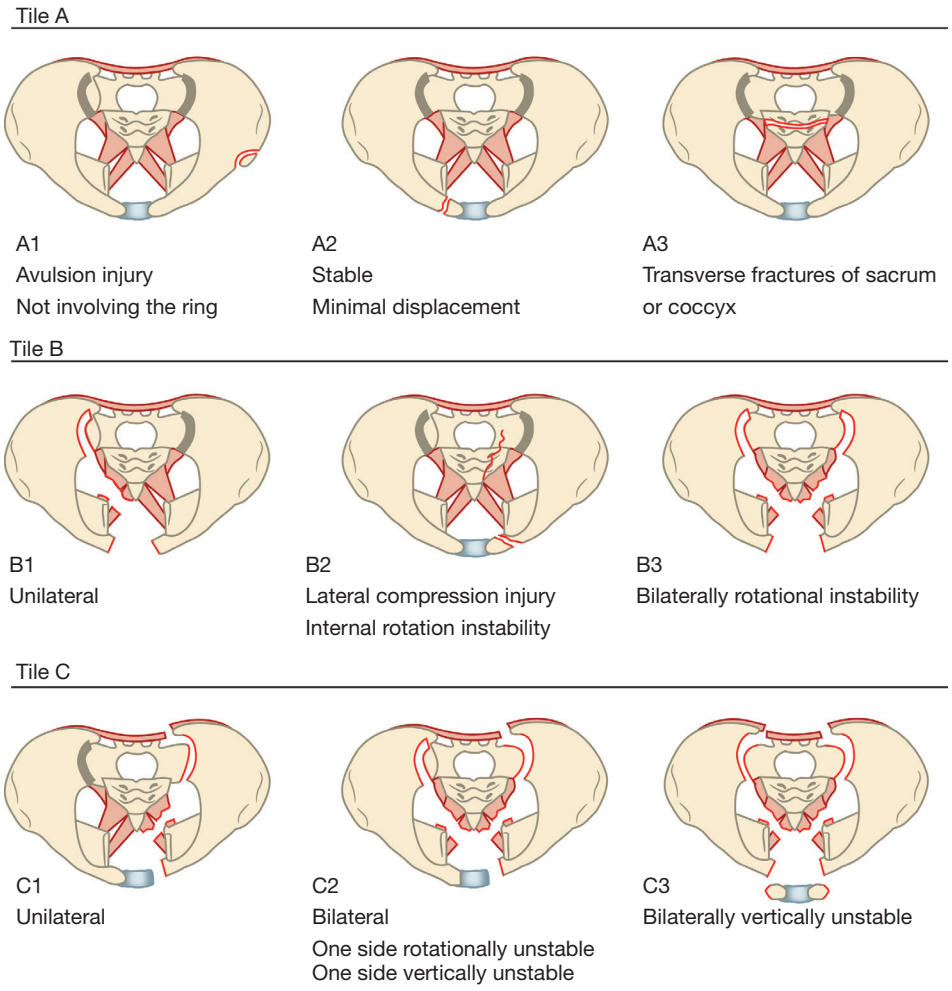

Figure 4. Tile's classification of injury pattern.

Urethral injuries in children typically follow a similar pattern to those seen in adults. However, posterior urethral injuries are more likely to involve tears of the prostatic and membranous urethra as well as the bladder neck than in adults, because of the position of the bladder in children (Koraitim et al, 1996).

Assessment and initial management

Initial assessment of patients with suspected pelvic fractures should follow Advanced Trauma Life Support (ATLS) algorithms with the aim of stabilising the patient's haemodynamic status, as this is a significant cause of mortality (American College of Surgeons Committee on Trauma, 2018). The arterial branches of the iliac vessels, pre-sacral venous plexus and pelvic fracture sites are frequent sources of pelvic bleeding and a blood volume >500 ml

Table 3. European Association of Urology classification of urethral injury

Grade	Description	Appearance	Management
I	Stretch injury	Elongation of the urethra without extravasation on urethrography	No treatment required
II	Contusion	Blood at the urethral meatus; no extravasation on urethrography	Managed conservatively with suprapubic cystostomy or urethral catheterisation
III	Partial urethral disruption	Extravasation of contrast at injury site with contrast visualised in the proximal urethra or bladder	
IV	Complete urethral disruption	Extravasation of contrast at injury site without visualisation of proximal urethra or anterior urethra or bladder	Suprapubic cystostomy and delayed repair or primary endoscopic realignment in selected patients delayed repair
V	Complete or partial disruption of posterior urethra with associated tear of the bladder neck, rectum or vagina	Extravasation of contrast at urethral injury site, presence of blood in the vaginal introitus in women Extravasation of contrast at bladder neck during suprapubic cystography rectal or vaginal filling with contrast material	Primary open repair

From Martínez-Piñeiro et al (2010)

within the pelvis evidenced by computed tomography imaging is strongly correlated with arterial bleeding and requires emergent blood transfusion (Blackmore et al, 2003). All patients with active pelvic bleeding should be managed with an appropriately fitted pelvic binder, ideally in the prehospital setting (Hsu et al, 2017). Severe haemorrhagic shock may require pelvic packing or arterial embolisation to control bleeding within the pelvis (Marzi and Lustenberger, 2014).

Orthopaedic considerations

A thorough examination of the patient's perineum, genitalia and rectum should subsequently be performed, documenting any laceration, bruising or swelling (British Orthopaedic Association, 2016). Lacerations in any of the aforementioned areas, as well as gross pelvic or lower limb asymmetry, should warrant consideration of an open fracture. Digital rectal examination should determine the presence and position of the prostate, blood, tone and presence of bony fragments. A non-palpable or high riding prostate is highly suggestive of urethral injury, although this test becomes less accurate with increasing patient body mass index (Johnson et al, 2013).

Urological considerations

Signs to alert the clinician of a lower urinary tract injury include blood at the external urethral meatus, an inability to void with a palpable bladder, haematuria and perineal swelling or bruising. A butterfly haematoma is a characteristic sign that is highly indicative of a combined bulbar urethral and Buck's fascia injury, whereby blood extravasates within Colles' fascia in a 'butterfly' shape beneath the scrotum (Persaud et al, 2019). This requires specialist urology input in order to optimise management (British Orthopaedic Association, 2016). Gross haematuria warrants an urgent retrograde cystogram to assess the integrity of the bladder (Ingram et al, 2008; British Orthopaedic Association, 2016). An experienced clinician should conduct a single attempt at inserting a 16F soft silicone catheter via the urethra. Computed tomography and clinical findings suggestive of urethral injury are not a contraindication to a catheterisation attempt. If catheterisation is successful, the appearance and presence of blood in the urine must be documented. In case of unsuccessful catheterisation as a result of urethral obstruction or frank blood drainage, the catheter should be removed gently without inflation of the balloon, followed by a retrograde urethrogram to aid diagnosis (Elliott and Barrett, 1997).

Failure of urethral catheterisation will require a further attempt using a cystoscope or guidewire urethrally or a suprapubic catheter. Immediate urinary drainage is not essential

during the first few hours, but early urinary diversion helps to monitor urine output, treat retention and reduce infection (European Association of Urology, 2020). Options to insert a suprapubic catheter depend on a number of factors including haemodynamic stability and the presence of a full or palpable bladder. If there is a palpable bladder then direct puncture and insertion of a suprapubic catheter (5 cm superior to the pubic symphysis in the midline) may be attempted with or without ultrasound guidance. Otherwise a suprapubic catheter can be inserted using a radiology-guided Seldinger technique or at subsequent laparotomy (Mundy, 1998; Corder and LaGrange, 2020). It is important to remember that a suprapubic catheter in the setting of pelvic trauma is not risk free because of bladder displacement secondary to pelvic haematoma and haemodynamic compromise. It has been commented that a suprapubic catheter may delay pelvic fracture fixation because of a theoretically increased risk of infection (Taffet, 1997). However, more recent evidence indicates no increased risk of infection at subsequent open reduction internal fixation to stabilise a pelvic fracture (Johnsen et al, 2018).

Signs of urinary leaking secondary to urethral damage or bladder rupture should be managed as suspected open fractures, with appropriate emergent antibiotic cover for 72 hours and early fracture fixation, patient physiology permitting (British Orthopaedic Association, 2016).

Investigations

Following stabilisation, plain anteroposterior pelvic X-rays or an abdominal and pelvic computed tomography scan should be arranged to allow for radiographic evaluation and Young and Burgess fracture classification of pelvic injury. Additional retrograde urethrograms and cystograms will guide further management by differentiating between partial or complete urethral tears and intraperitoneal or extraperitoneal bladder rupture (Yerasimides and Roberts, 2005).

Management

Close collaboration and operative planning between urological and orthopaedic surgeons is required when managing patients with combined pelvic fractures and urological trauma because of the associated multi-system injuries.

Fracture fixation

Prompt fracture reduction and pelvic realignment is the primary management goal from an orthopaedic perspective and demonstrably improves pelvic stability, thus reducing pelvic volume, haemorrhage and overall mortality. In the acute polytrauma patient this is typically achieved via anterior pelvic external fixation until the patient's physiology allows definitive internal fixation (Riemer et al, 1993; British Orthopaedic Association, 2016). External fixation decreases pelvic volume and promotes clot formation by re-approximating bleeding bone surfaces. This is typically achieved by inserting pins into the ilium bilaterally.

Urological management

Adequate urinary drainage is the primary objective of all subsequent considerations and must be adequately ensured early on. In case of intraperitoneal bladder rupture evidenced by contrast cystogram, an exploratory laparotomy and primary bladder repair is urgently indicated. While extraperitoneal bladder ruptures may be managed conservatively by catheter drainage alone, Yao et al (2018) demonstrated that operative repair of bladder rupture decreases the overall risk of pelvic orthopaedic hardware infection, and is therefore indicated when managing pelvic polytrauma patients. Equally, incidental discovery of bladder rupture during pelvic internal fixation should prompt primary repair by a urological surgeon. Paediatric bladder trauma requires specialist input because of the complex anatomical considerations and should only be managed by paediatric urologists (British Orthopaedic Association, 2016).

Paediatric and female urethral injuries warrant early involvement of a supra-regional urologist (British Orthopaedic Association, 2016). Since most female urethral injuries

are associated with bladder rupture, these can be managed via primary re-anastomosis or suturing during surgical exploration, where a transvesical approach is favoured to permit direct visualisation of all urological tissues. On the other hand, distal urethral injuries should be approached transvaginally to permit repair (Koraitim, 1999). Children should be managed similarly to adults, with delayed urethral surgical repair preferred in order to reduce complications such as incontinence, strictures and erectile dysfunction (Pichler et al, 2012).

Urgent primary urethral repair is indicated within 48 hours for patients suffering from perineal degloving, bladder neck trauma, massive bladder displacement, anterior urethral penetrative injury and associated anorectal injury. In most cases, primary urethral re-anastomosis or repair is not indicated in the acute setting and should be attempted 3 months post pelvic fixation, as the latter may provide sufficient initial urethral realignment (Philipraj, 2010).

Follow up and complications

Urological and sexual dysfunction are seldom discussed long-term sequelae of pelvic fractures, yet are exceedingly common and require specialist urology input. Genitourinary injury is the largest single risk factor for persistent impotence and sexual dysfunction in men and women, but up to 30% of patients with pelvic fractures without gross genitourinary injury go on to develop sexual dysfunction (Harvey-Kelly et al, 2011). As a result of the differences in pelvic anatomy the symptoms experienced by men and women will vary dramatically, but often cause significant long-term distress and a heavily underestimated psychosocial burden (Ayers et al, 2013).

Male sexual dysfunction as a consequence of pelvic trauma is often caused by compromise of the neurogenic and vascular supply to the corpus cavernosum of the penis. Injury to autonomic cavernosal nerves results in permanent cavernosal smooth muscle contraction, thus preventing blood flow into the penis for the purpose of erection. Similarly, disruption of the blood supply to the cavernosae prevents effective erection of the penis. In order to prevent further iatrogenic insult to these sensitive tissues, delayed reconstruction of the urethra is preferred rather than primary re-alignment as this reduces the incidence of new onset erectile dysfunction (Harwood et al, 2005).

Pelvic pain and dyspareunia are two common complications of pelvic ring injury in women and are both a significant cause of morbidity. In particular, injuries to the pubic symphysis and bladder rupture are associated with dyspareunia in women with pelvic fractures. It is thought that poor anatomical realignment of the pelvic bones, in situ metalwork, alongside soft tissue scar formation increases the incidence of dyspareunia (Vallier et al, 2012).

All patients with urological or sexual dysfunction in the context of pelvic fracture should be referred for specialist urological care and with assessment of functional status and patient-related outcome measures, which can be communicated through the Trauma Audit and Research network with a view to improve future care standards (British Orthopaedic Association, 2016; Bott et al, 2019).

Conclusions

Management of pelvic fracture-associated genitourinary injury in the polytrauma patient is a complex and multifaceted challenge for clinicians. This requires an early collaborative approach between orthopaedic and urological surgeons to reduce patient morbidity and improve functional outcomes.

Key points

- In all patients suffering high-energy trauma, suspect a pelvic injury, and in all patients suffering a pelvic injury, suspect urological trauma.
- Involve the urological team early when suspecting a urological injury to formulate an initial and definitive management plan.
- Identify the location and severity of the urological injury to guide management.

Curriculum checklist

This article addresses the following requirements from the urology trainee curriculum:

- To assess and manage patients who present with genitourinary trauma, including onward referral when necessary
- Assessment and management of bladder trauma including appropriate onward referral
- Assessment and management of urethral trauma including appropriate onward referral.

And from the orthopaedic trainee curriculum:

- Principles of management of associated ano-rectal, nervous, urological or genital injuries in pelvic injuries.

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Conflicts of interest

The authors declare no conflicts of interest.

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