Emergency Imaging of Male Genital and Urethral Trauma

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Learning objectives

- Review the imaging features of genital and urethral acute trauma in male adults (blunt and penetrating trauma) on multi-detector computed tomography (MDCT) and ultrasonography (US).

- Recognize them in the emergency MDCT despite not being clinically suspected, since male genital trauma may go unnoticed due to the presence of life-threatening injuries.

- Decide the most appropriate imaging tool for further genital evaluation or urethral injury confirmation.
Background

Traumatic injuries to male genitals vary and include blunt, penetrating and degloving injuries, and may result in significant injury to the lower genitourinary system and could be involved with associated pelvic fractures. Scrotal trauma is relatively uncommon and accounts for less than 1% of all traumas annually. Up to 85% of testicular injuries result from blunt trauma, and are often sports related, but other common mechanism of injury include motor vehicle collisions (involving two-wheeled vehicles in 64% of the cases), falls from height, direct blows to the torso or external genitalia. Penetrating scrotal trauma is mainly associated with gunshot wounds. Scrotal degloving injuries includes agricultural, manufacturing machinery or motorcycle or bicycle accidents, the most present-day genital skin avulsion cause.

Nowadays, MDCT is the mainstay of diagnostic assessment for trauma patient, and recognizing genital injury may be difficult by this technique, since the US is the first-choice imaging modality used to evaluate the injured scrotum: Hematocele is the most common finding, and the primary goal of US in the traumatized scrotum is to differentiate it from injury to the testis (intratesticular hematomas, fracture and testicular rupture). Trauma-induced testicular torsion is a well-recognized entity. US is also the preferred modality to evaluate penile trauma because it is well tolerated and widely available, and may manifest as a cavernosal or extratunical hematoma, penile fracture or arterial cavernous fistula (considered as high-flow priapism main cause after a genitoperineal trauma).

Genital trauma is usually not life threatening and affects the young (the peak age range is 10-30 years), and is often discovered late in the setting of acute trauma due to the presence of more life-threatening injuries. Despite being uncommon, external genital trauma must be promptly recognized to preserve function, cosmesis and minimizing long-term sexual and psychological sequelae.
Findings and procedure details

CT findings in male genital and urethral trauma

Multi-phased contrast-enhanced CT is always performed in blunt and penetrating trauma patient, and technical protocol depends on the physician in charge information, regarding the hemodynamic stability and about the suspected diagnosis. The parenchymal study of the abdomen and pelvis with portal venous timing is the main phase to perform, and hematuria or retroperitoneal hematoma requires excretory phase or cystography CT to assure urinary tract integrity. From the clinical point of view, the first important distinction is between penetrating and nonpenetrating traumas. A standard AP pelvic radiograph is the first assessment for bony injuries to the hip and pelvis in the setting of a trauma. Pelvic fractures may be involved in genital blunt trauma, and concomitant fractures of all four pubic rami or fractures of both ipsilateral rami are the high risk fracture type of urethral injury. In this context, an arterial phase study is performed to evaluate vascular injury, and also an excretory phase after 5 minutes or cystography CT to evaluate genitourinary damage are required. Gunshot wounds could require an unenhanced CT as the first study to localize the projectile if it is not well delimitated at simple X-ray or CT scout view.

Evaluating traumatic mechanism

- Gunshot wounds of the hip and pelvis (fig. 1, 2, 3 and 4)

Firearms are the main cause of male genital penetrating trauma. After obtaining hemodynamic stability, careful physical examination must be made in order to establish transabdominal gunshot wounds, which are those that traverse the gastrointestinal system before entering the pelvis. Once dismissed, hip joint involvement and injuries to the genitourinary system must be evaluated by finding the bullet or its trajectory. Bullet location is also important, since those lodged intra-articular should be removed. Penetrating injuries to the anterior urethra usually occur from gunshot wounds and involve the pendulous and bulbar urethral segments equally.

- Blunt pelvic trauma (fig. 5, 6 and 7)

Pelvic fractures may lead to life threatening bleeding originated from fractured bone, the pelvic venous plexus, major pelvic veins, and/or iliac arterial branches. Otherwise, major pelvic ring fracture due to blunt trauma results in lower urinary tract injury in up to 10% of cases, in particular complex fractures of the anterior pelvic arch, and initial management is largely conservative. Classically, it was thought that the posterior urethra at the level of the membranous urethra was the most commonly injured portion of the urethra occurring
in conjunction with pelvic fractures, and unstable diametric pelvic fractures and bilateral ischiopubic rami fractures have the highest likelihood of injuring the posterior urethra. Now it is thought that it is actually the proximal portion of the bulbous urethra that is most injured. However, traumatic mechanism should be taken into account, because straddle-type injuries caused by a crush mechanism are commonly related to anterior urethral damage. This occurs when the immobile bulbous urethra is compressed against the inferior aspect of the pubis. In particular, the combination of straddle fractures with diastasis of the sacroiliac joint has the highest overall risk.

Otherwise, scrotal injuries are frequently sports related and caused by projectiles, such as baseballs or by a direct kick to the groin. As a result, younger men are most often injured with a peak age range between 10 to 30 years.

**Evaluating the damage**

1. Urethral injuries

Urethral injuries have been traditionally classified anatomically as either anterior or posterior, but additional classification systems, such as Goldman classification or The Committee on Organ Injury Scaling of the American Association for the Surgery of Trauma (AAST) have been proposed. Urethrography allows correct injury classification, whatever the system used, but CT excretory phase could also be diagnostic.

Goldman classification of urethral injuries is based on anatomical location, and is a more widely accepted classification than one proposed by the AAST:

- **Type I**: Stretching of the prostatic urethra without discontinuity.

- **Type II**: Membranous urethral disruption above an intact urogenital diaphragm (no inferior contrast extravasation into the perineum).

- **Type III**: Membranous urethral disruption with injury of the urogenital diaphragm (contrast extravasation above and below the urogenital diaphragm).

- **Type IV**: Bladder neck injury (extraperitoneal contrast extravasation around the bladder base)

- **Type V**: Isolated anterior urethral injury

The Committee on Organ Injury Scaling of the AAST has developed another urethral-injury scaling system based on clinical management:
- Type I: Contusion (blood at the urethral meatus and normal urethrogram). No treatment required.

- Type II: Stretch injury (Elongation of the uretra without extravasation). It can be managed conservatively with suprapubic cystostomy or urethral catheterisation.

- Type III: Partial disruption (Extravasation of contrast at injury site with contrast in the bladder). It can be managed conservatively with suprapubic cystostomy or urethral catheterisation.

- Type IV: Complete disruption (Extravasation of contrast at injury site without visualization in the bladder, and less than 2 cm of urethral separation). It will require endoscopic realignment or delayed urethroplasty.

- Type V: Complete disruption (Complete transaction with more than 2 cm of urethral separation, or extension into the prostate or vagina). It will require endoscopic realignment or delayed urethroplasty.

2. Scrotal injury (fig. 8, 9 and 10)

Blunt trauma may cause local haematoma, ecchymosis of the scrotum (subcutaneous scrotal haematoma), or injuries to the testicle, epididymis or spermatic cord. Ultrasonography is the most sensitive and specific imaging method for detecting intrascrotal injury, but CT is useful to identify other related entities, such as testicular dislocation or active bleeding after testicular avulsion. A clinical organ injury severity scale for the scrotum of the AAST has also been proposed:

Type I: Contusion.

Type II: Laceration less than 25% of scrotal diameter.

Type III: Laceration equal to or more than 25% of scrotal diameter.

Type IV: Avulsion less than 50%.

Type V: Avulsion equal to or more than 50%.

3. Penile injury (fig. 11 and 12)

Penile injury may result from penetrating or blunt trauma. Surgical exploration without initial imaging is usually required for penetrating injuries, but blunt traumatic damage are often evaluated with imaging. Similar to the scrotum, US is the preferred technique for penile imaging, and it will be explained below. Type IV and V of AAST organ injury severity scale for the penis are the only that can be seen at CT.
Another entity that should be taken into account is traumatic priapism, which is considered as high-flow or non-ischemic priapism. It results from unregulated and continuous arterial inflow into the lacunar spaces. High-flow priapism needs to be assessed by color duplex Doppler US in order to characterized the possible formation of an arterial-lacunar fistula, as discussed below. However, there are three types of high-flow priapism: traumatic, neurogenic and post-shunting. Priapism can be related to transient paralysis and spinal shock, so a spinal cord injury (especially cervical cord injury) must be identified while performing CT (fig. 13).

**US findings in male genital trauma**

When low-energy trauma is suspected, it is not necessary to perform a CT, and scrotal and penile complaints could be evaluated with US. Evaluation of the urethra with ultrasound is limited, and only the presence of echogenic air within the injured corpora cavernosa suggests urethral injury.

1. Scrotal injury

Scrotal US is the most sensitive and specific imaging method for detecting intrascrotal injury, and it is important to assess the integrity and vascularity of the testes and detect alteration of the normal uniform echo pattern, hypoechoic areas, contour definition, less distinct or a discontinuity of echogenic line along the surface.

Scrotal injuries include lacerations, hematomas (fig. 14) and delayed blast-type injuries, but the most important is to assess the integrity of its content: Testicles, epididymis and spermatic cord.

- Testicular rupture (fig. 15 and 16): It is found in approximately 50% of direct blunt traumas to the scrotum, and associates disruption of tunica albuginea, while in intratesticular haematoma the tunica albuginea remains intact. AAST organ injury severity scale for the testis is as follows:

  Type I: Contusion or hematoma.

  Type II: Subclinical laceration of tunica albuginea.

  Type III: Laceration of tunica albuginea with less than 50% parenchymal loss.

  Type IV: Major laceration of tunica albuginea with equal to or more than 50% parenchymal loss.
Type V: Total testicular destruction or avulsion.

US specificity for detecting traumatic testis rupture is 75% and sensitivity 64%, so operative exploration should be undertaken if physical examination findings suggest significant testicular injury, even when the US is equivocal.

- Haematoceles, in which blood accumulates in the space between the tunica albuginea and tunica vaginalis.

- Traumatically induced testicular torsion (the incidence being 4% to 8%) (fig. 17).

- Traumatic epididymitis, epididymal fracture and epididymal hematoma (fig. 18).

Up to 10% to 15% of testicular neoplasms are first found incidentally on US examination for other indications, therefore continued follow-up imaging of any intratesticular lesion found in a patient with trauma is necessary.

2. Penile injury

Acute penile complaints are uncommon and often related to traumatic or vascular causes. Penile fracture or rupture of the corpus cavernosum almost exclusively occurs during erection. US can detect the exact site of the fracture as an interruption of the tunica albuginea with extruding hematoma, which may be seen deep to the Buck fascia or the skin. AAST organ injury severity scale for the penis is as follows:

Type I: Cutaneous laceration or contusion.

Type II: Bucks’ fascia (cavernosum) laceration without tissue loss (fig. 19)

Type III: Cutaneous avulsion or laceration through glans, meatus, cavernosal or urethral defect less than 2 cm.

Type IV: Cavernosal or urethral defect equal to or more than 2 cm (partial penectomy).

Type V: Total penectomy.

Priapism is a prolonged penile erection not associated with sexual desire. It is broadly classified as low-flow (ischemic) or high-flow (arterial or nonischemic). Nonischemic priapism presents clinically as a painless erection that typically follows genital trauma, and is not considered as an urologic emergency. High-flow priapism is characterized
by formation of a fistula between the cavernosal artery and the lacunae in the corpus cavernosum, known as an arterial-lacunar fistula, and may present days or even weeks after the original injury.
Fig. 1: Figures 1, 2, 3 and 4 corresponding to the same patient: Urethral trauma caused by gunshot wound. Figure 1. CT scan view (A) and axial contrast-enhanced MDCT in arterial phase (B) in a patient with a pelvic gunshot wound. A high density foreign body with metallic artifact is seen located in left ischial tuberosity corresponding to the bullet (red arrow). Note subtle right subcutaneous and muscular air bubbles representing the entry wound (green arrow).

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Fig. 2: Figures 1, 2, 3 and 4 corresponding to the same patient. Urethral trauma caused by gunshot wound. Figure 2. Axial contrast-enhanced MDCT in arterial (A), venous (B) excretory (C) phases and CT cystography (D) in the same patient. Note left pararectal fat collection (red arrow), but no contrast extravasation in the arterial and venous phase suggesting active bleeding is seen. Finally, CT cystography is performed with 70 mL of iodinated contrast material, demonstrating urinary contrast extravasation in the left pararectal space (green arrow). Note rectal catheter (blue arrow) previously inserted in order to exclude rectal perforation.

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Fig. 3: Figures 1, 2, 3 and 4 corresponding to the same patient. Urethral trauma caused by gunshot wound. Figure 3. Axial (A), sagittal (B) and coronal (C) MIP reconstructions of CT cystography showing extraperitoneal contrast extravasation extending from prostate posterior margin into the left pararectal space (red arrow), indicating prostatic urethra injury. Note the bullet in left ischial tuberosity (green arrow).

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**Fig. 4:** Figures 1, 2, 3 and 4 corresponding to the same patient. Urethral trauma caused by gunshot wound. Figure 4. Retrograde cystography (A) and voiding cystourethrography (B) are performed two weeks later. Posterior urethral injury is demonstrated, and no bladder injury is identified. Contrast extravasation is seen adjacent to the lower prostatic urethra (red arrow), but it does not extend below the urogenital diaphragm (Goldman Type II urethral injury). Note the bullet in left ischial tuberosity (green arrow).

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**Fig. 5:** Axial contrast-enhanced MDCT in arterial (A) and venous (B) phases in a patient previously treated from right hypogastric artery embolization (red arrow) after falling from 5th floor. Note minimum contrast extravasation in the right margin of bulbar urethra, which could indicate bulbar urethral injury (green arrow). Pneumoperitoneum extending to right spermatic cord (blue arrow) is seen secondary to packing surgery.

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Fig. 6: Figures 6 and 7 corresponding to the same patient. Prostatic urethral injury in a blunt trauma Figure 6. Axial contrast-enhanced MDCT in arterial (A) and venous (B) phases and cystography CT (C) showing an hematoma in the right obturator foramen area, with no active bleeding. Urinary contrast extravasation from prostatic urethra is seen after introducing contrast iodinated material through Foley catheter (red arrow). Note right superior pubic ramus fracture (green arrow).

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Fig. 7: Figures 6 and 7 corresponding to the same patient. Prostatic urethral injury in a blunt trauma Figure 7. Voiding cystourethrogram (after introducing iodinated contrast material through cystostomy) is performed 3 month following the trauma episode. An irregularity of the prostatic urethra is demonstrated (red arrow) corresponding to previous urethral injury, without contrast extravasation.

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Fig. 8: Axial contrast-enhanced MDCT in arterial (A), venous (B) and late (C) phases in a patient with a biking accident. Left scrotum and spermatic cord are enlarged, undefined, inhomogeneous and occupied by focal high dense areas, consistent with hematoma. Focal nodular hyperdensity in late phase (green arrow) is seen in left scrotum indicating active bleeding. Left testis could not be recognized. Note the presence of air bubbles (blue arrow) indicating skin disruption, consistent with testicular avulsion. At surgery, spermatic cord was ligated and testicular fragments with hematoma were found in left scrotum.

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Fig. 9: Axial contrast-enhanced MDCT in arterial (A), venous (B) and late (C) phases in a patient with multiple pelvic fractures. Hematoma with multiple active bleeding focus in right inguinal canal, penile base and perineum are seen (red arrow). Bilateral hematocele is shown (green arrow), but testicles are intact (not shown). Note right ischiopubic ramus fracture (blue arrow).

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**Fig. 10:** Axial unenhanced CT in a patient with recent pelvic surgery. An iatrogenic left scrotum hematoma (red arrow) is seen. Note also diffuse subcutaneous oedema (green arrows) and both testicles are pushed forward (blue arrows), with no signs of injury.

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**Fig. 11:** Figures 11 and 12 corresponding to the same patient. Left corpus cavernosum trauma. Figure 11. Axial contrast-enhanced MDCT in arterial (A), venous (B) and late (C) phases showing corpora cavernosa asymmetry, with enlargement of left corpus cavernosum suggesting intracavernosal hematoma (green arrows). Active contrast extravasation from the left corpus cavernosum to the posterior margin of the penile base (red arrows) is seen. Note right ischiopubic ramus fracture (blue arrows).

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**Fig. 12:** Figures 11 and 12 corresponding to the same patient. Left corpus cavernosum trauma. Figure 12. Coronal (A) and sagittal (B) MIP reconstruction of CT venous phase, showing contrast extravasation from the left corpus cavernosum (red arrow) to the penile base (green arrow).

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Fig. 13: Axial contrast-enhanced MDCT in arterial (A) and venous (B) phases and sagittal reconstruction of non-contrast cervical CT (C) in a patient with traffic accident and spinal cord injury. Note the enlargement and hyperattenuation of both corpus cavernosum and corpus spongiosum related to the high-flow priapism. Grade 1-2 anterolisthesis C4 on C5 secondary to right facet joint fracture (not shown).

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Fig. 14: Testicular US in a young patient with motorcycling accident. Left testicular parenchyma is homogeneous and normal internal vascularity (A). Inhomogeneous extratesticular hematoma adjacent to the lower pole that extends to the inguinal region, with different echogenic pattern (B) and (C).

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**Fig. 15:** Right testicle US in a patient with motorcycling accident. Contour abnormality of the lower pole and inhomogeneous intratesticular echotexture are seen (red arrow) secondary to trauma. Tunica albuginea (TA, green arrows) is not defined in this location (red arrow), so a testicular rupture must be considered. Note also the presence of extratesticular hematocele (blue arrow) that complicates the TA visualization.

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**Fig. 16:** Right testicle US in a patient with biking accident. Contour abnormality of the superior pole is seen secondary to tunica albuginea (red arrows) rupture, with extrusion of testicular parenchyma (green arrow). Voluminous right hydrocele (blue arrows).

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Fig. 17: Testicular US in a young patient with left inguinal pain after sport blunt trauma. No focal intraparenchymal lesions are seen in the left testis, but decreased flow is noted comparing with the contralateral testis (A and B). Note enlargement of left spermatic cord, and whirlpool sign (C) is seen, indicating traumatically incomplete testicular torsion.

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Fig. 18: Right testicular US in a young patient with trauma. No parenchymal injuries are seen (asterisk), but enlargement of the head of epididymis is noted (white arrow), with an
inhomogeneous echotexture that suggests post-traumatic hematoma of the epididymis. Note an epididymal cyst (red arrow).

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Fig. 19: Penile US with longitudinal (A) and axial (B) view in a young patient with sudden pain, showing loss of continuity of the tunica albuginea of the ventral surface of the right corpus cavernosum (dotted line and red arrow), according to penile fracture. Note also hematoma in the deep fascia of the penis (green arrows). RC: Right Corpus Cavernosum, LC: Left Corpus Cavernosum, CS: Corpus Spongiosum.

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Conclusion

Genital and urethral injury in male adults is often a delayed diagnosis in the emergency trauma setting, causing devastating long-term consequences. These lesions should be considered and recognized on emergency CT scans, which may precede US or RUG.
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