Urological Trauma

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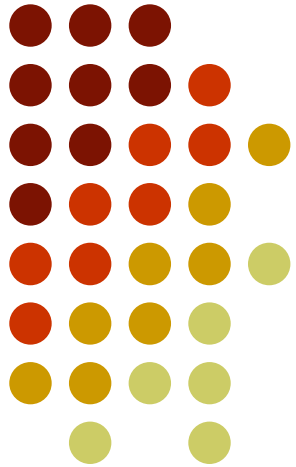


introduction

- Urologic trauma is classified according to the location of injury:

1- **upper urinary tract** (kidneys and ureters)

2- **lower urinary tract** (bladder and urethra), and **external genitalia** (penis, scrotum, and testes).

Renal trauma

Renal Anatomy

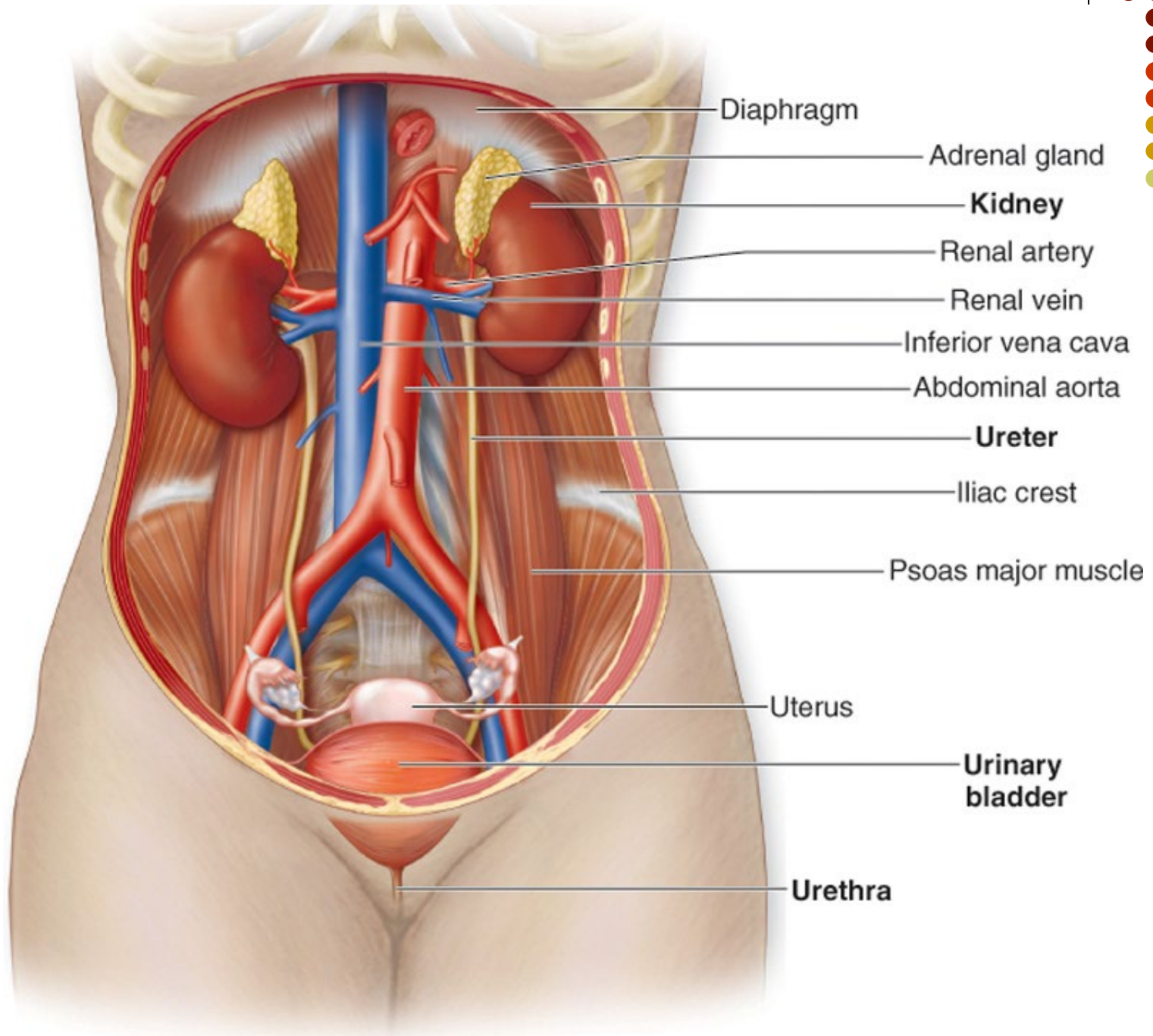
- The kidneys are retroperitoneal organs on each side of the vertebral column (T12-L3), at about the level of the twelfth rib.

- The left kidney is lightly higher in the abdomen than the right.

- On an average, each kidney weighs 150 g.

- The kidneys have the following coverings:

1. Fibrous capsule
2. Perirenal fat
3. Renal fascia
4. Pararenal fat


Diaphragm
Adrenal gland
Kidney
Renal artery
Renal vein
Inferior vena cava
Abdominal aorta
Ureter
Iliac crest
Psoas major muscle
Uterus
Urinary bladder
Urethra

Relevant anatomy

- The superior aspect of the kidneys is somewhat protected by the lower ribs.
- the lower poles are inferior to the 12th ribs.
- The parenchyma of the kidney has **a segmental arterial supply.**
- there is numerous anatomical variations, including pelvic kidneys; horseshoe kidneys; and multiple renal arterial, venous, and ureteral duplications.

Renal trauma

- The kidney is the **most commonly injured structure in the urinary tract**, accounting for **1%** of all traumatic injuries. Nevertheless, **operative intervention is pursued in only approximately 10%** of renal injuries.

- The majority of renal injuries are **mild** and can be managed conservatively.

Mode of Injury

- The mechanisms of renal injuries are classified as **blunt (closed)** or **penetrating (open).**

- Blunt injuries → tend to fracture along the planes between the segmental vessels, **but** penetrating injuries → cross the segmental vessels.

- **Blunt trauma (90%)** can be the result of **direct compression** or **deceleration.**
  - Motor vehicle accidents
  - falls
  - direct blows to the flank
  - **Deceleration injuries** are particularly dangerous because they may lead to **renal vascular injuries.**

- **<u>Penetrating wounds(10%)</u>** are ones open to the external environment.
  - Gunshots
  - Stab wounds

- Renal injuries from penetrating trauma tend to be **more severe** and less predictable than those from blunt trauma.

Box 10.1 Staging of the renal injury

Using CT, renal injuries are staged according to the American Association for the Surgery of Trauma (AAST) Organ Injury Severity Scale. Higher injury severity scales are associated with poorer outcomes.

Grade I	Contusion or subcapsular hematoma with no parenchymal laceration
Grade II	Parenchymal laceration of cortex <1 cm deep, no extravasation of urine (i.e., collecting system intact) (Fig. 10.1)
Grade III	Parenchymal laceration of cortex >1 cm deep, no extravasation of urine (i.e., collecting system intact)
Grade IV	Parenchymal laceration involving cortex, medulla, and collecting system OR segmental renal artery or renal vein injury with contained hemorrhage
Grade V	Completely shattered kidney OR avulsion of renal hilum

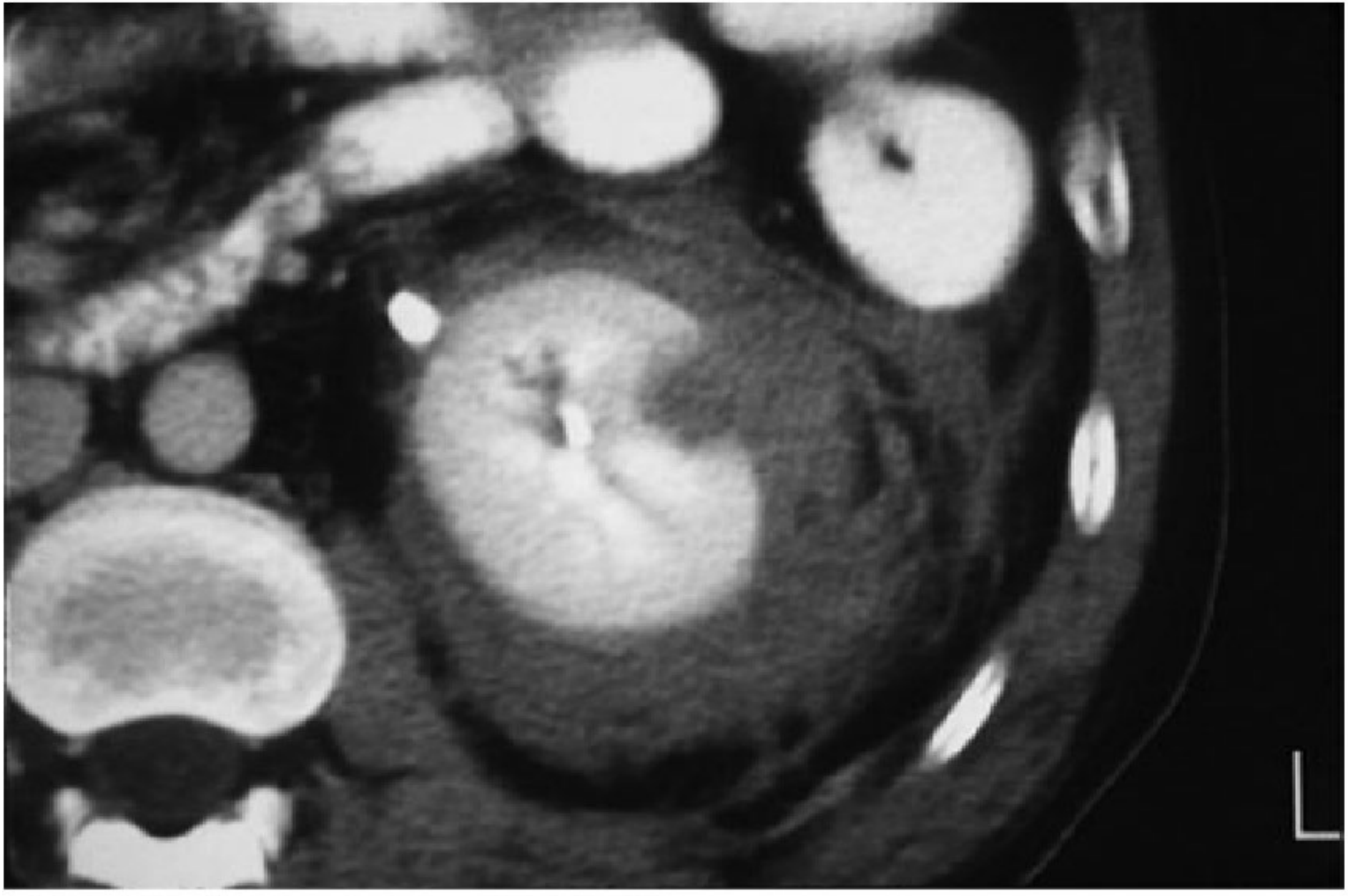


Figure 10.1 Renal CT with IV contrast in blunt trauma patent shows a superficial (grade 2) laceration amenable to nonoperative management.

Initial emergency assessment

1. Initial assessment of the trauma patient should include **(ABC)** controlling any external **bleeding** and **resuscitation** of shock as required, and securing of the **airway.**

2. Take careful **history**

3. **Physical examination** is usually carried out during stabilization of the patient.

4. When renal injury is suspected, **further evaluation** is required for a prompt diagnosis.

History and physical examination

- **Haemodynamic stability** should be decided upon admission
- **History** should be taken from conscious patients, witnesses, and rescue team personnel regarding the **time and setting of the incident.**
- **Abnormal kidneys are more liable to injury** thus, a history of **past renal surgery**, and known **pre-existing renal abnormalities** (large cysts, stones) should be recorded.
- In penetrating wounds Do **examination** of thorax, abdomen, flanks and back for should be obtained **(eg. Bruises, rib fractures…etc)**

- The following findings on physical examination may indicate possible renal involvement:

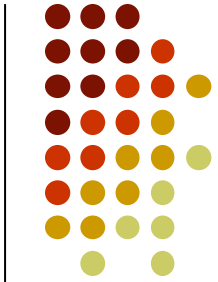
1. ***Haematuria***
2. Flank pain
3. Flank ecchymosis
4. Flank abrasions
5. Fractured ribs
6. Abdominal distension
7. Abdominal mass
8. Abdominal tenderness.

Laboratory studies

-Urinanalysis:

- It is the **single most important laboratory test** in the evaluation of renal injuries.
- **Hematuria is an important indicator** of injury to the kidney ,yet the presence or absence of hematuria should be viewed in the clinical context and not used as the sole decision point in the assessment of a patient with a possible renal laceration.
- **The degree** of hematuria, **does not** precisely correlate with the severity of injury.

Imaging studies



- **The goal** of radiographic assessment is to provide complete and **accurate staging** of renal injuries in order **to determine the need for and to plan operative management.**

- **Indications:**
  1. Gross hematuria
  2. Microscopic (>5 RBCs per high-powered fi eld [hpf]) or dipstick hematuria in a hypotensive patient (systolic blood pressure of <90 mmHg recorded at any time since the injury)
  3. History of rapid deceleration with evidence of multisystem trauma (e..g., fall from a height, high-speed motor vehicle accident).
  4. Penetrating chest and abdominal wounds (knives, bullets) with any degree of hematuria or suspicion of renal injury based on wound location

- **These criteria do not apply to <u>pediatric</u>** trauma patients; in this population, **significant renal injury can occur** even in the setting of microscopic hematuria without hypotension.

Ultrasonography

- **Advantages**

1. It is noninvasive
2. It may be performed in real time in concert with resuscitation
3. It may help define the anatomy of the injury.

- **Disadvantages**

1. Optimal study results related to anatomy require an experienced sonographer
2. Bladder injuries may be missed.

Computed Tomography

- **Advantages:**

1. It allows unsurpassed functional and anatomic assessment of the kidneys and urinary tract
2. It allows for the diagnosis of concurrent injuries.

- **Disadvantages:**

1. It requires intravenous contrast in order to maximize information about functionality, hematoma, and, possibly, bleeding.
2. The patient must be stable enough to go to the scanner
3. Full urinary assessment is dependent on the timing of contrast and scanning in order to view the bladder and ureters.

Intravenous Pyelogram

- **Advantages**

1. It allows functional and anatomic assessment of both kidneys and ureters,
2. It may be performed in the emergency department or operating room.

- **Disadvantages**

1. It requires multiple images for maximal information.
2. The radiation dose is relatively high.
3. Findings do not reveal the full extent of injury.

Angiography

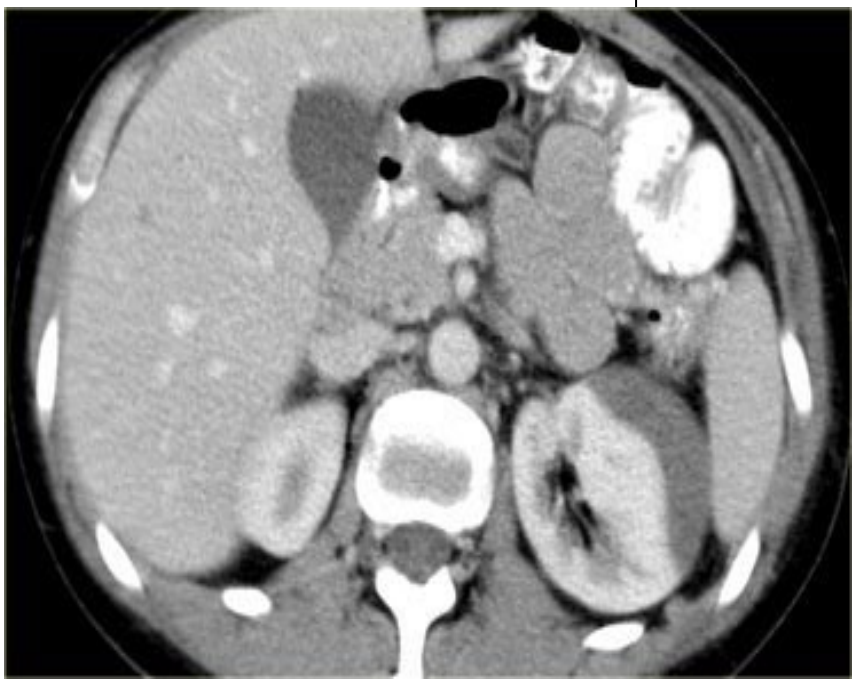
- **Advantages:**

1. It has the capacity to aid in both the diagnosis and treatment of renal injuries
2. It may further define injury in patients with moderate IVP abnormalities or with vascular injuries.

- **Disadvantages:**

1. It is invasive
2. It requires contrast
3. It requires mobilization of resources to perform the study, which may be time-consuming
4. The patient must travel to the radiology department.

Abdominal CT scan demonstrating multiple kidney lesions of varying radiographic densities



On the left a typical subcapsular hematoma, which is also a grade I renal injury.

Management of renal trauma

- Stable patients, following grade 1-4 blunt renal trauma, should be managed **conservatively** with bed-rest, prophylactic antibiotics, and continuous **monitoring** of vital signs **until haematuria resolves**

- **Indications for surgical** management include:

  1. **Haemodynamic instability**
  2. Exploration for associated injuries
  3. Expanding pulsatile **retroperitoneal haematoma during laparotomy**
  4. grade IV (in haemodynamically unstable patient) and, especially, grade V injuries often require nephrectomy to control bleeding (grade V injuries function poorly if repaired).

  Patients with **penetrating trauma** to the kidney require renal exploration **unless** radiographic imaging clearly delineates injury that can be managed safely nonoperatively in a hemodynamically stable patient.

Post-operative management and follow up

- Repeated imaging is recommended for all hospitalized patients within 2 to 4 days following renal trauma

- Within 3 months of major renal injury, patients' follow-up should involve:
  1. Physical examination
  2. Urinalysis
  3. Individualized radiological investigation
  4. Serial blood pressure measurement
  5. Serum determination of renal function

- Long-term follow-up should be decided on a case-by-case basis

Complications

- **Early complications:**

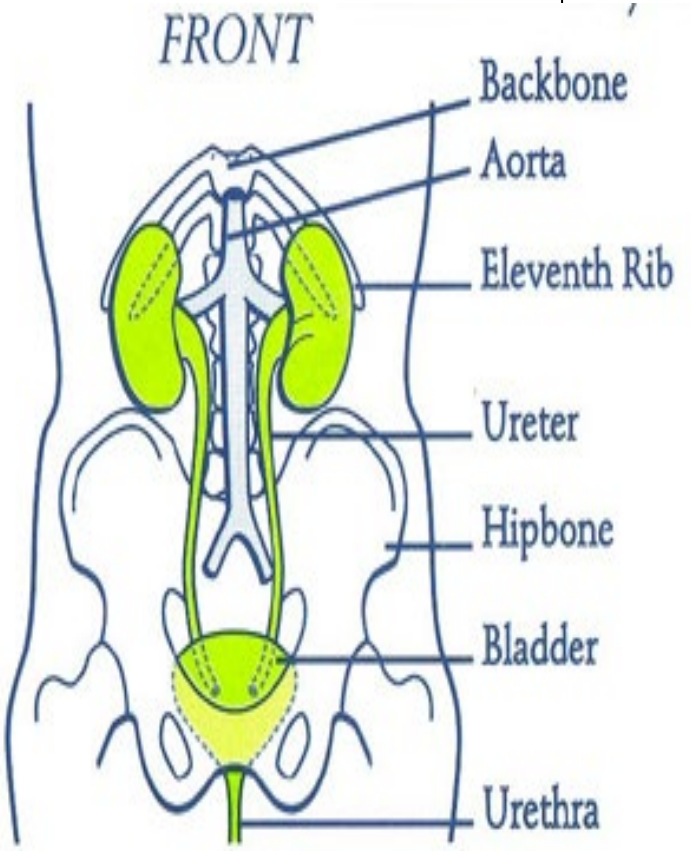
-occur within the first month after injury
-include:
1-bleeding 2- infection
3-perinephric abscess 4-sepsis
5-urinary fistula 6-hypertension
7-urinary extravasation 8-urinoma.

- **Delayed complications:**

-include:
1- bleeding 2- hydronephrosis
3-calculus formation 4-chronic pyelonephritis
5-hypertension 6-arteriovenous fistula
7- pseudoaneurysms.

Ureteral Anatomy

- The ureters are retroperitoneal tubes measuring each about 25 cm long and about 3 mm in diameter.
- They descend with an inclination medially on the posterior abdominal wall opposite the tips of the lumbar transverse processes. They continue following the contour of the pelvis.
- They pass obliquely in the wall of the bladder of 1 inch before they open at the sides of the trigone.



Ureteral Trauma

- Trauma to the ureter is relatively rare and accounts for only 1% of all urinary tract trauma.
- The ureters may be injured as a result of external violence (penetrating or blunt trauma) or by iatrogenic injury during an operation.

Mode of Injury:

- **Simple**: Perforation (Iatrogenic)
- **Complex**: Transection (extensive surgeries, RTA)

Diagnosis

- No classic clinical symptoms and signs associated with acute ureteral trauma caused by external injury. **(EASY TO MISS)**

- Ureteral trauma should be **suspected in:**

1. Penetrating abdominal injury and blunt deceleration trauma, in which the kidney and renal pelvis can be torn away from the ureter.

2. Isolated ureteral injuries if missed: subsequent evidence of upper tract obstruction, urinary fistula formation and sepsis.

3. Gynecological pelvic surgery: complaints of flank pain, vaginal leakage of urine or become septic.

Laboratory Studies

- Laboratory evaluation should include urinalysis, urine culture, complete blood count, and creatinine determination from the serum and drainage.
- Interestingly, hematuria is not a reliable finding in ureteral injuries, as only 74% of cases involve gross or microscopic hematuria. A failure to observe hematuria may be seen with a completely transected ureter or partial transection of an adynamic segment.

Imaging Studies

- **CT**: It is the criterion standard for evaluating abdominal injuries due to blunt trauma in stable patients. Contrast-enhanced CT scanning is highly sensitive in detecting urine extravasation and thus can be considered the primary imaging modality to evaluate for ureteral integrity in the stable patient.

- **IVP**: used in patients who must undergo immediate exploratory laparotomy for a penetrating injury to the abdomen

- **Retrograde pyelography**: it is the most sensitive radiographic study for the diagnosis of ureteral injury. It may be used in the stable patient as an adjunct to other imaging modalities when other clinical information is needed. It also has the added advantage of facilitating the placement of a ureteral stent in the same session, if indicated.

- **Antegrade ureterography**: it is not routinely used in diagnosing ureteral injuries. It is useful in conjunction with percutaneous nephrostomy tube placement or placement of an antegrade ureteral stent.

Classification of ureteral lesions

Grade	Description of Injury
I	Contusion or hematoma
II	< 50% transection
III	> 50% transection
IV	Complete transection with < 2 cm devascularization
V	Avulsion with > 2 cm devascularization

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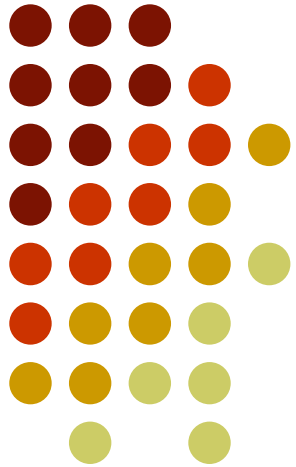
Contusion

Although a contusion may be considered a minor injury, it can result in a stricture if left untreated. Extensive areas of contusion may even result in ureteral necrosis secondary to microvascular damage. Minor injuries can be treated with internal ureteral stenting, while severe or large areas of contusion should be excised and ureteroureterostomy performed.

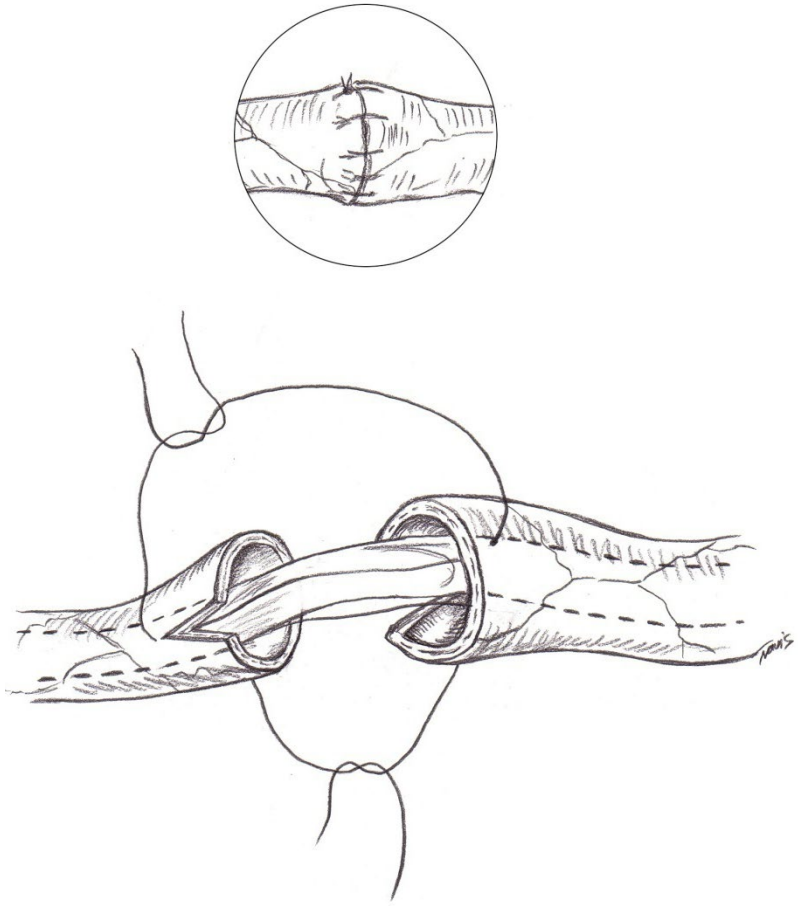
Partial transection

Partial ureteral transections can be repaired with primary closure. Instead, the injured segment should be resected, with 2-cm margins, and the edges reapproximated. For non-ballistic injuries, the defect may be closed primarily by closing the longitudinal laceration transversely in order to avoid narrowing of the lumen).



- **Complete transections**; upper, middle and distal ureteral injuries

1. **Ureteroureterostomy**: involves an end-to-end repair of ureteral defects smaller than 3 cm .This is mostly performed in the upper and mid ureter.

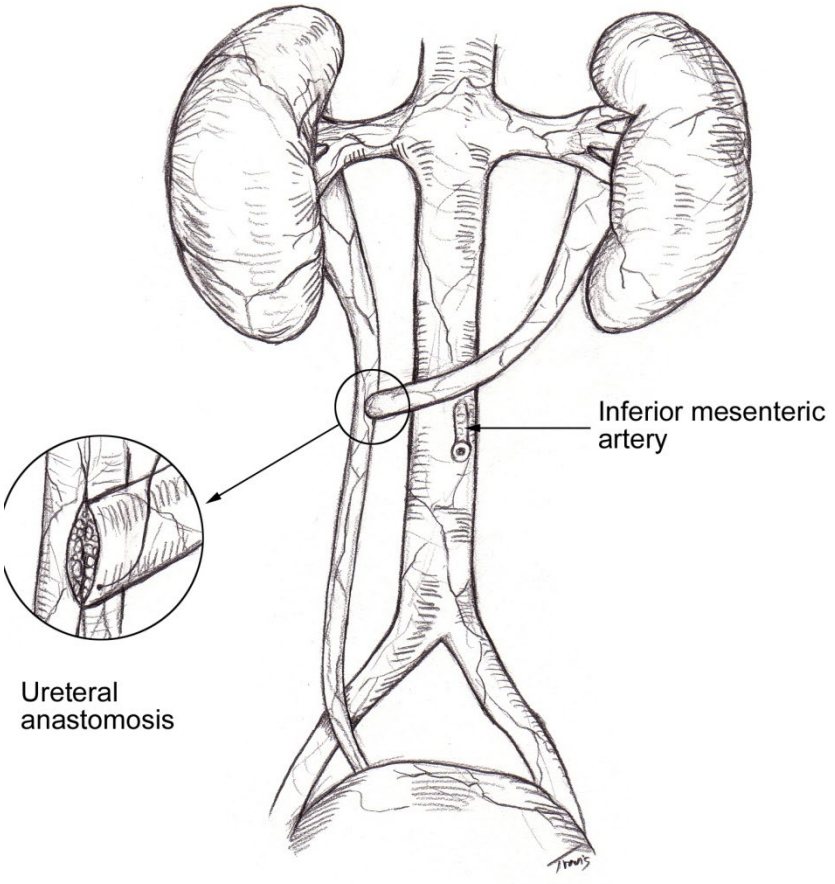


2. **Ureteropyelostomy:** the ureter may be anastomosed directly into the renal pelvis, this is done in case of proximal ureteral injury.

3. **Ureterocalicostomy:** If the renal pelvis or ureteropelvic junction is damaged beyond repair the ureteral stump may be sewn end-to-side into an exposed renal calyx.

4.

Transureteroureterostomy: this can be performed to manage an extensive defect that involves the mid or upper ureter if the length for anastomosis to the bladder is insufficient. This involves bringing the injured ureter across the midline to the recipient ureter in an end-to-side anastomosis



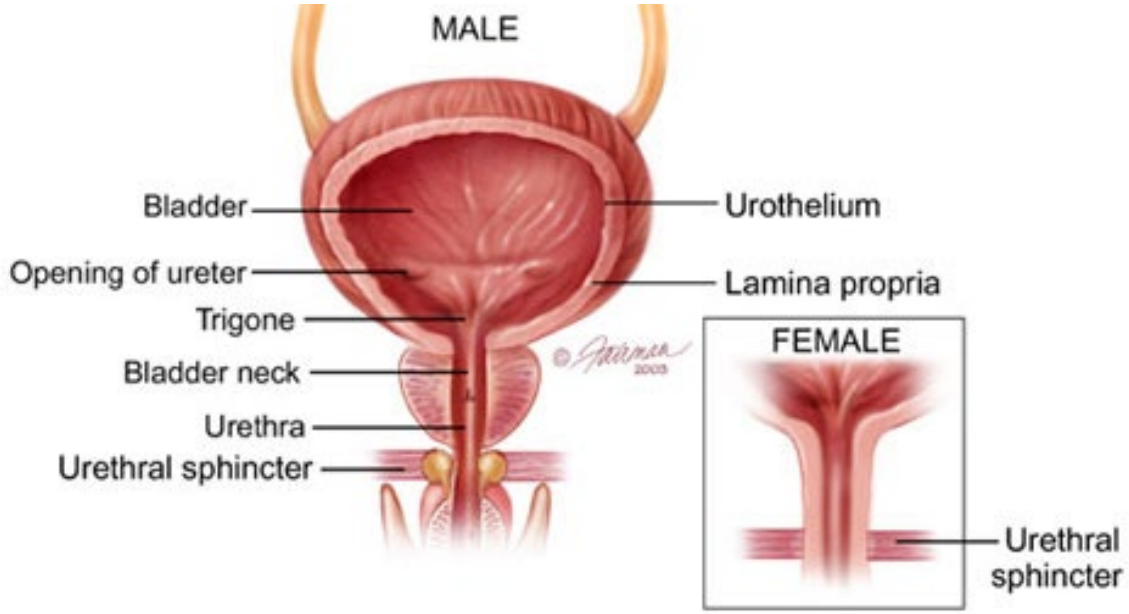
5. **Ureteroneocystostomy:** Injuries to the lower ureter are usually associated with disruption of its blood supply from the iliac vessels. Therefore, these injuries are best repaired with ureteroneocystostomy .The principles of repair include debridement and spatulation of the ureter, tunneling in the bladder wall toward the bladder neck in a 3:1 ratio of tunnel length to diameter of ureter.

6. **Vesicopsoas hitch:** This procedure involves mobilizing the bladder and pulling it superiorly and laterally by fixing it to the psoas tendon.

7. **Boari bladder flap :** For injuries too long to be bridged with the psoas hitch procedure alone, a Boari flap can be created to provide an additional 12-15 cm of length

Bladder Anatomy

- The adult bladder is located in the anterior pelvis and is enveloped by extraperitoneal fat and connective tissue. It is separated from the pubic symphysis by an anterior prevesical space known as the space of Retzius. The dome of the bladder is covered by peritoneum, and the bladder neck is fixed to neighboring structures by reflections of the pelvic fascia and by true ligaments of the pelvis.



Relevant Anatomy

The type of extravasation depends upon the location of the laceration and its relationship with the peritoneal reflection.

- If the perforation is above the peritoneal reflection, the extravasation is intraperitoneal.
- If the injury is below the peritoneal reflection, the extravasation is extraperitoneal.

With an anterosuperior perforation, urinary extravasation may be intraperitoneal, extraperitoneal or both. If the tear is posterosuperior, fluid can spread intraperitoneally and/or retroperitoneally.

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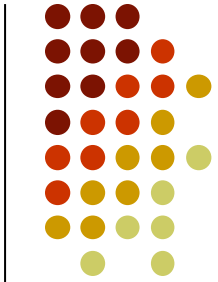
Bladder Trauma



- Lower urinary tract injury may be caused by either blunt, penetrating, or iatrogenic trauma.
- 70-97% of patients with bladder injuries from blunt trauma have associated **pelvic fractures.**
- An exceedingly light blow may rupture the fully distended bladder, but the empty bladder is seldom injured except by crushing or penetrating wounds.

Classification

Type	Description
1	Bladder contusion
2	Intraperitoneal rupture (dome is most weak part of the bladder)
3	Interstitial bladder injury
4	Extraperitoneal rupture
a.	Simple
b.	Complex
5	Combined injury

Diagnosis

- The two most common sign and symptoms are **gross haematuria** and **abdominal tenderness** in patients with major bladder injuries.
- Other findings may include the **inability to void**, bruises over the suprapubic region and **abdominal distension**.
- Extravasation of urine may result in **swelling in** the perineum, scrotum and thighs, as well as along the anterior abdominal wall within the potential space between the transversalis fascia and the parietal peritoneum. (if left undiagnosed → abscess may occur)
- Intraperitoneal extravasation may lead to **referred shoulder pain** and respiratory distress.

Laboratory studies and Imaging studies

- Macro / Microscopic haematuria (95%)
- **Cystography: standard diagnostic procedure**; most accurate.
- **CT: method of choice** for evaluation of blunt or penetrating abdominal / pelvic injury.
- **IVP**: high false negative results
- **U/S**: not routinely used for evaluation of bladder injury

Management

- The first priority in the treatment of bladder injuries is **stabilization of the patient and treatment of associated life-threatening injuries.**

- **Blunt trauma**:
- → **Extraperitoneal rupture**: catheter drainage.
- → **Intraperitoneal rupture**: surgical exploration.

- **Penetrating injuries**: All bladder perforations due to a penetrating trauma should undergo **emergency exploration and repair**

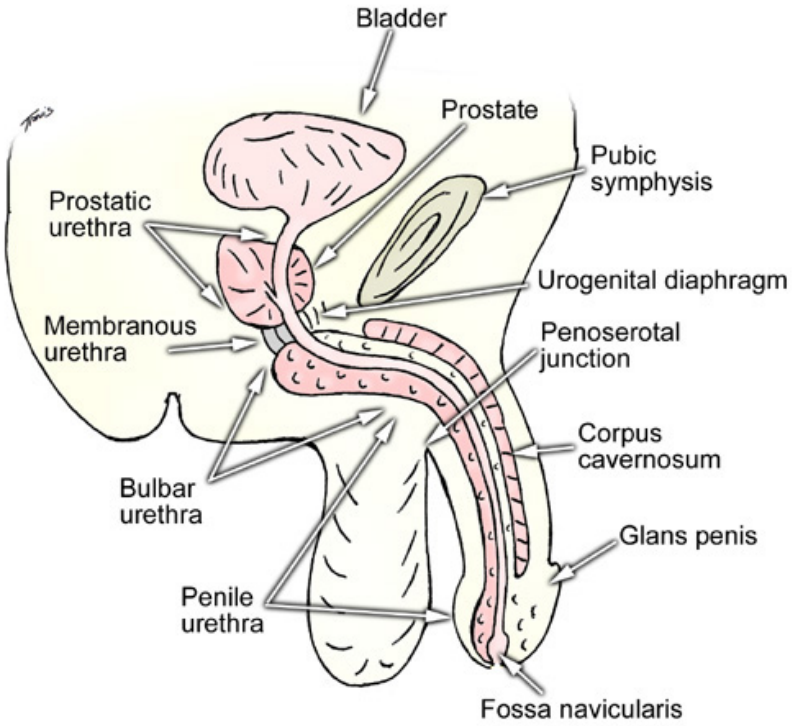
- The **perivesical hematoma** should be **left undisturbed** to avoid introducing bacteria.

Urethral Anatomy

- **Male urethra:**

Canal for the discharge of urine and seminal fluid. It is 18-20 cm in length.

The male urethra may be divided into 2 portions. **The posterior urethra** includes the prostatic urethra and the membranous urethra, **The anterior urethra** includes 3 segments. The bulbar urethra courses through the proximal corpus spongiosum and ischial cavernosus-bulbospongiosus muscles to reach the penile urethra. The penile urethra then extends through the pendulous portion of the penis to the final segment, the fossa navicularis. The fossa navicularis is invested by the spongy tissue of the glans penis.



- **Female urethra:**

Canal for discharge of urine that is 4 cm in length.
It corresponds to the prostatic and membranous urethra in the male (posterior urethra). The anterior urethra corresponds to the labia minora

Relevant Anatomy

- The membranous urethra is prone to injury from pelvic fracture
- The bulbar urethra is susceptible to blunt force injuries because of its path along the perineum
- Straddle-type injuries from falls or kicks to the perineal area can result in bulbar trauma. Conversely, the penile urethra is less likely to be injured from external violence because of its mobility, but iatrogenic injury from catheterization or manipulation can occur, which is also possible in the fossa navicularis.

Diagnosis

- A diagnosis of acute urethral trauma **should be suspected from the history**. A **pelvic fracture,** or any **external penile** or **perineal trauma,** can be suggestive of urethral trauma.
- In conscious patient, a thorough voiding history should be obtained to **establish the time of last urination**, **force of urinary stream**, **painful urination** and **presence of haematuria.**

- On **digital rectal examination**, the so-called **high-riding prostate** may be identified, or the **prostate may appear to be absent** (*a large pelvic hematoma causes superior displacement of the prostate when the urethra is disrupted*)

- The following clinical indicators of acute urethral trauma warrant a complete urethral evaluation:

1. ***Blood at the meatus*** / *Blood at the vaginal introitus*
2. ***Haematuria****:* although non-specific, haematuria on a first voided specimen may indicate urethral injury.
3. ***Pain on urination*** *or* ***inability to void*** *(disruption)*
4. ***Haematoma or swelling***

Retrograde urethrography is the radiographic imaging study of choice for evaluation the patient with suspected urethral injury.

- **<u>This study should precede any attempts to pass a urethral catheter.</u>**

Management

- **Anterior urethral injury**
  - Blunt trauma
    - Partial tears: suprapubic cystostomy to divert urine away from site of injury, and this is maintained for 4 weeks to allow healing.
    - Complete tear: end to end anastomosis
  - Open injury: surgical exploration and repair
- **Posterior urethral injury**
  - Partial tear : cystostomy
  - Complete tear: urethroplasty later on

Thank you