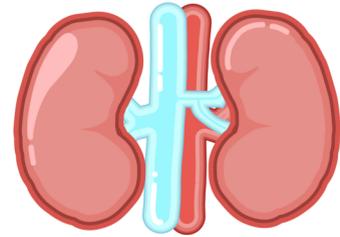


UROLOGICAL TRAUMA

Observed by : Dr. Mo'nes Naamneh

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Renal Anatomy



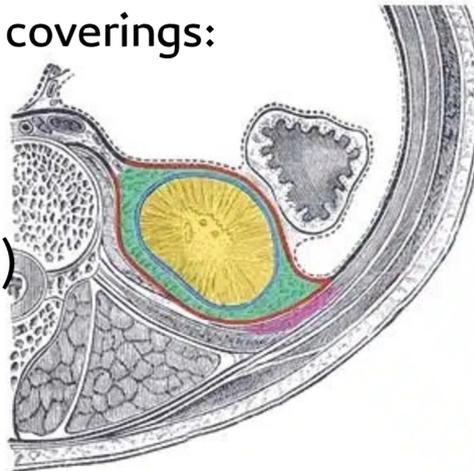
*The kidneys **are retroperitoneal** organs on each side of the vertebral column (**T12-L3**), at about the level of the twelfth rib.

*The left kidney is lightly higher in the abdomen than the right, due to liver in right side

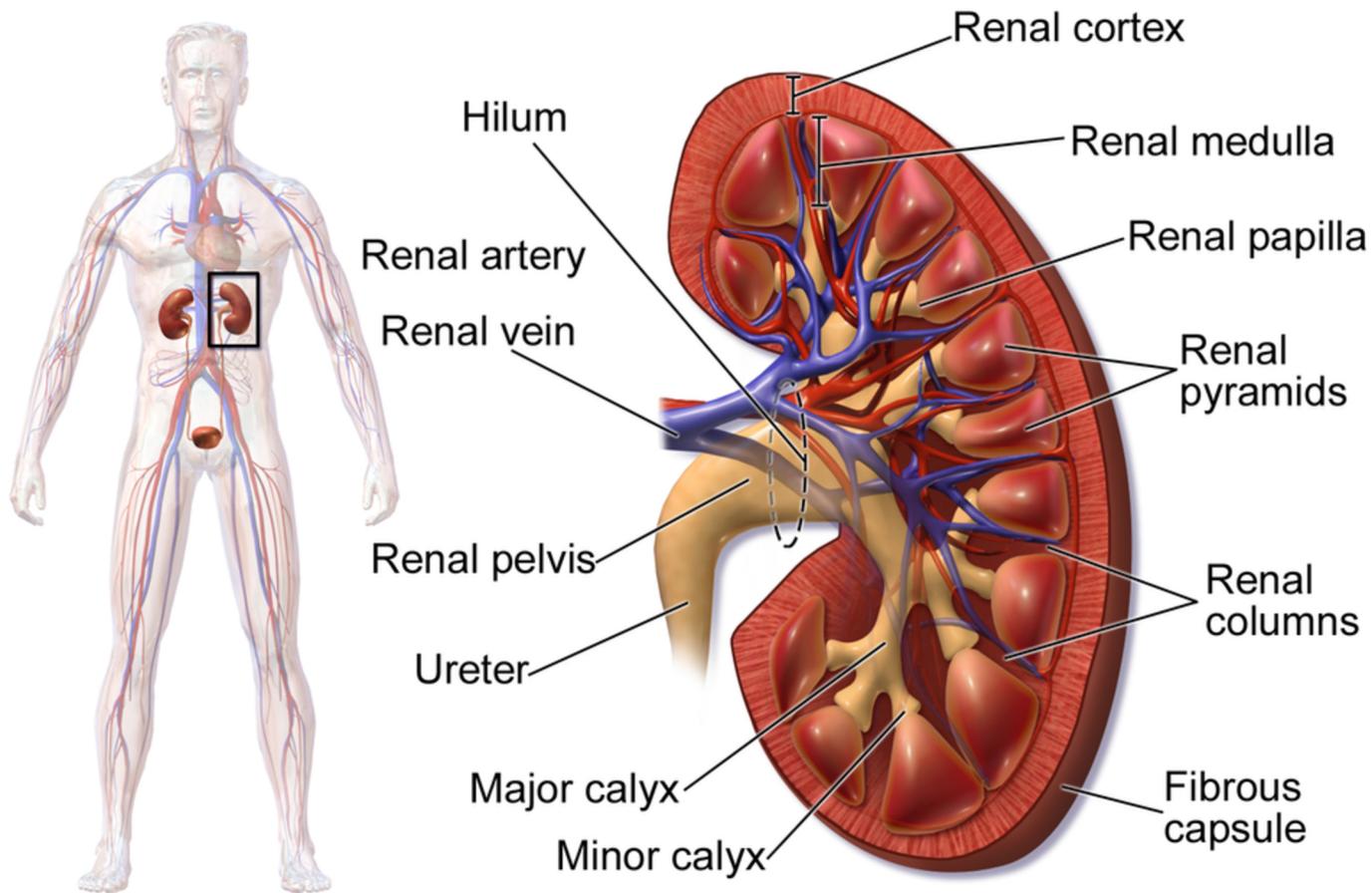
*On an average, each kidney weighs **150 g.**

*The kidneys have the following coverings:

- 1 . Fibrous capsule
- 2 . Perirenal fat
- 3 . Renal fascia(Gerota's fascia)
- 4 . Pararenal fat



-  Kidney
-  Renal capsule
-  Perirenal fat
-  Renal fascia
-  Pararenal fat



Kidney Anatomy

Renal trauma

Epidemiology

Death from injury is **twice** as common in males and particularly in relation to road traffic accidents, drowning, self-harm and interpersonal violence, and accounts for the **7th** leading cause of death globally in male

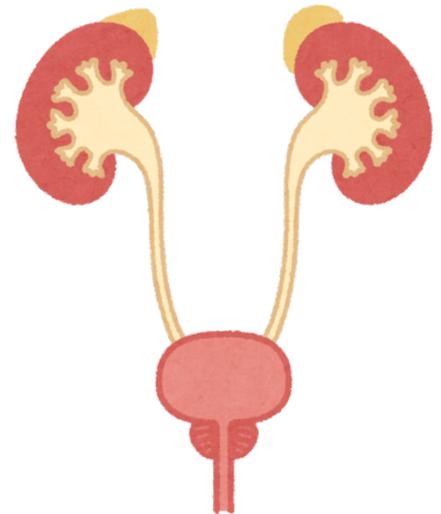
classification of trauma

The most used classification grading system is the **AAST** (American Association for the Surgery of Trauma) injury scoring scale .

It is useful for managing **renal trauma**, but for the other urological organs, the injuries are commonly described by their anatomical site and severity (partial/complete)

introduction

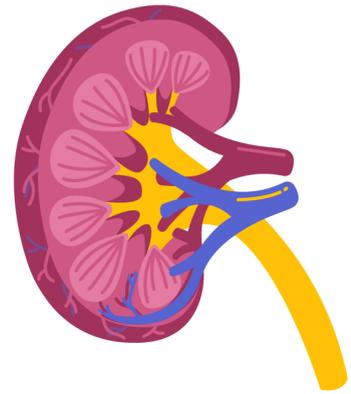
- Urologic traumas is classified according to the location of injury:
 - 1- **upper urinary tract** (kidneys and ureters)
 - 2- **lower urinary tract** (bladder and urethra), and **external genitalia** (penis, scrotum, and testes).



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 urinary tract** , accounting for **5% of all traumatic injuries**

Nevertheless, operative intervention is pursued in only approximately 10% of renal injuries. (usually part of poly-trauma)

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

The kidneys in children **more prone** to injury because of the relatively **greater size** , the **smaller protective muscle mass** and **cushion of perirenal fat** , and more **pliable rib cage**

Renal trauma

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

* **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. (deceleration : the body is forcibly stopped (. but the content of cavities remain in motion

***Penetrating wounds(10%)** 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

Grade*	Type of injury	Description of injury
1	Haematoma and/or Contusion	Subcapsular non-expanding haematoma or parenchymal contusion without parenchymal laceration.
2	Haematoma Laceration	Non-expanding perirenal haematoma confined to Gerota fascia.(Renal fascia) Renal parenchymal laceration < 1 cm depth without urinary extravasation.
3	Laceration	Renal parenchymal laceration > 1 cm depth without collecting system rupture or urinary extravasation. Any injury in the presence of a kidney vascular injury or active bleeding contained within Gerota fascia.(Renal fascia)
4	Laceration	Parenchymal laceration extending into urinary collecting system with urinary extravasation. Renal pelvis laceration and/or complete ureteropelvic disruption.
	Vascular	Segmental renal vein or artery injury. Active bleeding beyond Gerota fascia into the retroperitoneum or peritoneum. Segmental or complete kidney infarction(s) due to vessel thrombosis without active bleeding.
5	Laceration	Shattered kidney with loss of identifiable parenchymal renal anatomy.
	Vascular	Main renal artery or vein laceration or avulsion of renal hilum. Devascularised kidney with active bleeding.

contrast enhanced CT scan

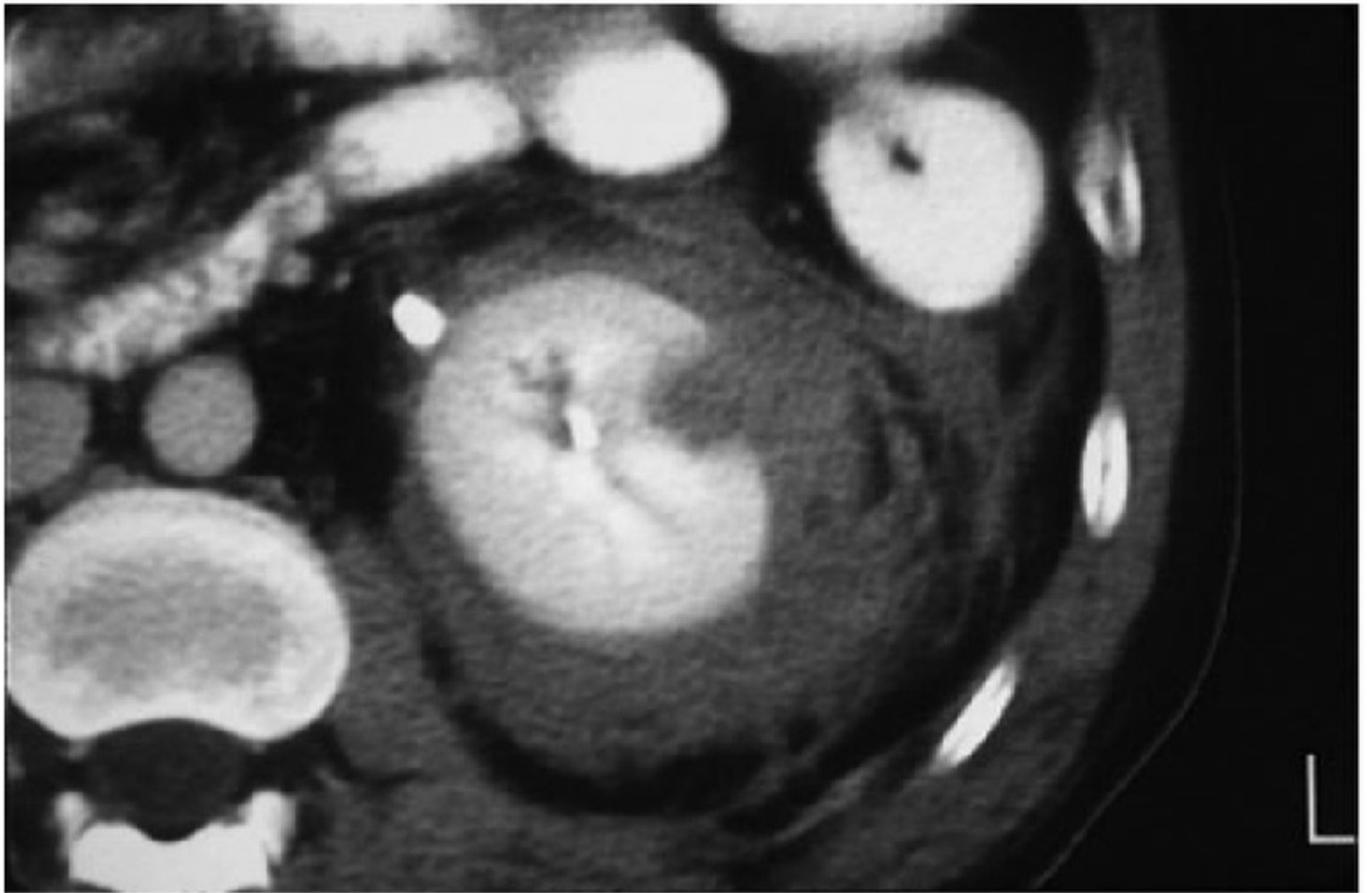


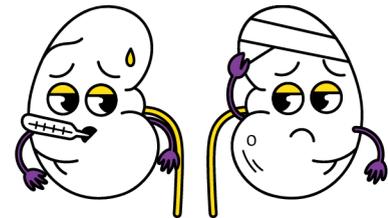
Figure 10.1 Renal CT with IV contrast in blunt trauma patient shows a superficial (grade 2) laceration amenable to nonoperative management.

Initial emergency assessment

- Vital signs
- Initial assessment of the traumapatient should include (ABC) controlling any external bleeding and resuscitation of shock as required, and securing of the airway
- Take careful **history**
- **Physical examination** is usually carried out during stabilization of the patient. (may reveal flank bruising, stab wounds, or bullet entry or exit wounds and abdominal tenderness.
- 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:
 - ***Haematuria***
 - Flank pain
 - Flank ecchymosis
 - Flank abrasions
 - Fractured ribs
 - Abdominal distension
 - Abdominal mass
 - Abdominal tenderness.



Laboratory studies



Urinalysis:

- **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
- An increased creatinine level usually reflects pre-existing renal pathology ◦

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 field [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 pediatric trauma patients; in this population, significant renal injury can occur in the setting of *microscopic hematuria without hypotension*.



Ultrasonography

**FAST (Focused Assessment Sonography in Trauma)
to identify hemoperitoneum as the cause of haemorrhage
and hypovolemia**



**USED FOR
FOLLOW UP**

- ***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

Full urinary assessment is dependent on the timing of contrast and scanning in order to view the bladder and ureters.

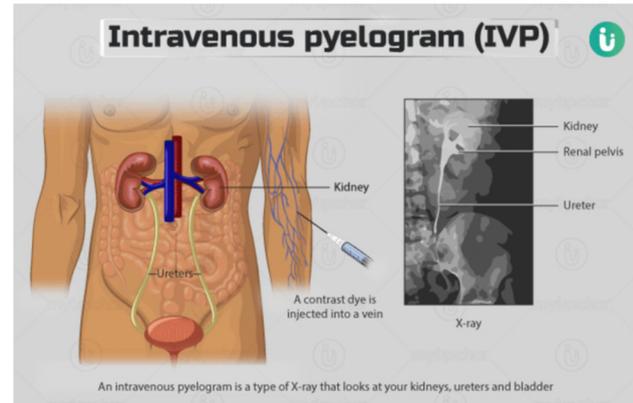
Intravenous Pyelogram

● 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 is relatively high .
- 3' finding do not reveal the full extent of injury.



1-retroperitoneal hematoma
2-renal injury is found which is likely to require nephrectomy

usually in surgery

Angiography

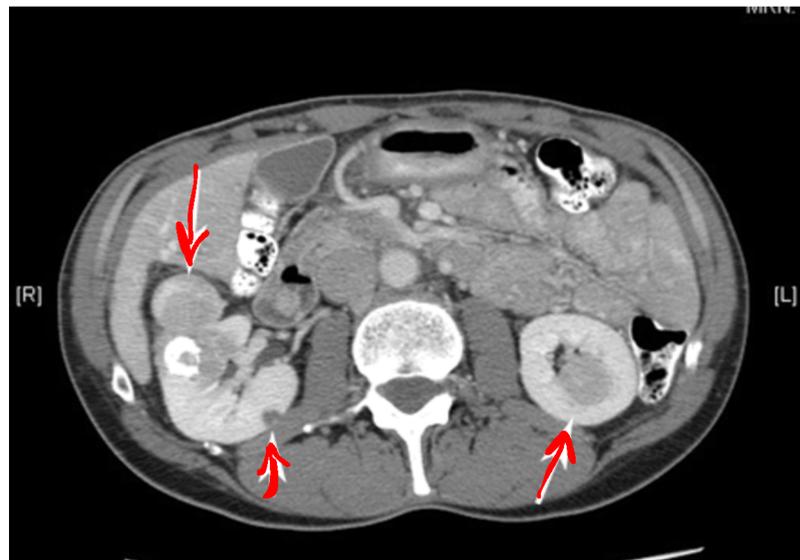
- **Advantages**

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.

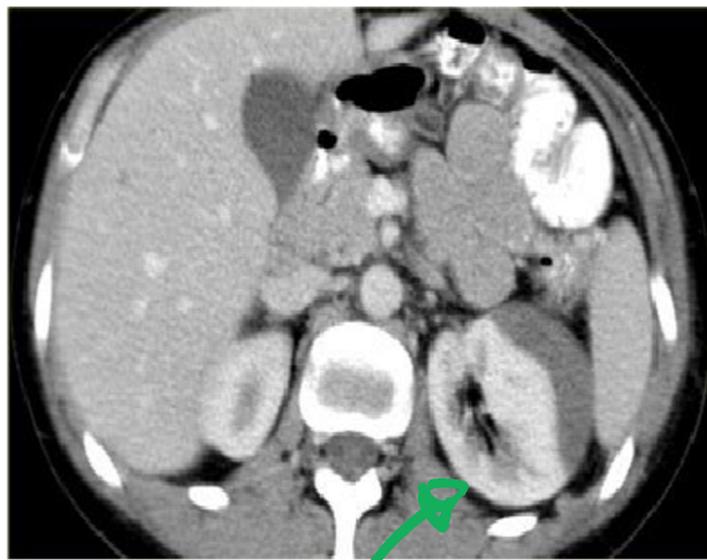
- **Disadvantages:**

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





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



unstable

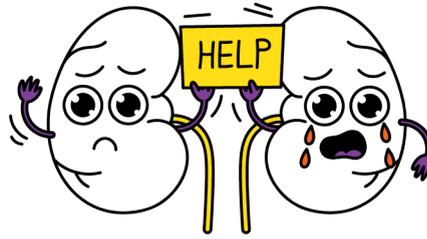


resuscitation



exploratory laprotomy

may be its grade 2 but not stable



stable



conservatively

bed rest

urinary catheterisation

prophylactic antibiotic

even grade 4

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

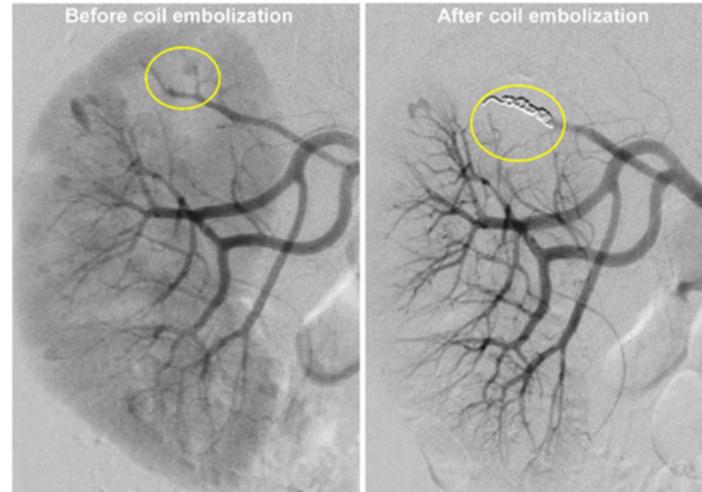
- **Indications for surgical** management include:



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).
 5. **urinary extravasation.**
- 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. °

selective angioembolisation

Selective angioembolisation has a key role in the non-operative management of blunt renal trauma haemodynamically stable patients



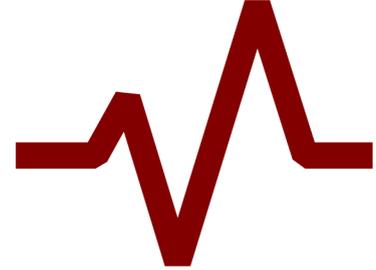
*Currently there are no validated criteria to identify patients who require SAE and its use in renal trauma remains variable.

*SAE, when compared with surgical repair, is associated with a **reduced rate of subsequent nephrectomy** in the management of blunt and penetrating high- grade renal trauma (Grade 4 and Grade 5)

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:**

1-Bleeding

2- hydronephrosis

3-calculus formation

4-hypertension

5-arteriovenous fistula

6- pseudoaneurysms.

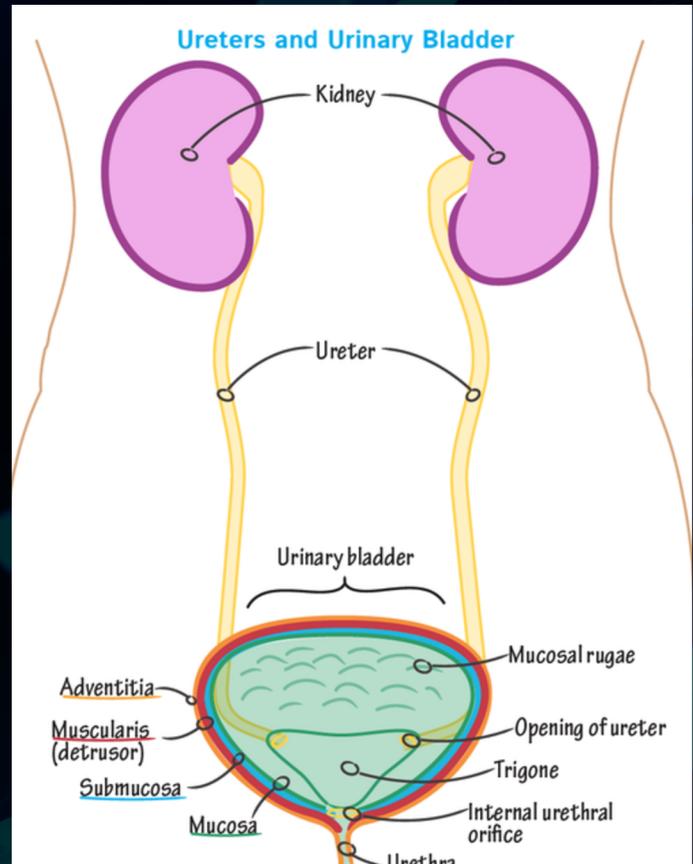
7-chronic pyelonephritis

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

- Noclassic clinical symptoms and signs associated with acute
- ureteral trauma caused by external injury. (EASY TO MISS)

Ureteral trauma should be suspected in:

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

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

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

managemaint

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

Ureteral Repair Procedures

Procedure	Indication	Location	Technique	Special Considerations
1. Ureteroureterostomy	Ureteral defects <3 cm	Upper and mid ureter	End-to-end repair	Most common for complete transections
2. Ureteropyelostomy	Proximal ureteral injury	Upper ureter	Direct anastomosis of ureter to renal pelvis	Requires healthy renal pelvis
3. Ureterocalicostomy	Renal pelvis or UPJ damaged beyond repair	Upper ureter	End-to-side connection of ureteral stump to exposed renal calyx	Salvage procedure when pelvis unusable
4. Transureteroureterostomy	Extensive mid/upper ureteral defect with insufficient length for bladder anastomosis	Mid or upper ureter	Bring injured ureter across midline to recipient ureter (end-to-side)	Cross-midline procedure

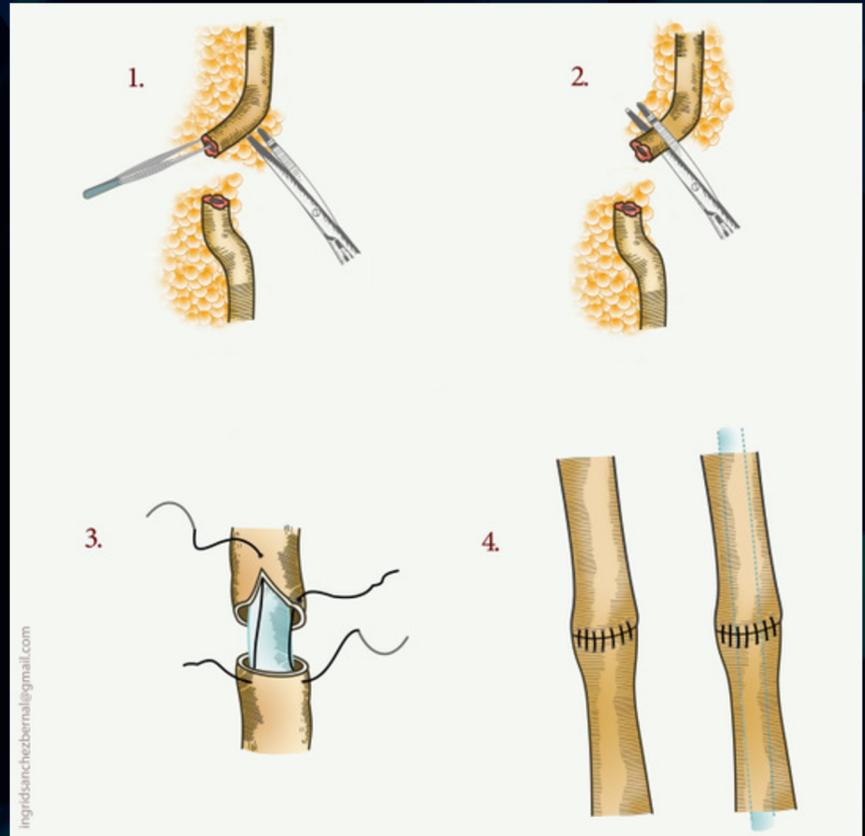
5. Ureteroneocystostomy	Lower ureteral injuries with blood supply disruption	Lower ureter	Debridement, spatulation, bladder wall tunneling (3:1 ratio)	Blood supply from iliac vessels often compromised
6. Vesicopsoas Hitch	Need additional reach for ureteral repair	Lower ureter (adjunct)	Mobilize bladder superiorly and laterally, fix to psoas tendon	Provides extra length for repair
7. Boari Bladder Flap	Injuries too extensive for psoas hitch alone	Lower ureter (adjunct)	Create bladder flap for additional length	Provides 12-15 cm additional length

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.

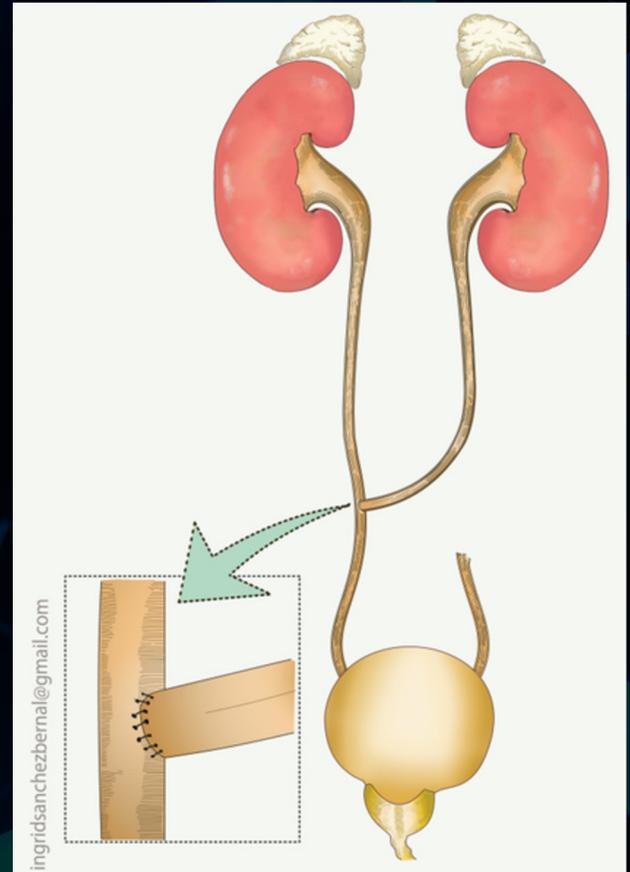


2. Ureteropyelostomy: the ureter may be anastomosed directly into the renal pelvis, this is done in case of proximal ureteral injury.

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

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:

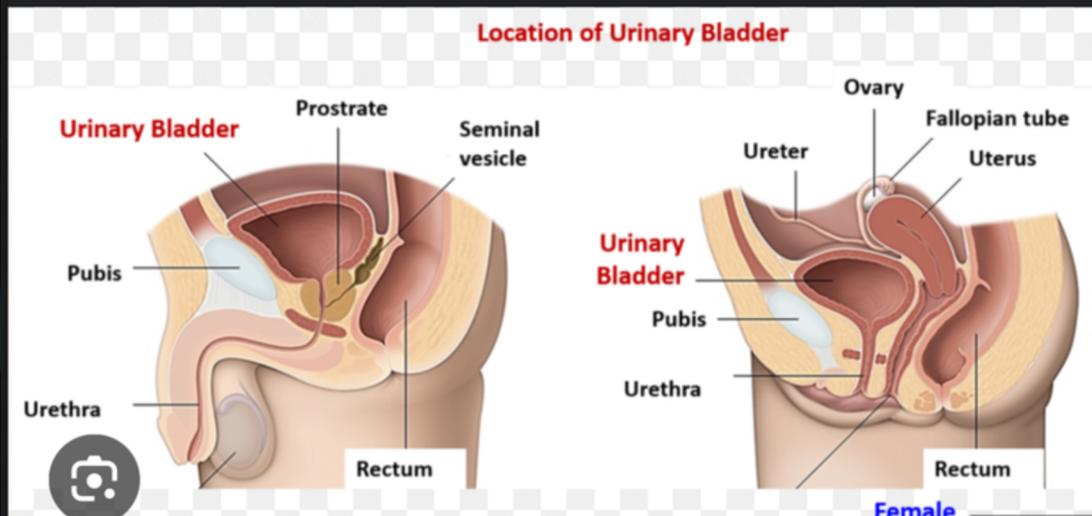
This procedure involves mobilizing the bladder and pulling it superiorly and laterally by fixing it to the psoas tendon.

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 pubicsymphysis 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.



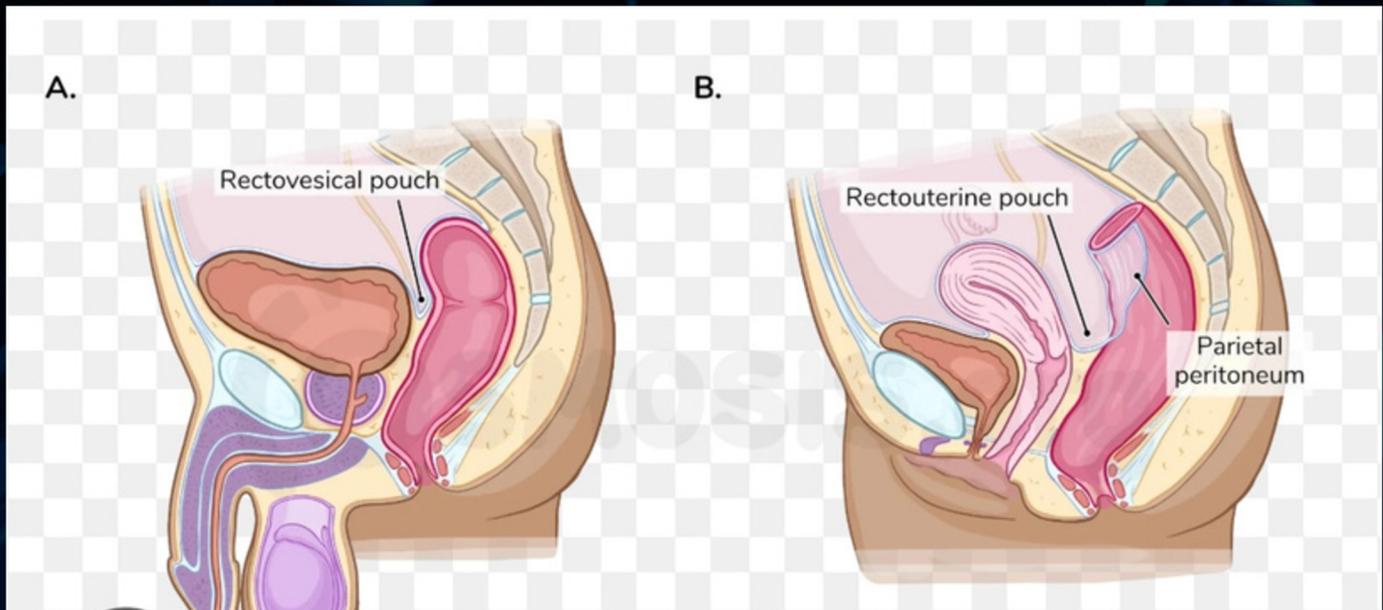
Bladder Trauma

- Bladder trauma is primarily classified according to the **location** of the injury: **intra-peritoneal, extraperitoneal, and combined intra-extraperitoneal** .

also Bladder trauma is categorised by **aetiology**: **non-iatrogenic** (blunt and penetrating) and **iatrogenic** (external and internal).

- 60-90% 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

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



penetrating wounds.

Classification:

Type:

Description

1

Bladder contusion

2

Intraperitoneal rupture (dome is the weakest part of the bladder) .

3

Interstitial bladder injury

4

Extraperitoneal rupture

4a

Simple

4b

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 or inadequate urine output** 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

Cystography must be performed using retrograde filling of the bladder with a minimum volume of

300-350 mL of dilute contrast material. Passive bladder filling by clamping the urinary catheter during the excretory phase of CT or IVP is not sufficient to exclude bladder injury . **Intraperitoneal extravasation** is visualised by free contrast medium in the abdomen outlining bowel loops or abdominal viscera . **Extraperitoneal** bladder injury is typically diagnosed by flame-shaped areas of contrast extravasation in the peri-vesical soft tissues (around the bladder). Contrast medium in the vagina is a sign of vesicovaginal fistula.



Management :

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

Blunt trauma :

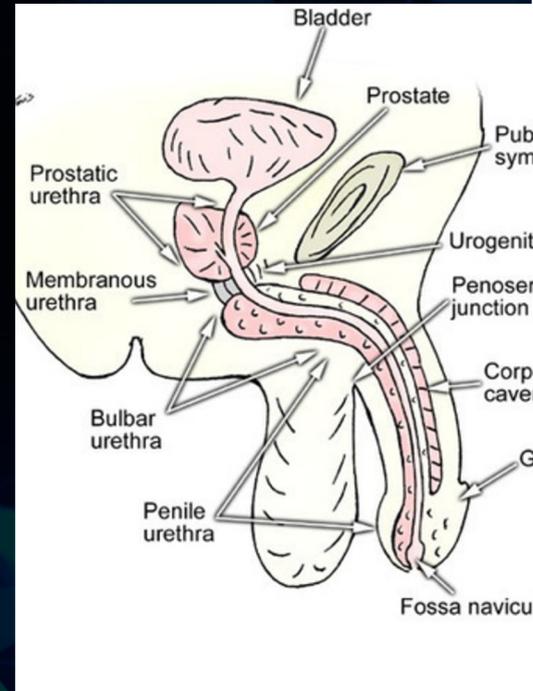
- **Extraperitoneal rupture** : catheter drainage.
- **Intraperitoneal rupture** : surgical exploration.
- **Penetrating injuries** : All bladder perforations due to a penetrating trauma should undergo **emergency exploration and repair**
- The **perivesical hematoma** should be **left undisturbed** 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.



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.

- **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

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 hematuria**
- On **digital rectal examination(DRE)** , the so-called **high-riding prostate** may be identified, or the **prostate may appear to be absent**
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:

Blood at the meatus /*Blood at the vaginal introitus*

Hematuria :lthough non-specific,haematuria on a first voided specimen may indicate urethral injury.

Pain on urination or **inability to void** (*disruption*)

Haematoma or swelling

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

- **This study should precede any attempts to pass a urethral catheter.**

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