

RENAL TRAUMA

Dr P.Vedamurthy Reddy

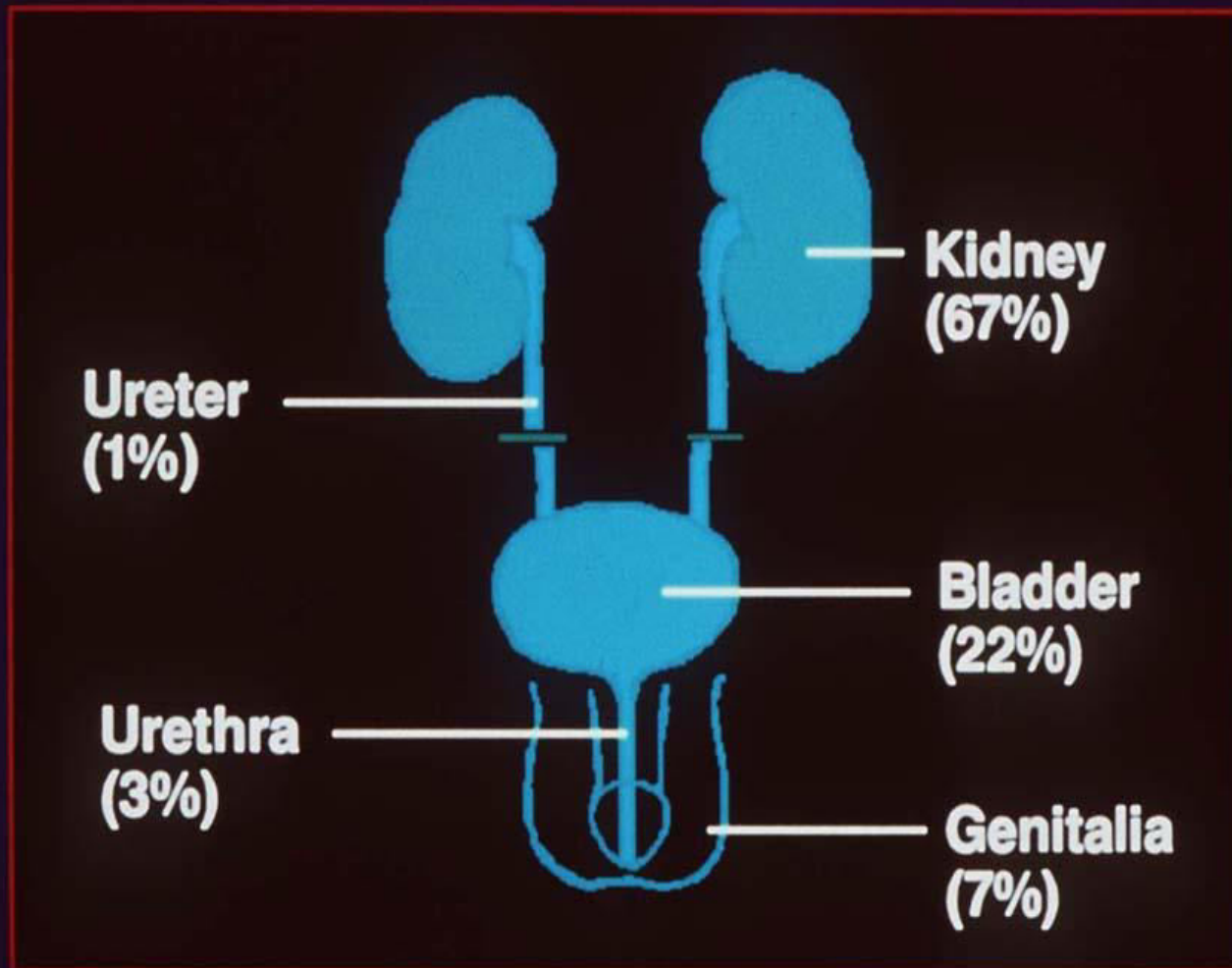
Professor and Head

Dept of Urology

Narayana Medical College

Nellore

SITES OF GENITOURINARY TRAUMA



RENAL INJURIES

- Most common genitourinary organs injured from external trauma.
- 10% of abdominal trauma cases
 - *Blunt Renal Trauma*
 - *Penetrating Renal Injuries*

- **Blunt Renal Trauma**

- Motor vehicle accidents
- falls from heights
- Assaults

- **MECHANISM**

- Direct transmission of kinetic energy and
- rapid deceleration forces

Mechanism of Renal Injuries

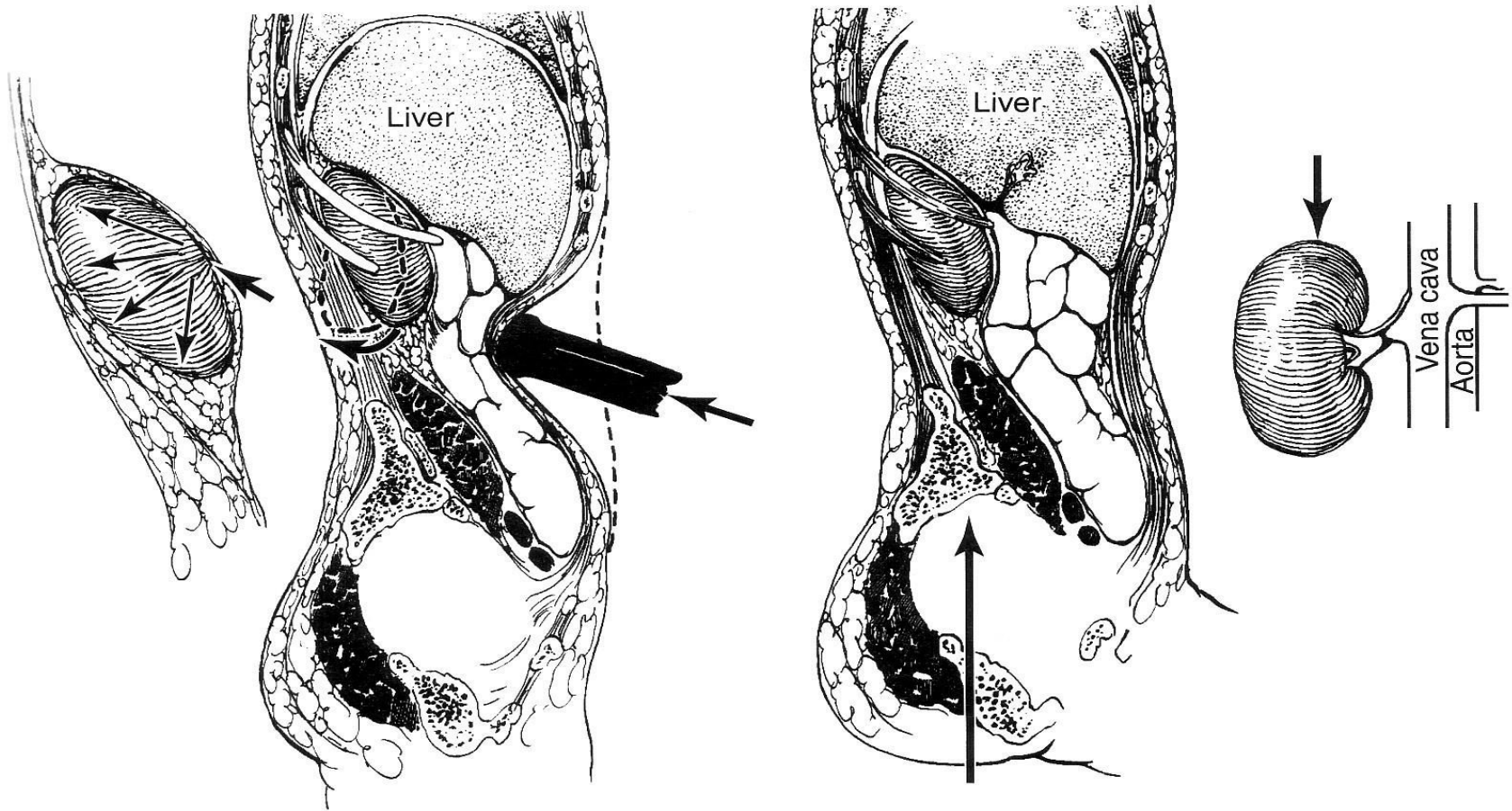


Figure 17-4. Mechanisms of renal injury. **Left:** Direct blow to abdomen. Smaller drawing shows force of blow radiating from the renal hilum. **Right:** Falling on buttocks from a height (contrecoup of kidney). Smaller drawing shows direction of force exerted on the kidney from above. Tear of renal pedicle.

- SITE:-
 - major renovascular injuries occur at retroperitoneal points of fixation such as
 - renal hilum or
 - ureteropelvic junction,
 - resulting in renal artery thrombosis, renal vein disruption, and renal pedicle avulsion.

- **Penetrating renal injuries**
 - gunshot and
 - stab wounds.
- Gunshot wounds comprise the great majority of penetrating trauma with stab wounds a distant second (86% vs. 14%).

- Stab wounds
 - cause both renovascular and parenchymal injuries.
 - Common entry sites
 - upper abdomen
 - flank and
 - lower chest

Indicators of possible renal injury



- Trauma to the anterior axillary line is
 - *prone to renal hilum and pedicle injury*
- Trauma to the posterior axillary line
 - *resulting in parenchymal injury.*
 - **Flank hematoma,**
 - **Flank tenderness,**
 - **Lower Rib fractures,** and
 - **Penetrating injuries to the low thorax or flank**

Evaluation and Management of renal injuries

- DUE TO:-
 - Advances in radiographic staging
 - improvements in hemodynamic monitoring
 - validated renal injury scoring systems
- Allow successful **nonoperative management** strategies for **renal preservation**.

- Indicators of significant urinary system injury include:-
 - presence of microscopic and hypotension (>5 [RBCs/HPF] or positive dipstick finding) OR
 - gross hematuria

Degree of hematuria and severity of renal injury do not correlate consistently.

- hematuria was absent in 7% of 420 grade IV renal injuries in a recent analysis.
- 36% of renal vascular injuries from blunt trauma demonstrated no blood in the urine.
- Approximately 50% of injuries to the ureteropelvic junction have **no microscopic or gross hematuria.**

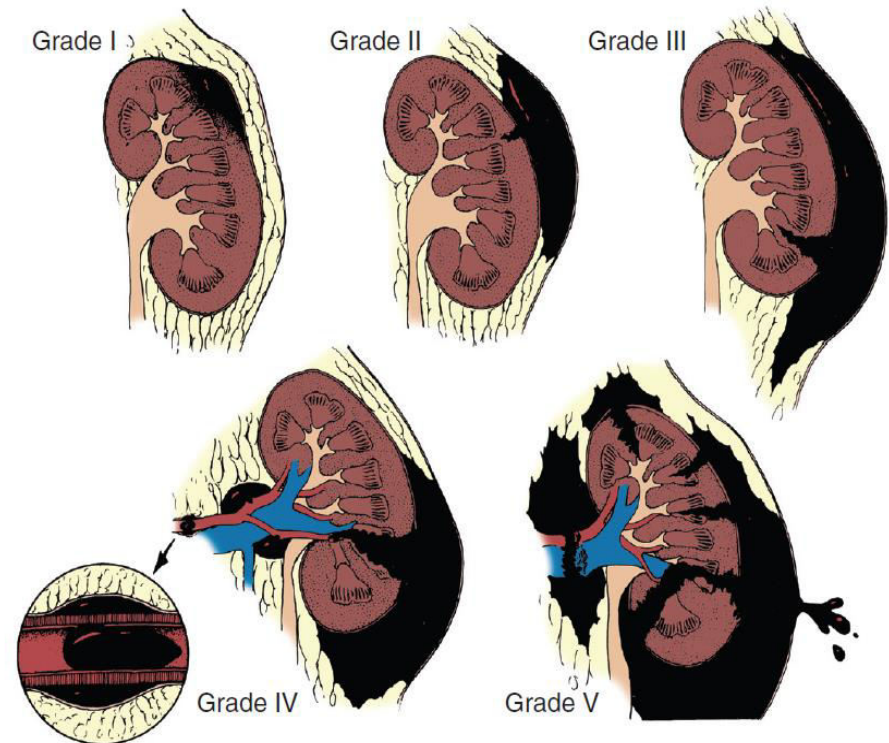
Classification of Renal Trauma

- Developed by The American Association for the Surgery of Trauma.
- Based on contrast-enhanced computed tomography (CECT)
- valid predictive tool for clinical outcomes in patients with renal trauma.

American Association for the Surgery of Trauma

Organ Injury Severity Scale for the Kidney

GRADE*	TYPE	DESCRIPTION
I	Contusion	Microscopic or gross hematuria, urologic studies normal
	Hematoma	Subcapsular, nonexpanding without parenchymal laceration
II	Hematoma	Nonexpanding perirenal hematoma confined to renal retroperitoneum
	Laceration	<1 cm parenchymal depth of renal cortex without urinary extravasation
III	Laceration	>1 cm parenchymal depth of renal cortex without collecting system rupture or urinary extravasation
IV	Laceration	Parenchymal laceration extending through renal cortex, medulla, and collecting system
	Vascular	Main renal artery or vein injury with contained hemorrhage
V	Laceration	Completely shattered kidney
	Vascular	Avulsion of renal hilum, devascularizing the kidney

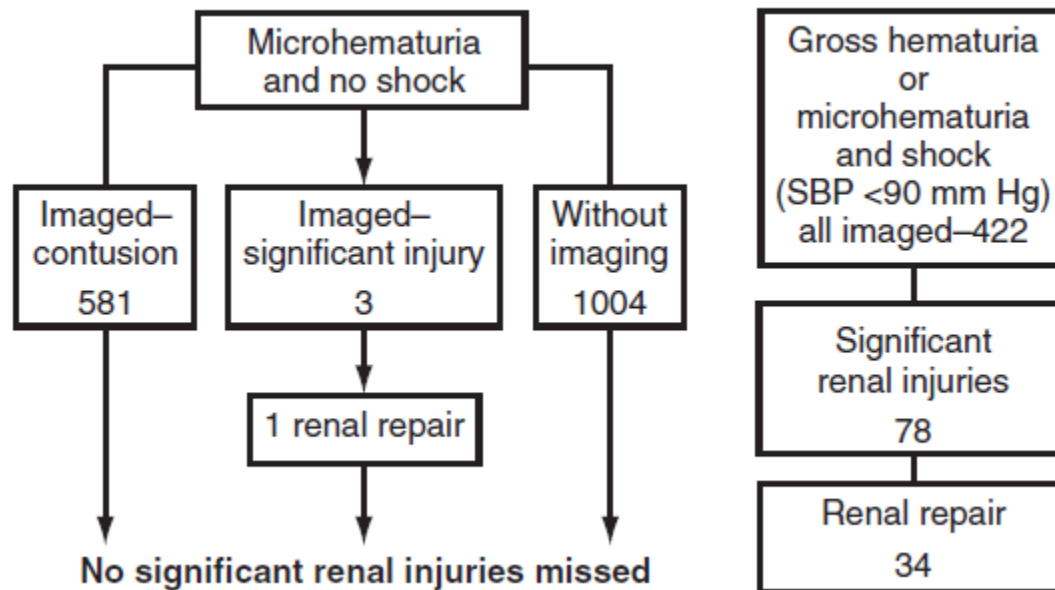


Indications for Radiologic Imaging

1. All penetrating trauma patients with a likelihood of renal injury (abdomen, flank, or low chest) who are hemodynamically stable.
2. All blunt trauma with significant mechanism of injury, specifically rapid deceleration as would occur in a motor vehicle accident or a fall from heights.
3. All blunt trauma with gross hematuria
4. All blunt trauma with hypotension
5. All pediatric patients with microscopic hematuria

Patients who are hemodynamically unstable after initial resuscitation require surgical intervention.

Algorithm demonstrating the results of the authors' study on radiographic assessment of renal injuries.



- **Penetrating injuries** with any degree of hematuria should be imaged.

- Children are known to be at a greater risk for renal trauma after blunt abdominal injury
- Pediatric patients carefully evaluated.
- Children have a high catecholamine output after **trauma** (which maintains blood pressure until approximately 50% of blood volume has been lost)

IMAGING STUDIES

- **Contrast-enhanced computed tomography (CECT)**
 - gold standard for genitourinary imaging in renal trauma
 - Highly sensitive and specific
 - Provides most definitive staging information
 - Parenchymal lacerations are clearly defined

- Extravasation of contrast-enhanced urine can easily be detected
- Associated injuries to other organs can be identified and
- The degree of retroperitoneal bleeding can be assessed by the size and dimensions of the retroperitoneal hematoma.
- Lack of uptake of contrast material in the parenchyma suggests arterial injury.

- Arteriovenous scanning
 - 80 seconds after contrast administration
 - provides visualization of the kidneys in the nephrogenic phase of contrast excretion
 - necessary to detect arterial extravasation.

- Injury to the renal collecting system may be missed; contrast material has not had time to be excreted into the parenchyma and collecting system adequately.
- Repeated/delayed scanning
 - 10 minutes after injection of contrast
 - identifies parenchymal lacerations and urinary extravasation

CECT findings suggestive of major injury

1. Medial hematoma

— suggesting vascular injury.

2. Medial urinary extravasation

— suggesting renal pelvis or ureteropelvic junction avulsion

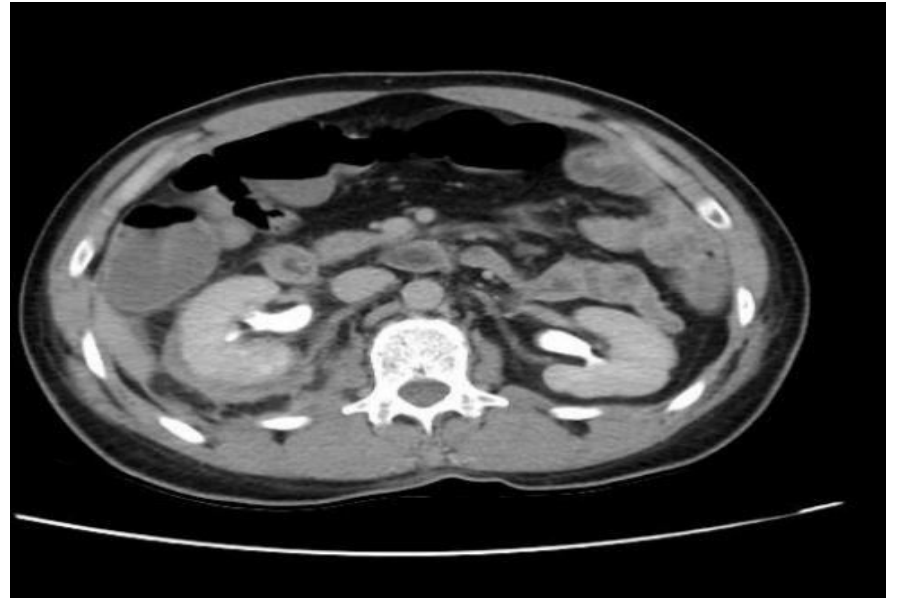
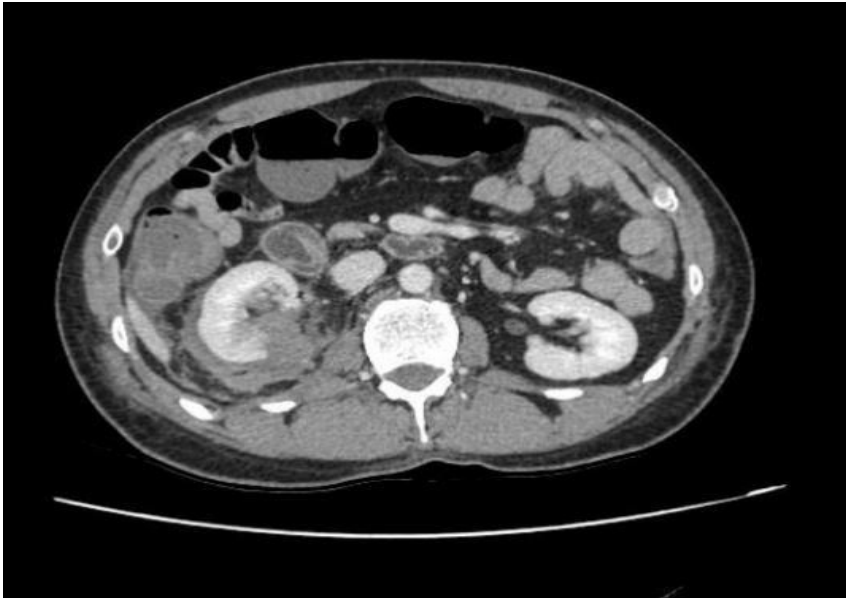
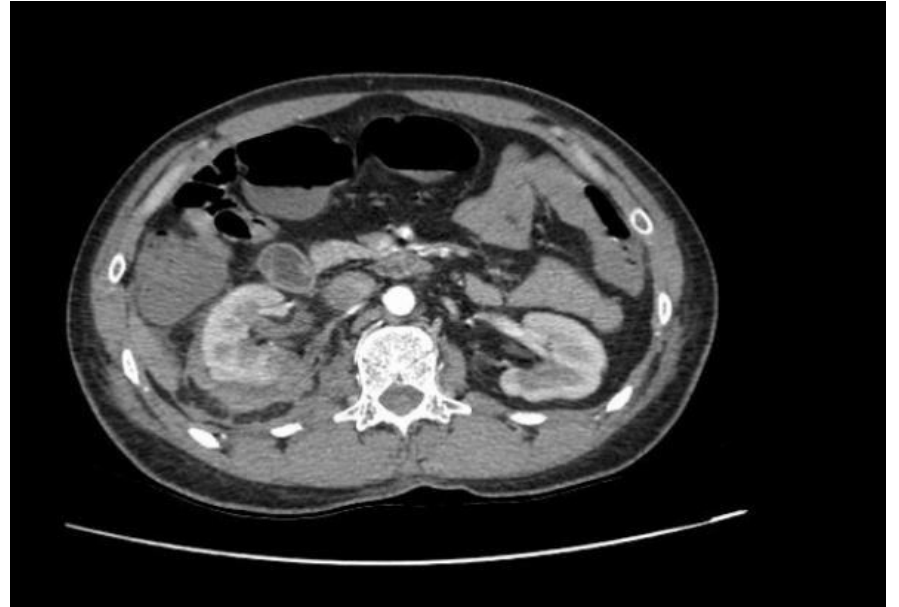
3. Lack of contrast enhancement of the parenchyma

— suggesting arterial injury.

VENOUS INJURY

- Major limitation of CT
 - inability to define a renal venous injury adequately.
- Medial hematoma accompanied by following findings strongly suggests a venous injury.
 - normal arterial perfusion,
 - normal parenchyma and
 - contrast material in the collecting system.

Gr II



Gr IV



Role of IVU & “Single-shot” IVU

- Excretory Urography (IVU) :
 - most commonly used modality to evaluate genitourinary injuries historically.
- “Single-shot” IVU:
 - limited but important role intraoperatively.

“Single-shot” IVP

- INDICATIONS:

- unexpected retroperitoneal hematoma surrounding kidney during abdominal exploration

- PURPOSE:

- To assess presence of a functioning contralateral kidney and
- To radiographically stage the injured side.

- **PROCEDURE:**

- only a single film is taken
- 10 minutes after intravenous injection (IV push) of 2 mL/kg of contrast material.
- If findings are not normal or near normal, the kidney should be explored to complete the staging of the injury and reconstruct any abnormality found.

OTHER IMAGING MODALITIES

- limited role in the evaluation of genitourinary trauma.
- Sonography:-
 - Facilitate rapid diagnosis of intra abdominal injuries (i.e., hemoperitoneum).
 - If necessary, sonography can confirm the presence of two kidneys and
 - can define a retroperitoneal hematoma.

RENAL ARTERIOGRAPHY

- both diagnostic as well as therapeutic.
- used to define arterial injuries suspected on CT or
- to localize and control arterial bleeding.
- useful in the primary setting with persistent bleeding in a hemodynamically stable patient.
- Pseudoaneurysms and AV fistula are treated by angiographic embolization to stop secondary hemorrhage.

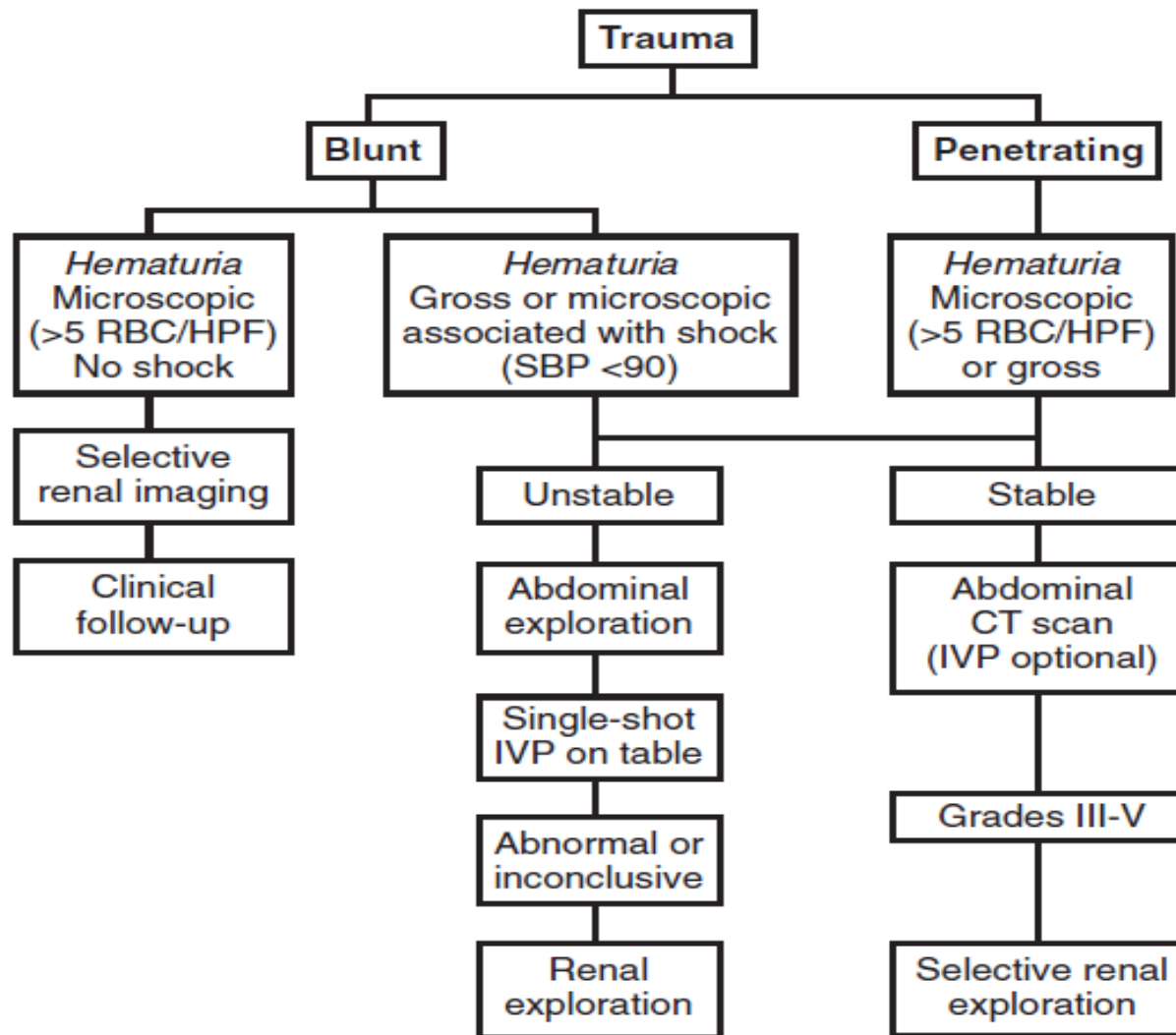
- Superselective embolization therapy:-
 - Effective minimally invasive technique
 - avoid unnecessary exploration that could otherwise result in a nephrectomy.

NONOPERATIVE MANAGEMENT

- Has become the standard of care in
 - hemodynamically stable,
 - grade I to III renal injuries
- grade IV and V injuries
 - more often require surgical exploration
 - Even these high-grade injuries can be managed without renal operation if carefully staged and selected

- Patients with high-grade injuries (grades III to V) selected for nonoperative management are closely observed with
 - serial hematocrit readings
 - strict bed rest is mandatory until gross hematuria resolves.

A Guide For Decision Making



FOLLOW UP

- The risk of complications in patients who have been treated conservatively increases with injury grade.
- Repeat imaging 2-4 days after trauma minimizes the risk of missed complications, especially in grade 3-5 blunt injuries.

- A decline in renal function correlates directly with injury grade, this is independent of the mechanism of injury and the method of management.

- Follow-up examinations should continue until healing is documented and laboratory findings have stabilised, although checking for latent renovascular hypertension may need to continue for years.
- In general, the literature is inadequate on the subject of the long-term consequences of renal tissue trauma.

DELAYED RENAL BLEEDING

- Most grades II to IV injuries resolve uneventfully
- Delayed renal bleeding can occur in up to **25%**
- Angiography with selective embolization of bleeding vessels.

Surgical Management

- *Absolute indications*
 - Hemodynamic instability with shock;
 - Expanding /pulsatile renal hematoma (usually indicating renal artery avulsion);
 - Suspected renal pedicle avulsion (grade 5); and
 - Ureteropelvic junction disruption.
- *Relative indications*
 - urinary extravasation together with nonviable tissue
 - renal injury together with colon/pancreatic injury
 - a delayed diagnosis of arterial injury (which most likely will need delayed nephrectomy).

MANAGEMENT OF SPECIAL CONDITIONS

- Intraoperative presence of a nonexpanding retroperitoneal hematoma:-
 - Nonoperative therapy is recommended
- Urinary extravasation alone from a grade IV parenchymal laceration or forniceal rupture:-
 - managed nonoperatively
 - with an expectation of spontaneous resolution of more than 90%.

- **Nonviable tissue** constitute **more than 25%** in association with a **parenchymal laceration** or **urinary extravasation** or both,
 - potential for complications greatly increases
 - and operative management is recommended

- **CRITICAL PATIENTS:-**

- patient's critical condition necessitates surgical intervention before appropriate imaging studies and
- renal injury is obvious (manifested by perirenal hematoma or hematuria),
- single-shot intraoperative IVP should be done.
- If findings are not normal,
 - renal exploration
 - reconstruction of injury.

RENAL EXPLORATION

- Best done by a **transabdominal approach**
- Allows complete inspection of intra-abdominal organs and bowel.
- Injuries to the great vessels, liver, spleen, pancreas, or bowel can be identified and stabilized if necessary before renal exploration.

Renal Exploration

**Surgical exploration of the
acutely injured kidney is best done by**

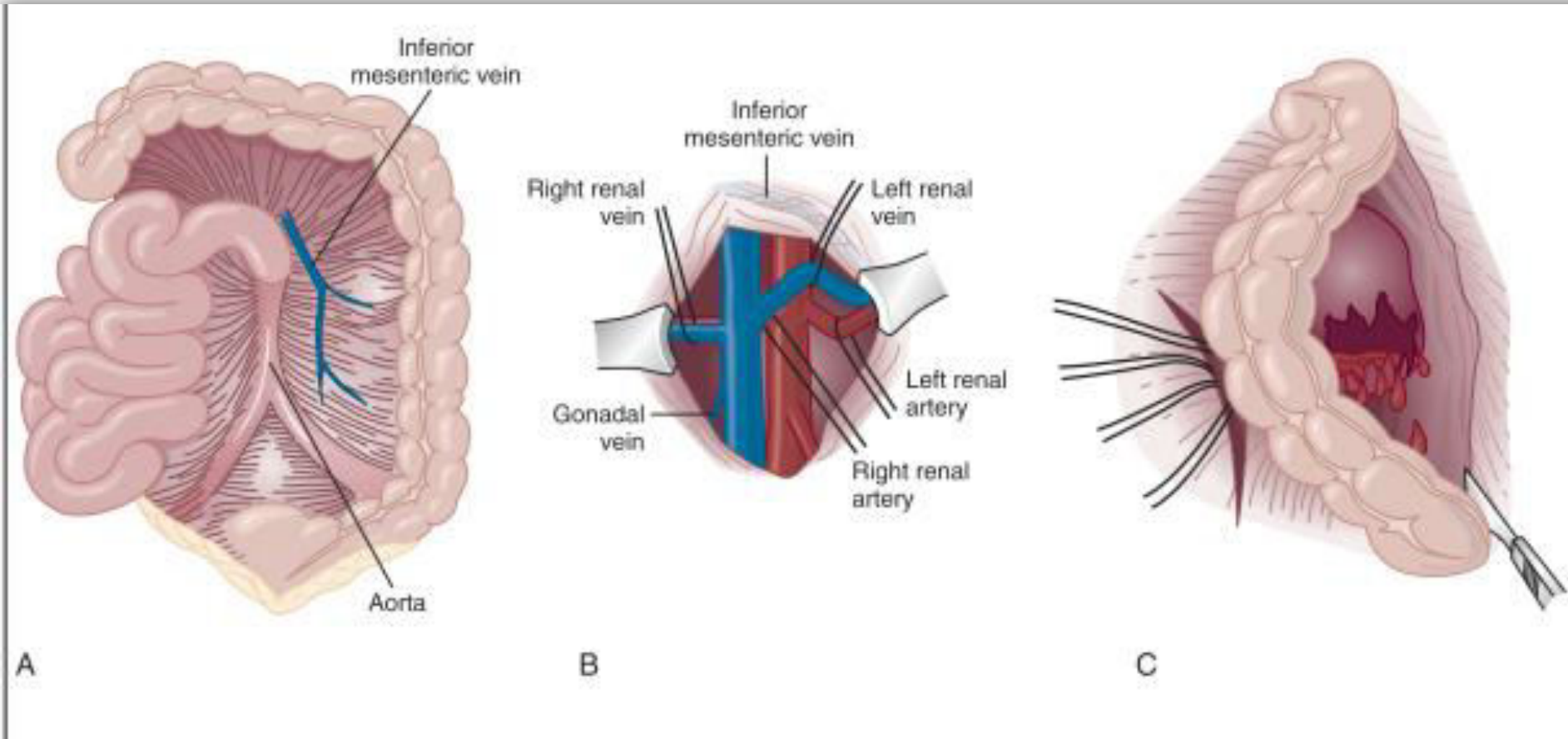


Transabdominal approach



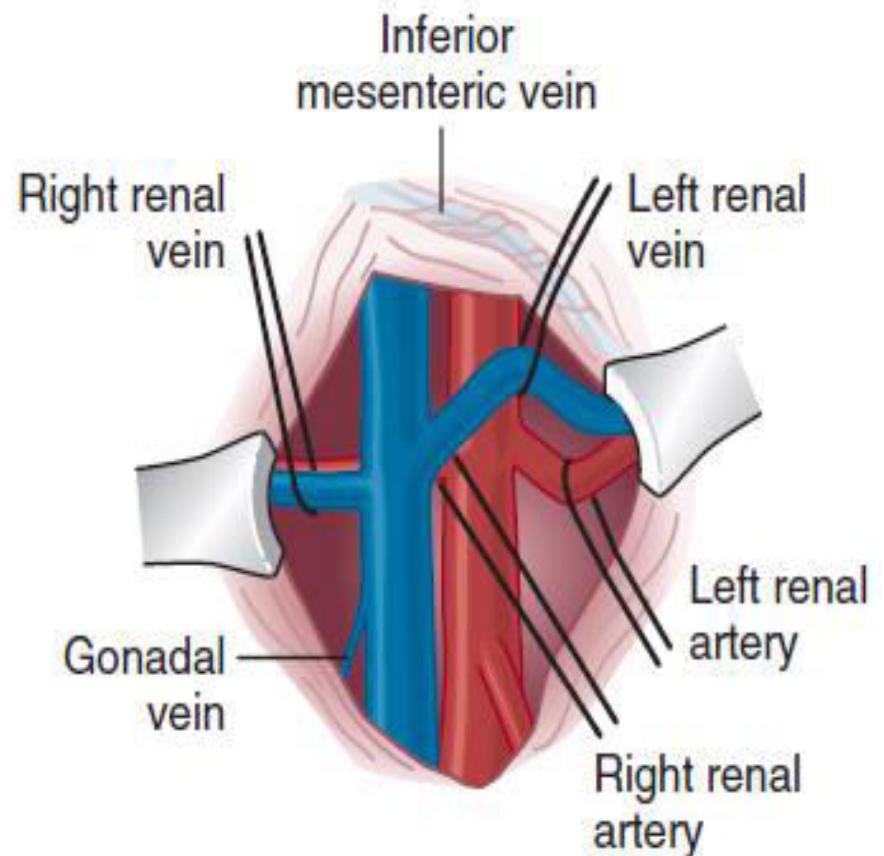
**allows complete inspection of
intra-abdominal organs and bowel**

Surgical Approach to the renal vessels and kidney

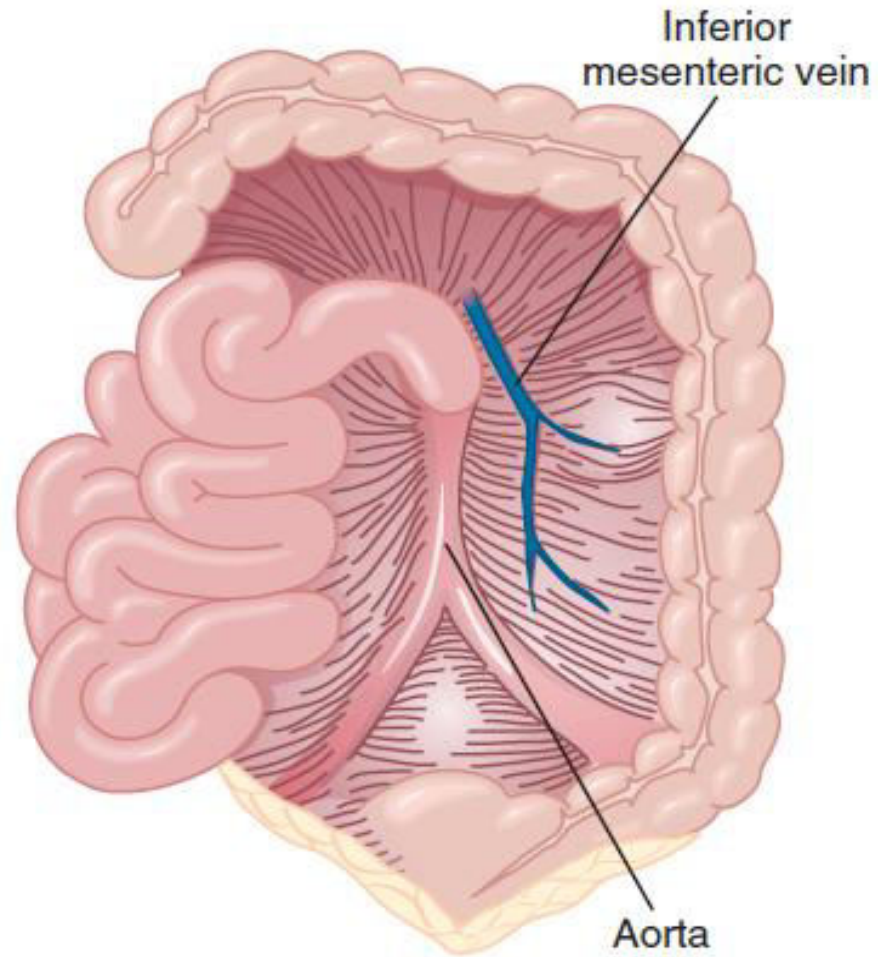


SURGICAL APPROACH TO RENAL EXPLORATION

- The renal vessels are isolated before exploration to provide the immediate capability to occlude them if massive bleeding ensue when Gerota's fascia is opened



- The transverse colon is lifted superiorly onto the chest,
- and the small bowel is lifted superiorly and to the right.
- This exposes the mid retroperitoneum.
- An incision is made over the aorta in the retroperitoneum just superior to the inferior mesenteric artery.



- The incision is extended superiorly to the ligament of Treitz.
- Exposure of the anterior surface of the aorta is accomplished and followed superiorly to the left renal vein, which crosses the aorta anteriorly.

- With a vessel loop controlling the vein, the anatomic relationships of the right and left renal arteries as they leave the aorta provide the ability to isolate and secure these structures with vessel loops.
- The right renal vein can be secured through this incision;
 - if this proves difficult, reflecting the second portion of the duodenum provides excellent exposure to the vein.

- Large hematomas:-
 - may extend over the aorta and
 - obscure the landmarks for the planned initial retroperitoneal incision.
 - inferior mesenteric vein used as an anatomic guide for an appropriate incision.
 - By making the retroperitoneal incision just medial to the inferior mesenteric vein and dissecting through the hematoma, the anterior surface of the aorta can be identified and followed superiorly to the crossing left renal vein.

- The kidney is exposed by incising the peritoneum lateral to the colon,
- followed by mobilization off Gerota fascia.
- This maneuver often requires release of the splenic (left) or hepatic (right) attachments of the colon.
- Gerota fascia is then opened and the kidney with injury is completely dissected from the surrounding hematoma.
- Should troublesome bleeding develop, the previously isolated vessels can be temporarily occluded with a vascular clamp or a vessel loop tourniquet.

- **Is Early Vessel Isolation Necessary?**

- Renal bleeding a major cause of nephrectomy in renal trauma.
- Obtaining early vascular control before opening Gerota fascia can decrease renal loss.
- **McAninch and Carroll, 1982:-**
 - the total nephrectomy rate was reduced from 56% to 18% .
- **McAninch and colleagues 1991:-**
 - In a series of 133 renal units in which early vessel isolation and control before opening Gerota fascia was achieved, the reported renal salvage rate of 88.7%.

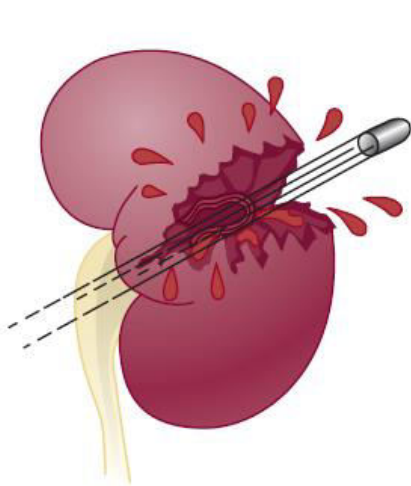
RENAL RECONSTRUCTION

- **Principles of renal reconstruction after trauma:-**
 - complete renal exposure,
 - measures for temporary vascular control,
 - debridement of nonviable tissue,
 - hemostasis by individual suture ligation of bleeding vessels,
 - watertight closure of the collecting system if possible,
 - coverage or reapproximation of the parenchymal defect, and
 - judicious use of drains

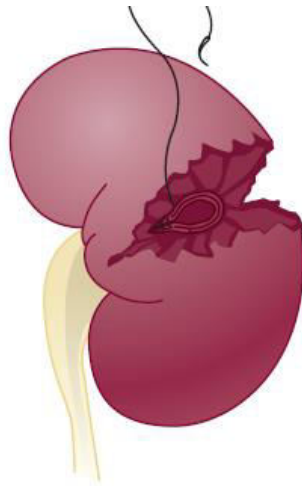
RENORRHAPHY

- Involves
 - exposure of the kidney
 - debridement of nonviable tissue
 - hemostasis obtained with absorbable 4-0 chromic sutures on bleeding vessels
 - closure of the collecting system and
 - approximation of the margins of the laceration (3-0 absorbable suture) with the use of renal capsule and an absorbable hemostatic agent bolster such as Gelfoam

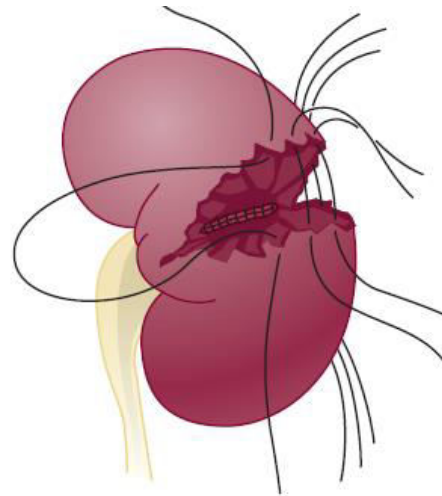
RENORRHAPHY



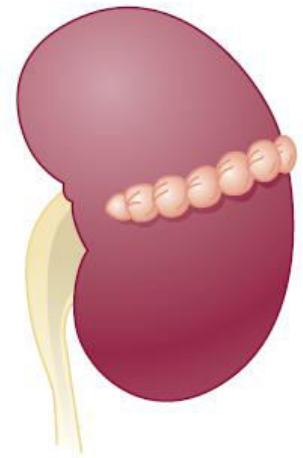
A Deep midrenal laceration into pelvis



B Closure of pelvis
Ligation of vessels



C Defect closure



D Absorbable gelatin
sponge (Gelfoam) bolster

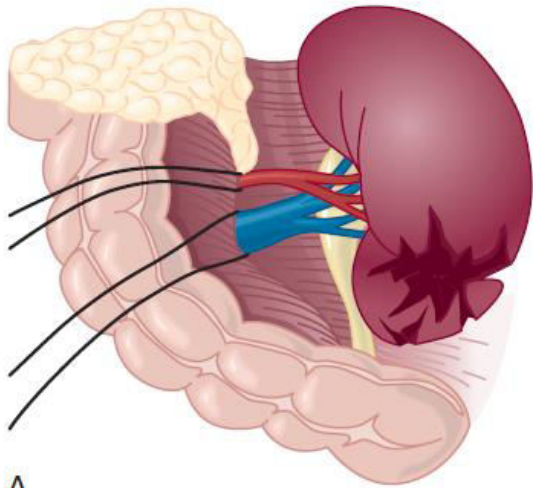
PARTIAL NEPHRECTOMY

- When polar injuries cannot be reconstructed, a partial nephrectomy should be done
- Nonviable tissue should be removed
- Hemostasis obtained, and the collecting system closed.

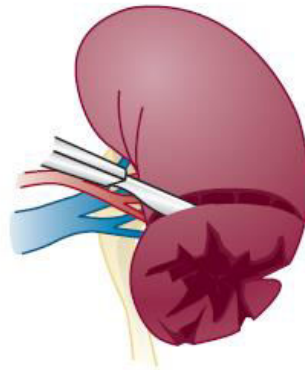
PARTIAL NEPHRECTOMY

- The open parenchyma should then be covered when possible by a pedicle flap of omentum
- With its rich vascular and lymphatic supply, omentum promotes wound healing and decreases the risk of delayed bleeding and urinary extravasation.
- If it's not available, the use of absorbable mesh, peritoneal graft, or retroperitoneal fat has been successful

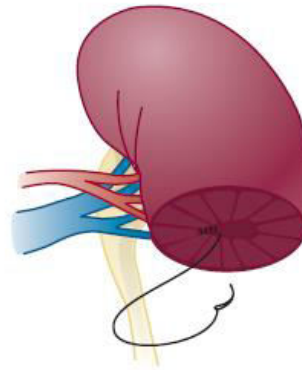
PARTIAL NEPHRECTOMY



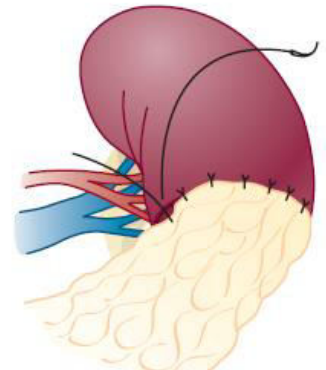
A



B Partial polar
nephrectomy



C Collecting system
closure



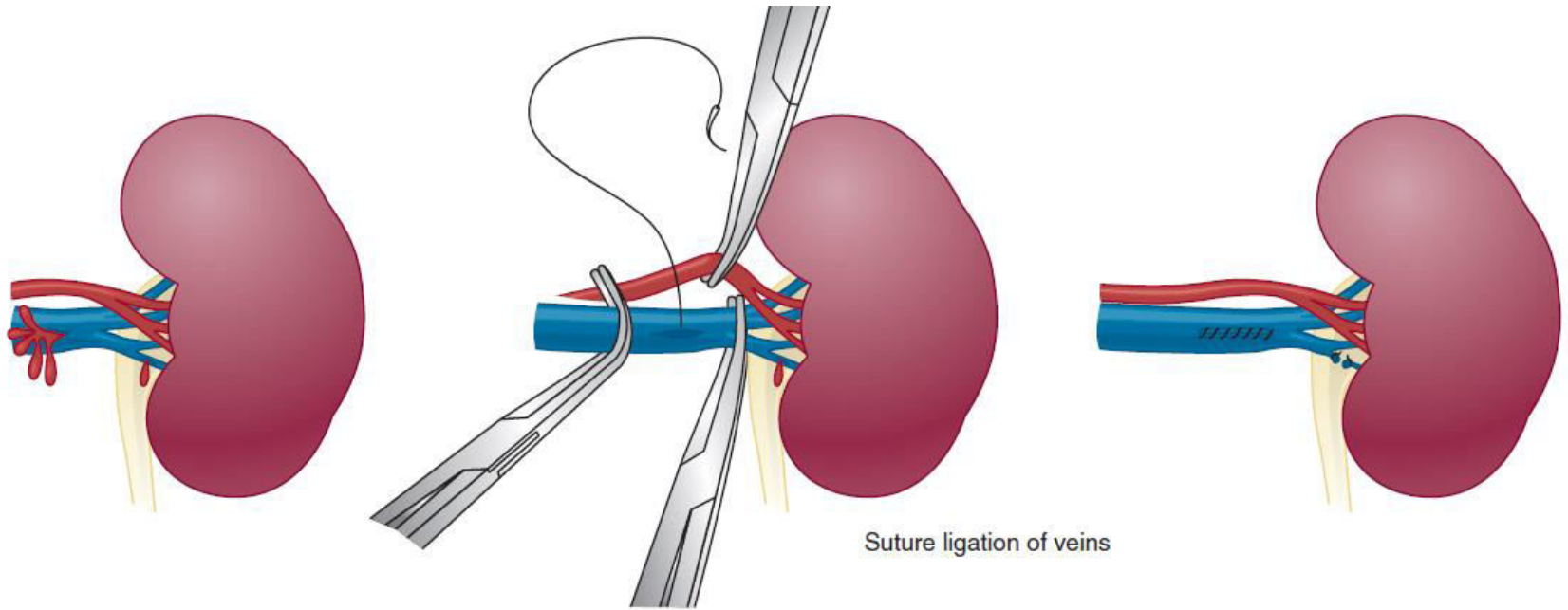
D Omental pedicle
flap

RENOVASCULAR INJURIES

- Uncommon
- often have associated injuries
- requires operative intervention
- For major renovascular injuries, nephrectomy is advocated.

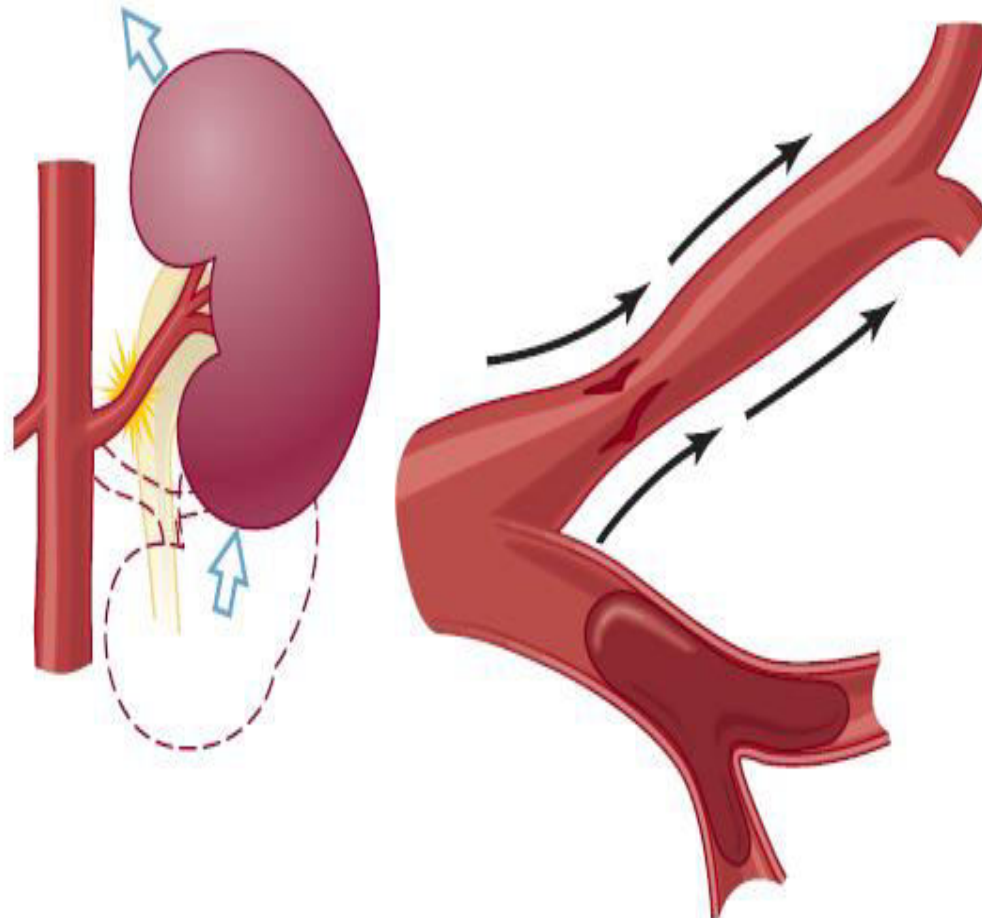
- Rare instances
 - where repair is possible,
 - renal salvage rates are low,
 - 33% renal salvage rate for main renal artery reconstruction
 - Vascular repair requires occlusion of the involved vessel with vascular clamps.
 - The lacerated main renal vessels injured by penetrating trauma can be repaired with 5-0 non absorbable vascular suture

VASCULAR INJURIES



RENAL ARTERY THROMBOSIS

- occurs secondary to deceleration injuries.
- The mobility of the kidney results in stretch on the renal artery,
- which in turn causes the arterial intima to disrupt.
- The consequent thrombus occludes the vessel, rendering the kidney ischemic.



- Diagnosis
 - CT or angiography
 - immediate renal exploration in the appropriate candidate in an attempt to salvage the kidney,
- outcomes
 - for salvage remain dismally low and
 - nephrectomy is almost always required.
- With delayed diagnosis (>8 hours), the kidney typically cannot be salvaged

DAMAGE CONTROL

- **Coburn (2002):-**
 - Noted benefit of damage control
 - improve renal salvage.
- The wound and area around the injured kidney are packed with laparotomy pads to control bleeding
- with a planned return in 24 hours to explore and evaluate the extent of injury.
- useful in patients with extensive injuries along with complex renal injuries to avoid total nephrectomy.

INDICATIONS FOR NEPHRECTOMY

- The unstable patient, with low body temperature and poor coagulation, cannot risk an attempt at renal repair if a normal contralateral kidney is present
- Total nephrectomy would be indicated immediately in extensive renal injuries when the patient's life would be threatened by attempted renal repair.

- **Nash and colleagues (1995):-**
 - 77% required removal because of the extent of parenchymal, vascular, or combined injury and
 - 23% required nephrectomy in otherwise reconstructable kidneys because of hemodynamic instability.

COMPLICATIONS

1. Persistent urinary extravasation can result in

- urinoma,
- perinephric infection,
- and even renal loss.

- **MANAGEMENT:-**

- initially administered systemic antibiotics and
- carefully observed with appropriate antibiotics.

- If still it persists, then placement of an internal ureteral stent often corrects the problem.

2. Delayed renal bleeding

- can occur up to several weeks after injury but
 - usually occurs within 21 days.
-
- Management
 - bed rest and hydration.
 - Persistent bleeding – angiography localize the bleeding vessel - embolization

3. Perinephric abscess

- Rare
- persistent urinary extravasation and urinoma are the precursors.

Management

- Percutaneous drainage
- followed by surgical drainage if necessary.

4. Hypertension

– The basic mechanisms

(1) renal vascular injury,

- leading to stenosis or occlusion of the main renal artery or one of its branches (Goldblatt kidney);

(2) compression of the renal parenchyma with extravasated blood or urine (Page kidney); and

(3) post-trauma arteriovenous fistula.

- In these instances, the reninangiotensin axis is stimulated by partial renal ischemia, resulting in hypertension

4.1.7 *Summary of evidence and recommendations for evaluation and management of renal trauma*

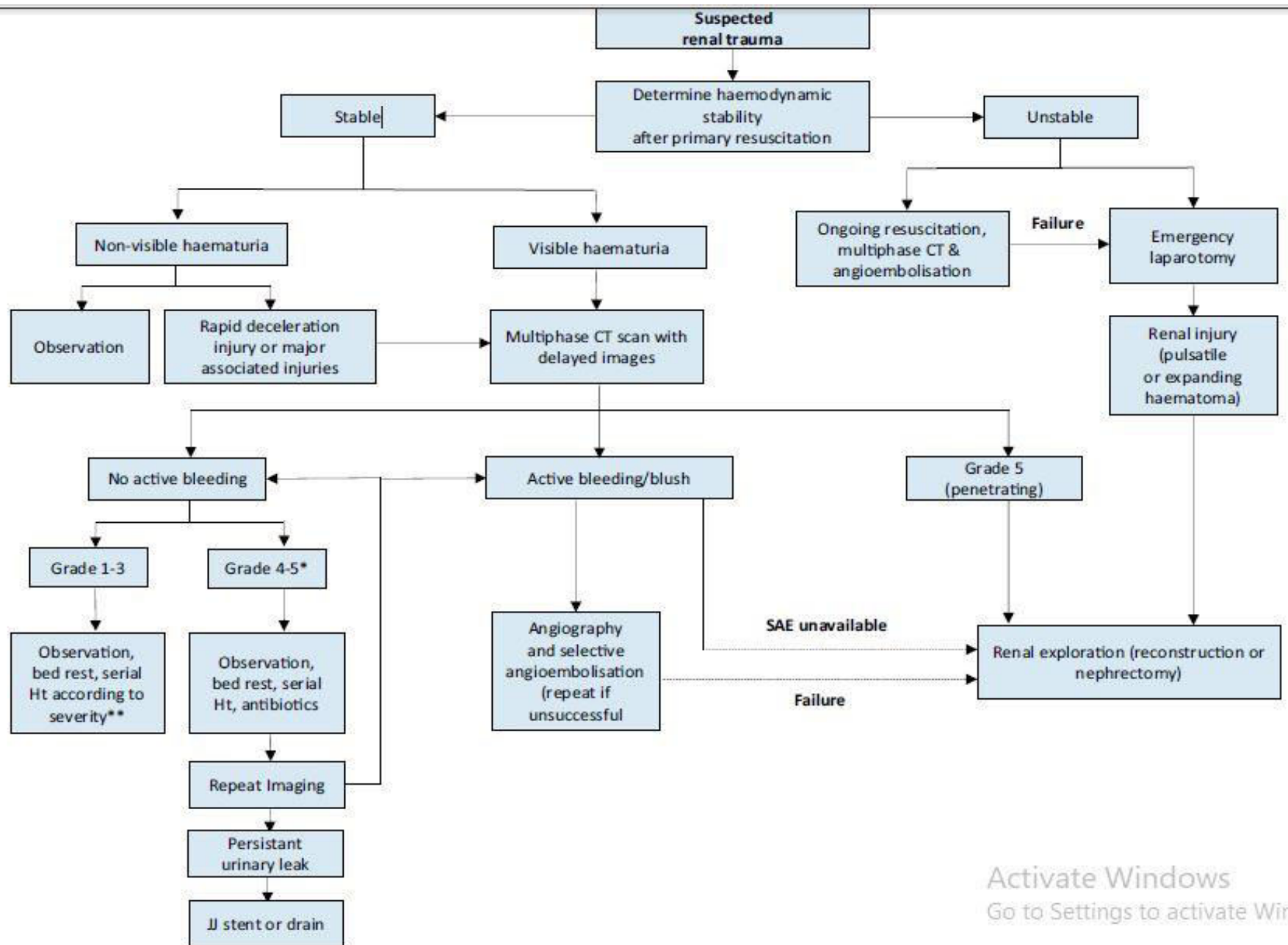
Summary of evidence	LE
Vital signs on admission give the most reliable indication of the urgency of the situation.	3
Special consideration should be given to patients with a solitary kidney and pre-existing renal disease.	4
Haematuria is a key finding following renal trauma; although, it may not be present in certain situations.	3
A multiphase CT scan is the best method for the diagnosis and staging of renal injuries in haemodynamically stable patients.	3
Haemodynamic stability is the primary criterion for selecting patients for non-operative management.	3
Selective angioembolisation is effective in patients with active bleeding from renal injury, without other indications for immediate abdominal operation.	3
Renal reconstruction should be attempted if haemorrhage is controlled and there is sufficient viable renal parenchyma.	3
Iatrogenic renal injuries are procedure-dependent (1.8-15%); the most common injuries are vascular.	3
Limited literature exists with regard to long-term consequences of renal trauma. Current follow-up includes physical examination, urinalysis, diagnostic imaging, serum creatinine, as well as annual blood pressure monitoring to diagnose renovascular hypertension.	4

Recommendations	Strength rating
Evaluation	
Assess haemodynamic stability upon admission.	Strong
Record past renal surgery, and known pre-existing renal abnormalities (ureteropelvic junction obstruction, solitary kidney, lithiasis).	Strong
Test for haematuria in a patient with suspected renal injury.	Strong
Perform a multiphase computed tomography scan in trauma patients with: • visible haematuria; • non-visible haematuria and one episode of hypotension; • a history of rapid deceleration injury and/or significant associated injuries; • penetrating trauma; • clinical signs suggesting renal trauma e.g. flank pain, abrasions, fractured ribs, abdominal distension and/or a mass and tenderness.	Strong

Management	
Manage stable patients with blunt renal trauma non-operatively with close monitoring and re-imaging as required.	Strong
Manage isolated Grade 1-4 stab and low-velocity gunshot wounds in stable patients non-operatively.	Strong
Use selective angioembolisation for active renal bleeding if there are no other indications for immediate surgical exploration.	Strong
Proceed with renal exploration in the presence of: • persistent haemodynamic instability; • Grade 5 vascular or penetrating injury; • expanding or pulsatile peri-renal haematoma.	Strong
Attempt renal reconstruction if haemorrhage is controlled and there is sufficient viable renal parenchyma.	Weak
Repeat imaging in high-grade injuries and in cases of fever, worsening flank pain, or falling haematocrit.	Strong
Follow-up approximately three months after major renal injury with: • physical examination; • urinalysis; • individualised radiological investigation including nuclear scintigraphy; • blood pressure measurement; • renal function tests.	Weak
Measure blood pressure annually to diagnose renovascular hypertension.	Strong

3.18.1.5 *Recommendations for the diagnosis and management of paediatric renal trauma*

Recommendations	Strength rating
Use imaging in all children who have sustained a blunt or penetrating trauma with any level of haematuria, especially when the history reveals a deceleration trauma, direct flank trauma or a fall from a height.	Strong
Use rapid spiral computed tomography with delayed images scanning for diagnostic and staging purposes.	Strong
Manage most injured kidneys conservatively.	Strong
Offer surgical intervention in case of haemodynamic instability and a Grade V renal injury.	Strong



**Thank You
For Your
Attention !**

