

Diagnosis & Management of Kidney Trauma

LAU - Urology Residency Program

LOP Urology Residents Meeting

Outline

- Introduction
- Investigation
- Staging
- Treatment

Introduction

- The kidneys are the most common genitourinary organs injured from external trauma.
 - 5% of all trauma and 10% of abdominal trauma cases
- Motor vehicle accidents, falls from heights, and assaults contribute to the majority of blunt renal trauma.

Blunt

- Perhaps the most important information to obtain in the history of the injury is the extent of **deceleration** involved in high-velocity impact trauma.
 - Retroperitoneal points of fixation such as the renal hilum or UPJ, result in renal artery thrombosis, renal vein disruption, and renal pedicle avulsion.

Penetrating

- Penetrating renal injuries most often come from gunshot and stab wounds.
 - weapon characteristics including caliber and types.
- Common entry sites including the upper abdomen, flank, and lower chest should alert to possible renal involvement
 - Anterior axillary line → hilum
 - Posterior axillary line → parenchymal

Physical Exam

- Vital signs
- Possible renal injury:
 - flank hematoma,
 - abdominal or flank tenderness,
 - rib fractures,
 - and penetrating injuries to the low thorax or flank.
- Gunshot injuries can be misleading!!!

Laboratory Tests

- Urinalysis
- Creatinine
- CBCD and other tests related to trauma

Hematuria

- The degree of hematuria and the severity of the renal injury don't consistently correlate.
- The presence or absence of hematuria should not be the sole determinant in the assessment of a patient with suspected renal trauma.

Hematuria

- For example,
 - absent in 7% of 420 grade IV renal injuries (Shariat et al, 2008a)
 - 36% of renal vascular injuries from blunt trauma → no blood in the urine (Cass, 1989).
 - 50% of injuries to the UPJ → no microscopic or gross hematuria.

Staging

To provides maximal guidance for treatment decisions:

- History (personal + trauma)
- Physical examination findings
- Imaging studies

Diagnostic Imaging

- 4-phase CT scan is the gold standard
- Other modalities:
 - Ultrasound
 - IVP/ One-shot Intra-op
 - MRI
 - Angiography

Indications for Renal 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

Indications for Renal Imaging

4. all blunt trauma with hypotension defined as a systolic pressure of less than 90 mm Hg at any time during evaluation and resuscitation
5. all pediatric patients with greater than 5 RBCs/HPF

Indications for Renal Imaging

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

Table 42-1.

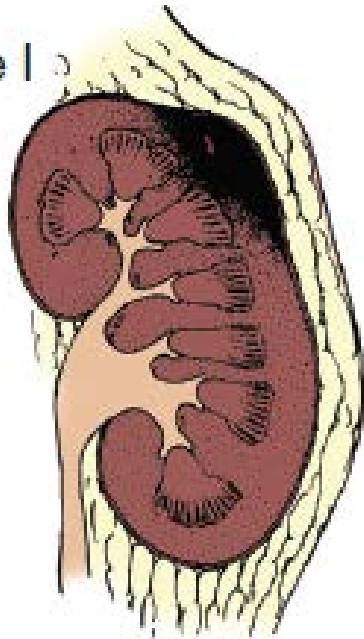
American Association for the Surgery of Trauma Organ Injury Severity Scale for the Kidney

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

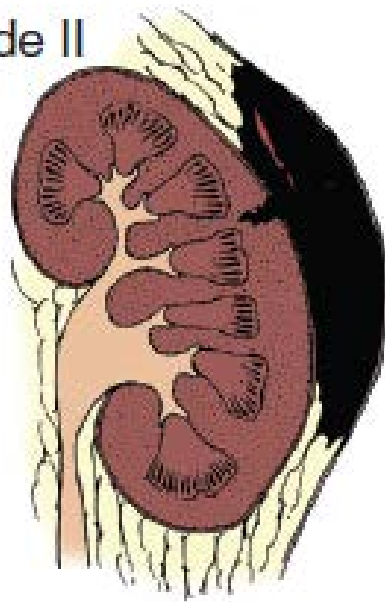
*Advance one grade for bilateral injuries up to grade III.

Data from Moore EE, Shackford SR, Pachter HL, et al. Organ injury scaling: spleen, liver, and kidney. *J Trauma* 1989;29:1664-6.

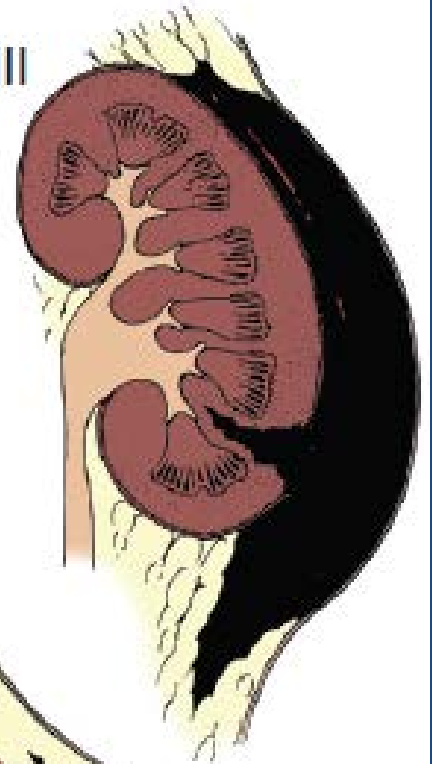
Grade I



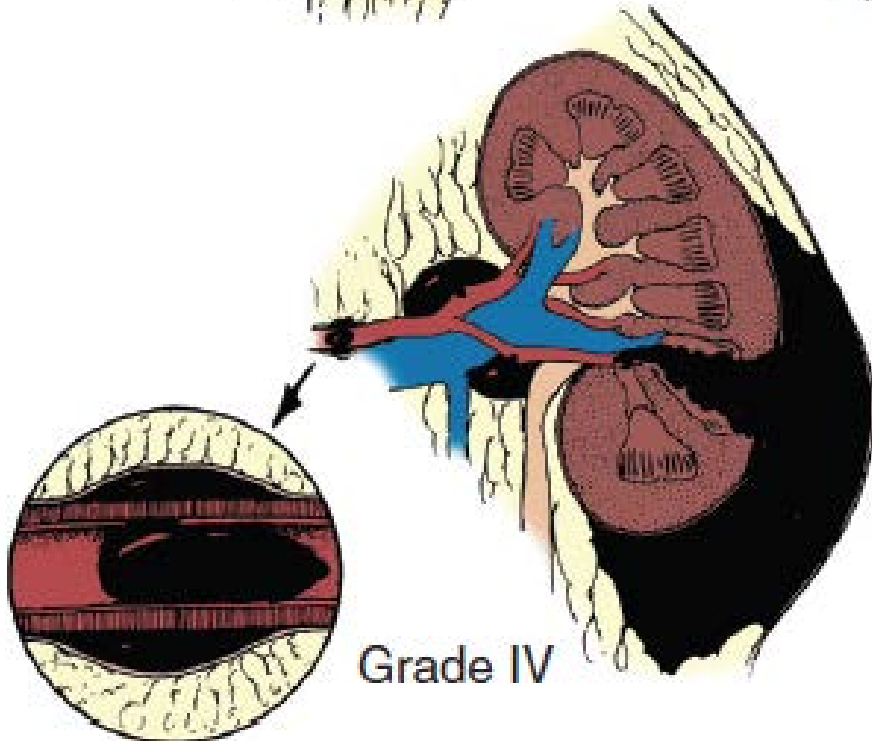
Grade II



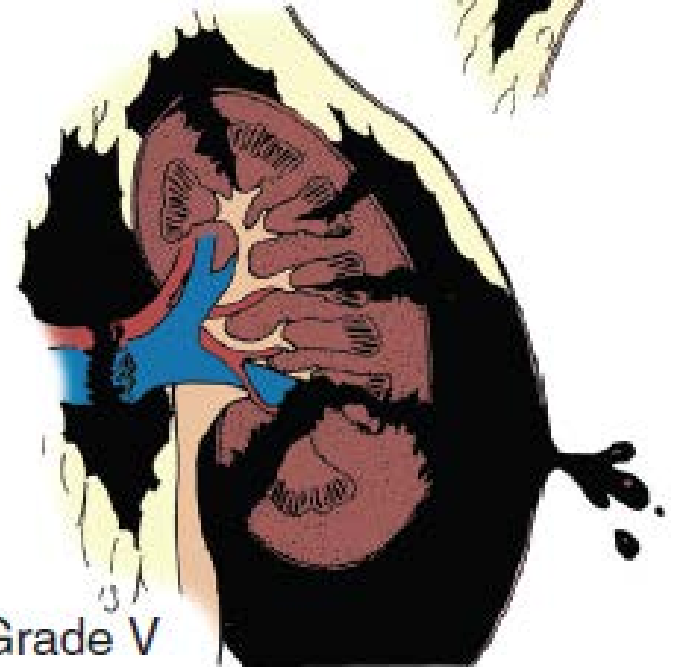
Grade III



Grade IV



Grade V



Imaging

- **Patients with microscopic hematuria without shock can be observed clinically without imaging studies.**
 - these patients rarely have a significant injury.
 - But if high suspicion go for imaging.
- **Penetrating injuries with any degree of hematuria should be imaged.**

Imaging Technique

- Contrast-enhanced computed tomography (CT) is the gold standard.
- Findings on CT that raise suspicion for major injury are:
 1. medial hematoma, suggesting vascular injury (may hide an isolated renal vein injury)
 2. Medial urinary extravasation, suggesting renal pelvis or UPJ avulsion injury;
 3. lack of contrast enhancement of the parenchyma, suggesting arterial injury.



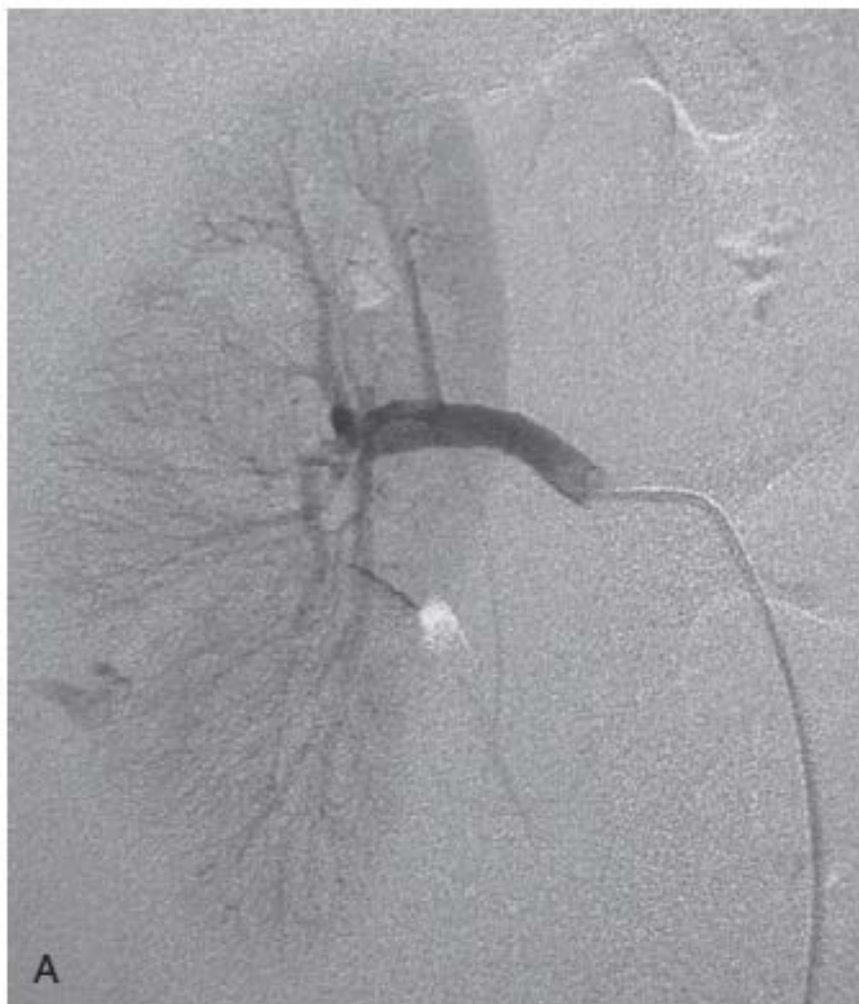
Computed tomography scan of a right renal stab wound (grade IV), demonstrating extensive urinary extravasation and large retroperitoneal hematoma

IVP

- Largely replaced by CT, a limited role includes the intraoperative “single-shot” IVP.
 - single film is taken 10 minutes after intravenous injection (IV push) of 2 mL/kg of contrast material

Imaging

- Ultrasound and Doppler add limited amount of information (hematoma, abdominal fluid...)
- Arteriography in stable patients → diagnostic and therapeutic.



Angioembolization of renal laceration: **A**, Arteriography demonstrating active arterial bleeding. **B**, Coil embolization used to control bleeding. Note presence of coil and large, triangular area of infarct.

Non-operative management

- Standard of care in stable well-staged patients.
- I-III → non-surgical management
- IV-V → more often require surgical exploration but can be managed non surgically in selected cases especially if no other organ injury.
- Kidneys heal with conservative management even if high grade injury present.
 - 4/6 grade V kidneys demonstrated satisfactory function after conservative treatment (Altman, 2000).

Non-operative management

- This concept continues into intraop scenarios where the injured kidney demonstrate non-expanding non-pulsatile hematoma!

Non-operative management

- The management of severe renal lacerations must balance two major issues:
 - the increased incidence of nephrectomy in patients undergoing immediate as opposed to delayed renal exploration
 - the associated morbidity of patients managed expectantly.

Non-operative management

- Serial hematocrit readings.
- Strict bed rest is mandatory.
- Urinary extravasation or nonviable parenchyma
→ periodic inpatient imaging,
 - although the authors are aware of no studies to prove it helps in the absence of worrisome symptoms (fever, flank pain, dropping hematocrit).

Non-operative management

- Although most grades II to IV injuries resolve uneventfully, delayed renal bleeding can occur in up to 25% (Wessells et al, 1997).
- Should bleeding persist or delayed bleeding occur, angiography with selective embolization of bleeding vessels can obviate surgical intervention.

Angiography

- Indications for angiography with embolization therapy:
 - bleeding from a renal segmental artery with or without parenchymal laceration,
 - AVs fistula or pseudoaneurysm,
 - persistent gross hematuria,
 - and/or blood loss exceeding 2 units in 24 hours.

Angiography

- Case reports of renal artery thrombosis treated with stents
 - Main issue in anticoagulation afterwards.

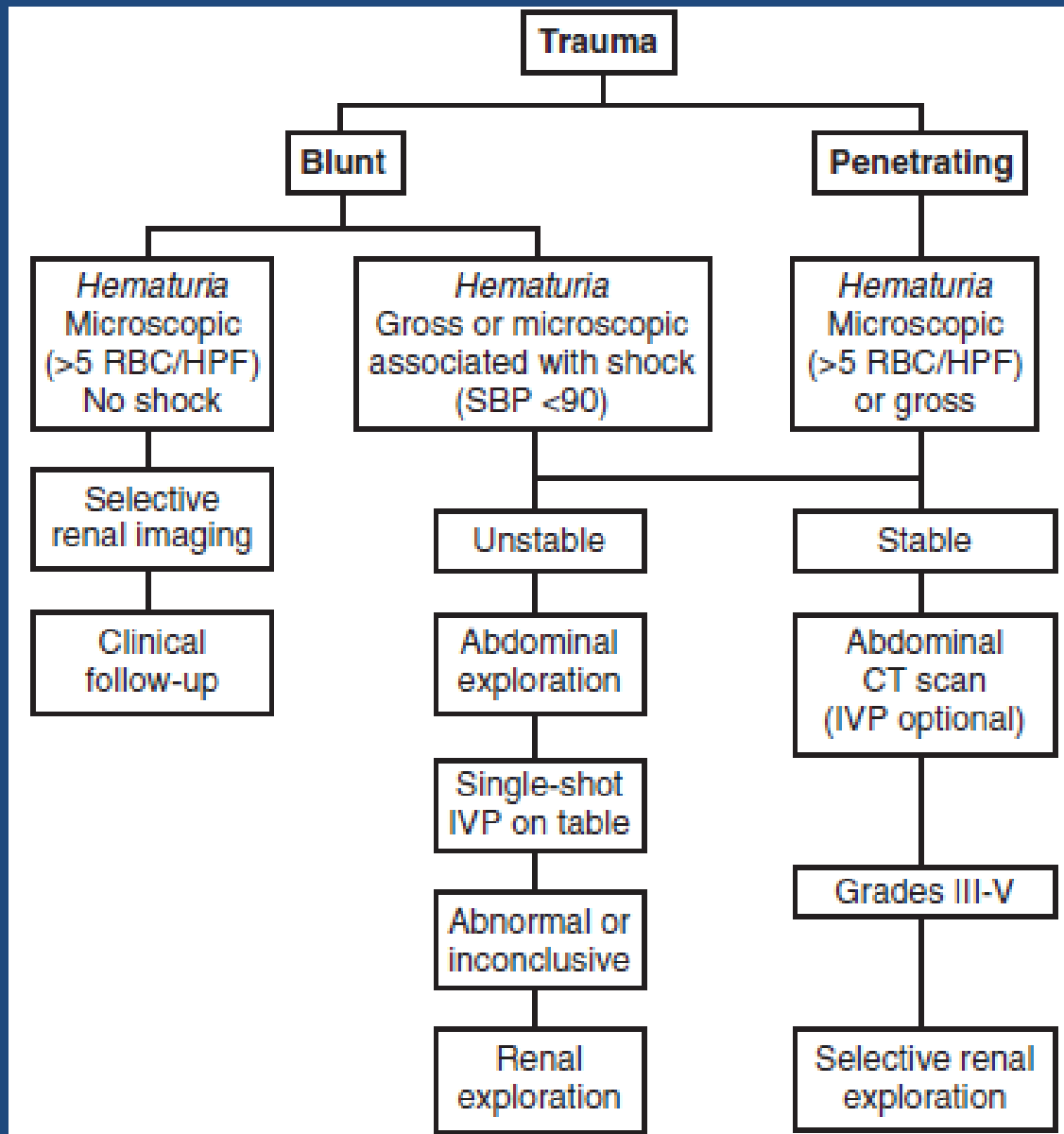
Non-operative management

- Urinary extravasation in solitary injuries can be managed without major intervention and a resolution rate of > 90%
- If significant urinary extravasation persists, placement of an internal ureteral stent for drainage often prevents prolongation of the extravasation and decreases the chance of perirenal urinoma formation
 - + broad spectrum antibiotics

Non-operative management

- Unilateral main arterial injuries will normally be managed non-operatively in a hemodynamically stable patient
- Surgical repair reserved for bilateral artery injuries or injuries involving a solitary functional kidney

Flow chart for adult renal injuries to serve as a guide for decision making.



Operative Management

Absolute indications include

1. hemodynamic instability with shock;
2. expanding/pulsatile renal hematoma (usually indicating renal artery avulsion) **> 3.5 cm**;
3. suspected renal pedicle avulsion (grade 5);
4. ureteropelvic junction disruption.

Relative indications are now rare:

- urinary extravasation together with nonviable tissue
- renal injury together with colon/pancreatic injury, and
- a delayed diagnosis of arterial injury (which most likely will need delayed nephrectomy).

Operative Management

- Should nonviable tissue constitute more than **25%** in association with a parenchymal laceration or urinary extravasation or both
 - the potential for complications greatly increases and operative management is recommended (Alsikafi et al, 2006).

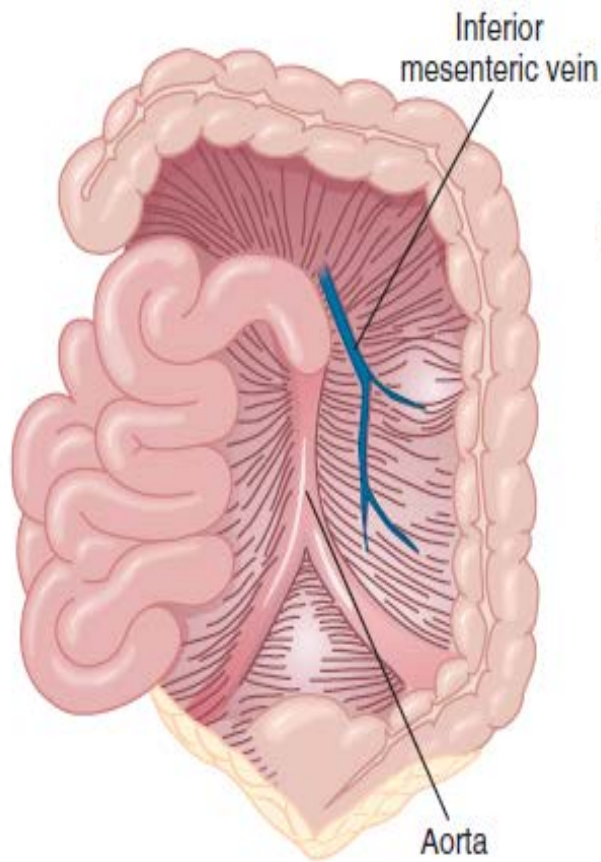
Operative Management

- If findings are not normal on intra-op IVP, renal exploration provides the opportunity to complete the staging process and reconstruct a significant injury.

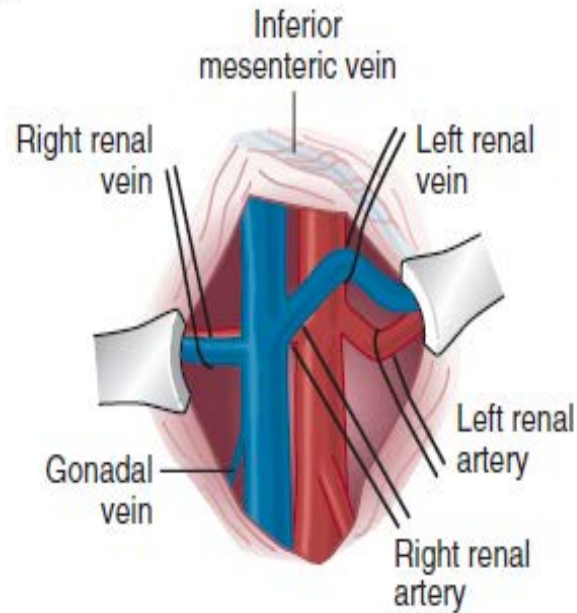
Operative Management

Renal Exploration

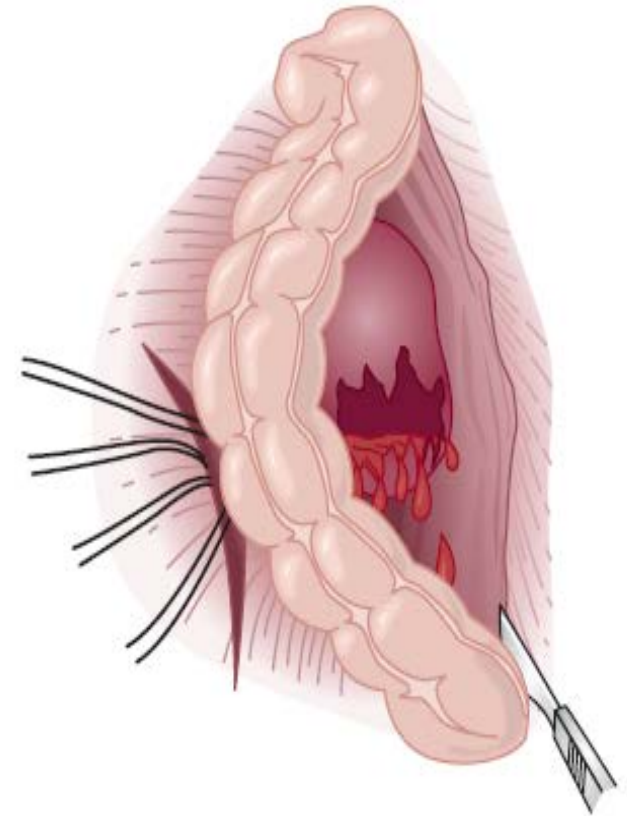
- Transabdominal approach → allows complete inspection of intra-abdominal organs and bowel.
- Obtaining early vascular control before opening Gerota fascia can decrease renal loss:
 - in a comparative series, the total nephrectomy rate was reduced from 56% to 18% (McAninch and Carroll, 1982).



A



B



C

The surgical approach to the renal vessels and kidney. **A**, Retroperitoneal incision over the aorta medial to the inferior mesenteric vein. **B**, Anatomic relationships of the renal vessels. **C**, Retroperitoneal incision lateral to the colon, exposing the kidney.

Treatment

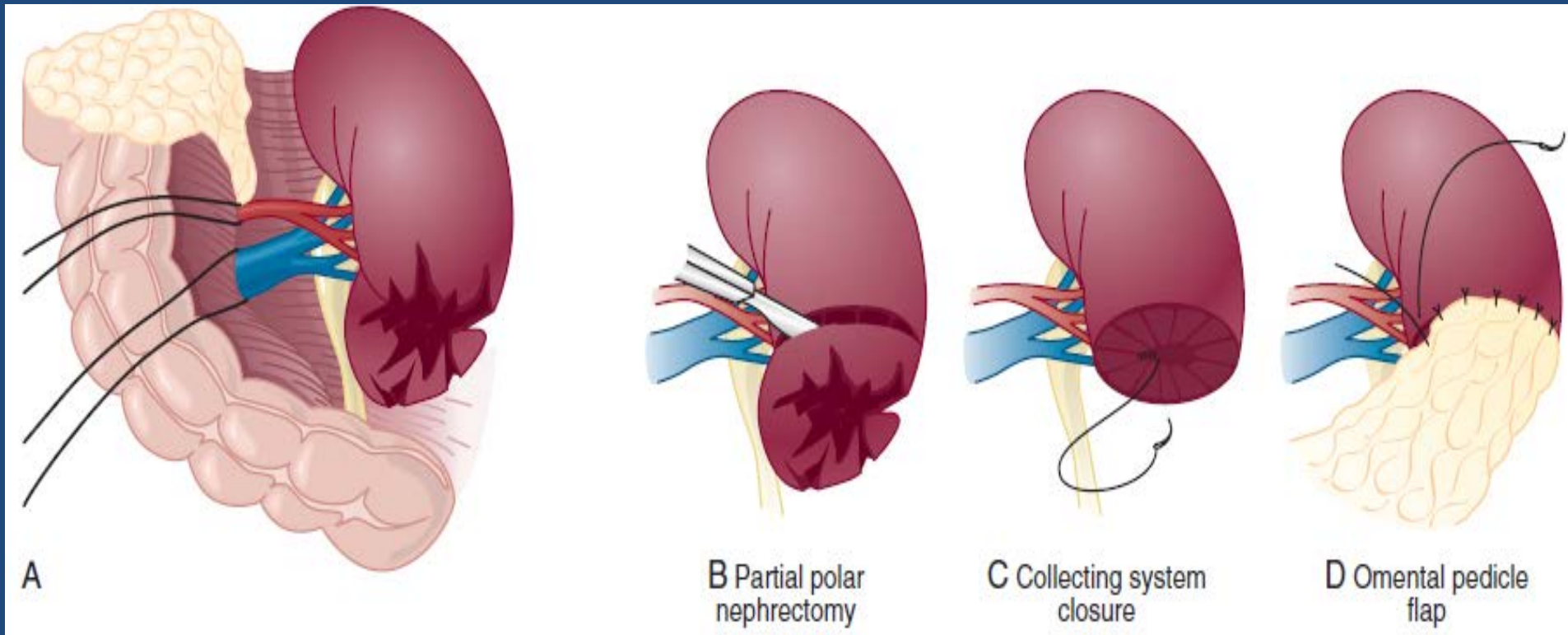
	GR
Following blunt renal trauma, stable patients should be managed conservatively and closely monitored for vital signs until gross haematuria resolves.	B
Isolated grade 1-3 stab and low-velocity gunshot wounds in stable patients, after complete staging, should be managed expectantly.	B
Indications for renal exploration include: <ul style="list-style-type: none">• haemodynamic instability;• exploration for associated injuries;• expanding or pulsatile peri-renal haematoma identified during laparotomy;• grade 5 vascular injury.	B
Radiological embolization is indicated in patients with active bleeding from renal injury but without other indications for immediate abdominal operation.	B
Intra-operatively, renal reconstruction should be attempted once haemorrhage is controlled and there is sufficient viable renal parenchyma.	B

GR = grade of recommendation.

Operative Management Renal Reconstruction

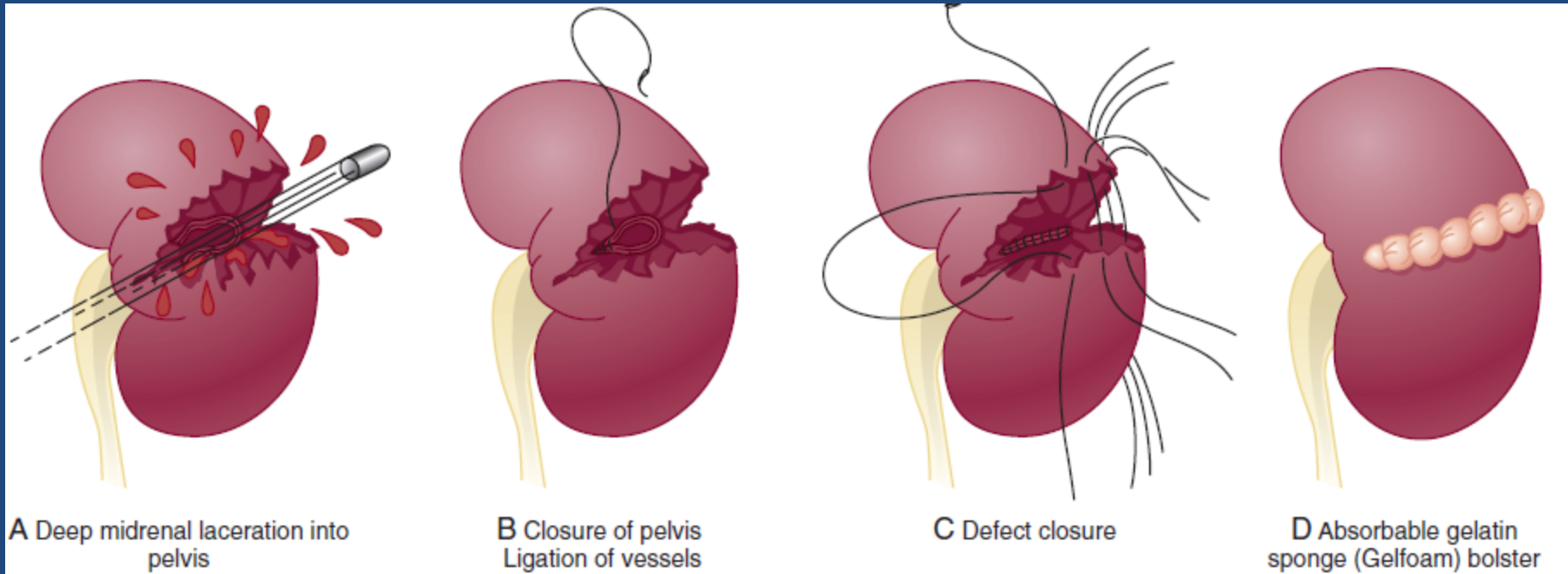
- **The principles of renal reconstruction after trauma include:**
 - complete renal exposure,
 - measures for temporary vascular control,
 - debridement of nonviable tissue,
 - hemostasis by individual suture ligation of bleeding vessels,
 - watertight closure of the collecting system if possible,
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

Operative Management Renal Reconstruction



Technique for partial nephrectomy: **A**, total renal exposure; **B**, sharp removal of nonviable tissue; **C**, hemostasis obtained and collecting system closed; **D**, defect covered.

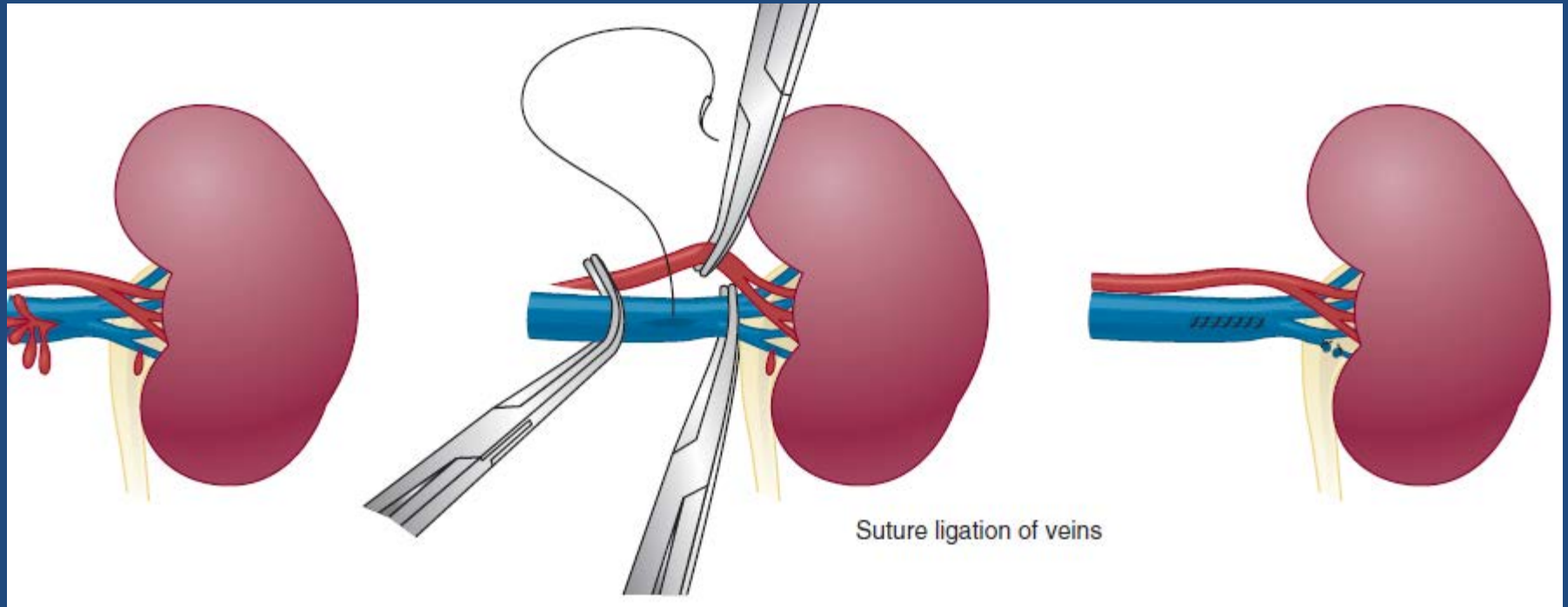
Operative Management Renal Reconstruction



Technique for renorrhaphy: **A**, typical injury in midportion of kidney; **B**, debridement, hemostasis, and collecting system closure; **C**, approximation of parenchymal margins; **D**, sutures tied over gelatin sponge bolster.

Renovascular Injuries.

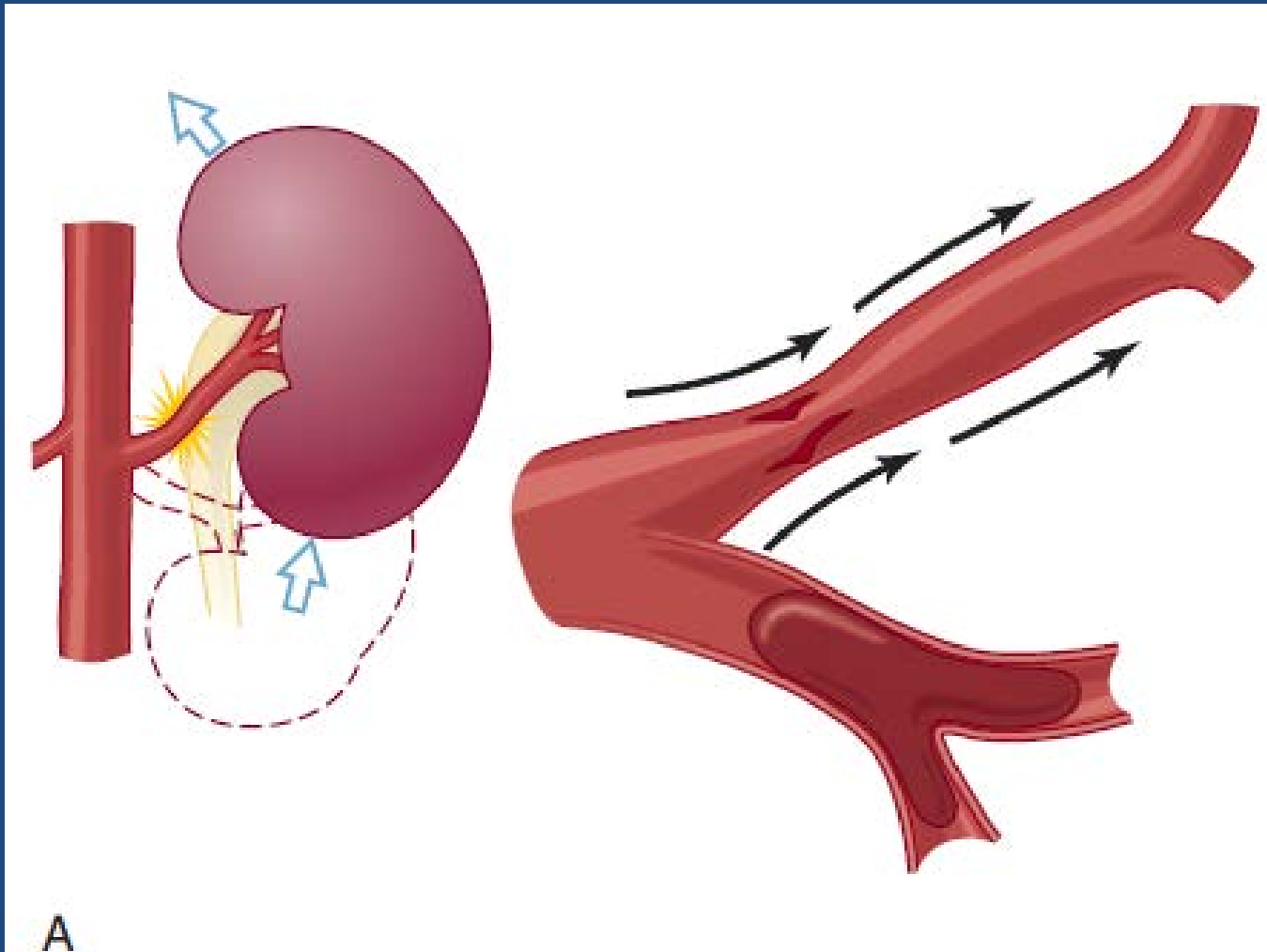
- For major renovascular injuries, speedy nephrectomy is advocated.
- In rare instances where repair is possible, renal salvage rates are low, (33% for main renal artery reconstruction even in the most expert of hands)(Elliott et al, 2007).
- **With delayed diagnosis (>8 hours), the kidney typically cannot be salvaged**



Vascular injuries. *Left*, Venous injuries may occur in the main renal vein or the segmental branches. *Middle*, Repair of main renal vein. *Right*, Ligation of segmental branch can be done safely.

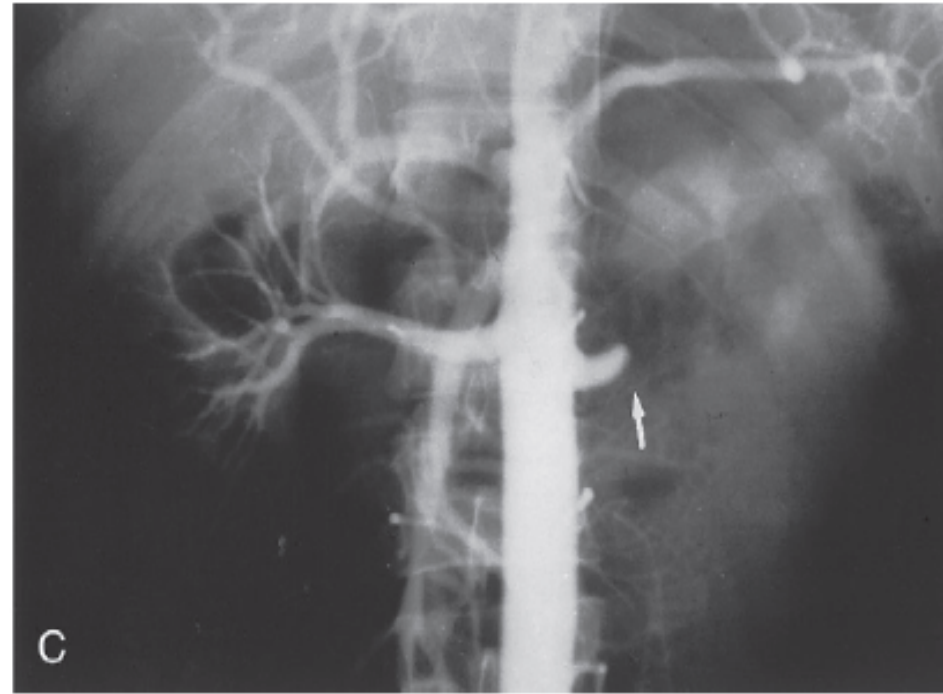
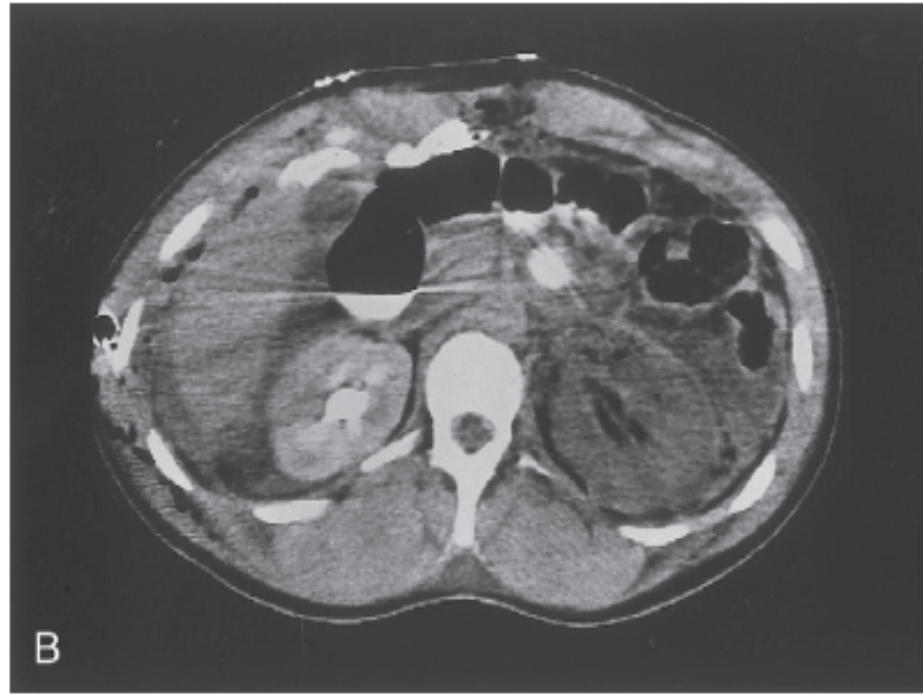
Renovascular Injuries.

- Main renal artery thrombosis from blunt trauma occurs secondary to deceleration injuries (stretch injury with intimal tear).
- Outcomes for salvage remain dismally low and nephrectomy is almost always required.
- When repair is attempted → excision with graft.
- Promising endovascular techniques but anticoagulation remains an issue.



A

A, Movement of the kidney from blunt trauma (deceleration injury) causes stretch on the renal artery, resulting in rupture of the arterial intima and formation of a thrombus.



B, Computed tomography of a left kidney with renal artery thrombosis, demonstrating lack of contrast material perfusion to the kidney. **C**, Arteriography demonstrating complete occlusion of the left renal artery secondary to thrombus formation.

Renovascular Injuries.

- Segmental renal arterial injuries result in ischemic infarction to a segment of the kidney.
- These should be observed nonoperatively when diagnosed unless
 - associated with a parenchymal laceration with infarction be greater than 20% of the parenchyma → careful consideration should be given to endovascular embolization or surgical correction.

Operative Management

Segmental renal artery injury

- Concerns include delayed bleeding and urinoma formation.
- A recent series demonstrated excellent outcomes with only 1 of 18 (6%) patients requiring subsequent intervention during conservative management of segmental renal artery injuries (Elliott et al, 2007).

Damage Control

- Coburn (2002) has noted the benefit of damage control to 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.
- This approach is commonly used by trauma surgeons in patients with extensive injuries and has long been used by general surgeons.
- It may well be useful in managing complex renal injuries to avoid total nephrectomy.

Complications

- Early complications (<1 month):
 - bleeding, infection, perinephric abscess, sepsis, urinary fistula, hypertension, urinary extravasation and urinoma
- Delayed complications include
 - bleeding, calculus formation, chronic pyelonephritis, hypertension, AVF, hydronephrosis and pseudoaneurysms

Complications

- Delayed renal bleeding can occur up to several weeks after injury but usually occurs within 21 days → bed rest and hydration +/- embolization
- Perinephric abscess (rare) → drain
- Hypertension (injury, compression, AV fistula (Renin-angiotensin))

Follow-up

- The risk of complications in patients who have been treated conservatively increases with grade.
 - Repeat imaging 2-4 days after trauma minimizes the risk of missed complications, especially in grade 3-5 blunt injuries
- CT scans should always be performed on patients with fever, unexplained decreasing hematocrit or significant flank pain

Treatment

	GR
Repeat imaging is recommended in cases of fever, flank pain, or falling haematocrit.	B
Nuclear scintigraphy is useful for documenting functional recovery.	C
First follow-up should be at approximately 3 months after major renal injury with hospitalization. Each follow-up should include: physical examination, urinalysis, individualized radiological investigation, serial blood pressure measurement and renal function test.	C
Medical management and minimally invasive techniques should be the first choice for the management of complications.	C
Long-term follow-up should be decided on a case-by-case basis.	C

GR = grade of recommendation.

Summary

- Expectant management strategies of renal trauma allow for maximal renal preservation.
- The degree of hematuria and the severity of renal injury do not consistently correlate.
- Contrast-enhanced computed tomography (CT) is the gold standard for genitourinary imaging in renal trauma.
- Patients with microscopic hematuria without shock can be observed clinically without imaging studies.
- Hemodynamically stable, well-staged renal injuries should be conservatively managed (even with severe, high-grade injuries).

Summary

- Selective embolization provides an effective and minimally invasive means to stop active bleeding from parenchymal lacerations and segmental arterial injury.
- CT findings suspicious for major injury include (1) medial hematoma (vascular injury); (2) medial urinary extravasation (renal pelvis or ureteropelvic junction injury); and (3) lack of contrast enhancement of the parenchyma (arterial injury).
- Intraoperative “one-shot” IVP confirms the presence of a contralateral functioning kidney.
- Early vascular control before opening Gerota fascia can decrease renal loss.

Thank you!
(questions?)