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### **Renal Trauma**

### Presentation

- Renal injuries are the most common injuries of the urinary system.
- The kidney is well protected by heavy lumbar muscles, vertebral bodies, ribs, and the viscera anteriorly.
- Fractured ribs and transverse vertebral processes may penetrate the renal parenchyma or vasculature.
- Most injuries occur from automobile accidents or sporting mishaps, chiefly in men and boys.
- Kidneys with existing pathologic conditions such as hydronephrosis or malignant tumors are more readily ruptured from mild trauma.

# Etiology

- Blunt trauma directly to the abdomen, flank, or back is the most common mechanism, accounting for 80–85% of all renal injuries.
- Trauma may result from motor vehicle accidents, fights, falls, and contact sports.
- Vehicle collisions at high speed may result in major renal trauma from rapid deceleration and cause major vascular injury.
- Gunshot and knife wounds cause most penetrating injuries to the kidney.
- Associated abdominal visceral injuries are present in 80% of renal penetrating wounds.

## Classification

- Grade 1 (the most common)—Renal contusion or bruising of the renal parenchyma. Microscopic hematuria is common, but gross hematuria rarely occurs.
- Grade 2—Renal parenchymal laceration into the renal cortex.
  Perirenal hematoma is usually small.
- Grade 3—Renal parenchymal laceration extending through the cortex and into the renal medulla. Bleeding can be significant in the presence of large retroperitoneal hematoma.
- Grade 4—Renal parenchymal laceration (single or multiple) extending into the renal collecting system; also main renal artery thrombosis from blunt trauma, segmental renal vein, or both; or artery injury with contained bleeding.
- Grade 5—Multiple Grade 4 parenchymal lacerations, renal pedicle avulsion, or both; main renal vein or artery injury from penetrating trauma; main renal artery or vein thrombosis.



# **Early Pathologic Findings**

- Lacerations from blunt trauma usually occur in the transverse plane of the kidney. The mechanism of injury is thought to be force transmitted from the center of the impact to the renal parenchyma.
- In injuries from rapid deceleration, the kidney moves upward or downward, causing sudden stretch on the renal pedicle and sometimes complete or partial avulsion.
- Acute thrombosis of the renal artery may be caused by an intimal tear from rapid deceleration injuries owing to the sudden stretch.

# Late Pathologic Findings

 1. Urinoma—Deep lacerations that are not repaired may result in persistent urinary extravasation and late complications of a large perinephric renal mass and, eventually, hydronephrosis and abscess formation.  2. Hydronephrosis—Large hematomas in the retroperitoneum and associated urinary extravasation may result in perinephric fibrosis engulfing the ureteropelvic junction, causing hydronephrosis.  3. Arteriovenous fistula—Arteriovenous fistulas may occur after penetrating injuries but are not common.

- 4. Renal vascular hypertention (<1% of cases). The basic mechanisms for arterial hypertension as a complication of trauma are
  - (1) renal vascular injury, leading to stenosis or occlusion of the main renal artery or one of its branches.
  - (2) compression of the renal parenchyma with extravasated blood or urine.
  - (3) post-trauma arteriovenous fistula.
  - In these instances, the reninangiotensin axis is stimulated by partial renal ischemia, resulting in hypertension.

# **Clinical Findings**

- The best indicators of significant urinary system injury include the presence of microscopic (>5 RBCs/HPF) or positive dipstick finding) or gross hematuria and hypotension (systolic blood pressure <90 mm Hg).</li>
- The presence of microscopic hematuria is often characteristic. However, gross hematuria has been observed in minor renal contusions and microscopic hematuria has been associated with severe renal injuries.
- Therefore the degree of hematuria and the severity of the renal injury do not consistently correlate.

## Symptoms

- There is usually visible evidence of abdominal trauma.
- Pain may be localized to one flank area or over the abdomen.
- Associated injuries such as ruptured abdominal viscera or multiple pelvic fractures also cause acute abdominal pain and may obscure the presence of renal injury.
- Retroperitoneal bleeding may cause abdominal distention, ileus, and nausea and vomiting.

# Signs

- Initially, shock or signs of a large loss of blood from heavy retroperitoneal bleeding may be noted.
- Ecchymosis in the flank or upper quadrants of the abdomen is often noted.
- Lower rib fractures are frequently found.
- Diffuse abdominal tenderness may be found on palpation; an "acute abdomen" usually indicates free blood in the peritoneal cavity.
- A palpable mass may represent a large retroperitoneal hematoma or perhaps urinary extravasation.

# Laboratory Findings

- Microscopic or gross hematuria is usually present.
- The hematocrit may be normal initially, but a drop may be found when serial studies are done.

This finding represents persistent retroperitoneal bleeding and development of a large retroperitoneal hematoma.

 Persistent bleeding may necessitate operation.

# **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;
- (4) all blunt trauma with hypotension defined as a systolic pressure of less than 90 mm Hg at any time during evaluation
- (5) all pediatric patients with greater than 5 red blood cells (RBCs)/HPF.

- all blunt trauma patients with gross hematuria and patients with microscopic hematuria and shock (systolic blood pressure <90 mm Hg any time during evaluation and resuscitation) should undergo renal imaging, usually with CT using intravenous contrast.
- Patients with microscopic hematuria without shock can be observed clinically without imaging studies.
- Penetrating injuries with any degree of hematuria should be imaged.

# **Imaging Studies**

- Contrast-enhanced computed tomography (CT) is the gold standard for genitourinary imaging in renal trauma.
- It is the most direct and effective means of staging renal injuries.
- This noninvasive technique clearly defines parenchymal lacerations and urinary extravasation; shows the extent of the retroperitoneal hematoma; identifies nonviable tissue; and outlines injuries to surrounding organs such as the pancreas, spleen, liver, and bowel.
- One major limitation of CT is the inability to define a renal venous injury adequately.

- Findings on CT that raise suspicion for major injury are
  - (1) medial hematoma, suggesting vascular injury;
  - (2) medial urinary extravasation, suggesting renal pelvis or ureteropelvic junction avulsion injury; and
  - (3) lack of contrast enhancement of the parenchyma, suggesting arterial injury.

- Arteriography defines major arterial and parenchymal injuries when previous studies have not fully done so.
- Arterial thrombosis and avulsion of the renal pedicle are best diagnosed by arteriography and are likely when the kidney is not visualized on imaging studies.
- The major causes of nonvisualization are total pedicle avulsion, arterial thrombosis, severe contusion causing vascular spasm, and absence of the kidney (either congenital or from operation).

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



 Computed tomography of a left kidney with renal artery thrombosis, demonstrating lack of contrast material perfusion to the kidney.



Arteriogram following blunt abdominal trauma shows typical findings of acute renal artery thrombosis (arrow) of left kidney.



## **Early Complications**

- Hemorrhage is perhaps the most important immediate complication of renal injury.
- Heavy retroperitoneal bleeding may result in rapid exsanguination.
- Patients must be observed closely, with careful monitoring of blood pressure and hematocrit.
- The size and expansion of palpable masses must be carefully monitored.
- Bleeding ceases spontaneously in 80–85% of cases.
- Persistent retroperitoneal bleeding or heavy gross hematuria may require early operation.

- Urinary extravasation from renal fracture may show as an expanding mass (urinoma) in the retroperitoneum.
- These collections are prone to abscess formation and sepsis.
- A resolving retroperitoneal hematoma may cause slight fever (38.3°C [101°F]), but higher temperatures suggest infection.
- A perinephric abscess may form, resulting in abdominal tenderness and flank pain.

## Late Complications

- Hypertension, hydronephrosis, arteriovenous fistula, calculus formation, and pyelonephritis are important late complications.
- Careful monitoring of blood pressure for several months is necessary to watch for hypertension.
- At 3–6 months, a follow-up excretory urogram or CT scan should be obtained to be certain that perinephric scarring has not caused hydronephrosis or vascular compromise; renal atrophy may occur from vascular compromise and is detected by follow-up urography.
- Heavy late bleeding may occur 1–4 weeks after injury.

### Treatment

#### A. Emergency Measures

 The objectives of early management are prompt treatment of shock and hemorrhage, complete resuscitation, and evaluation of associated injuries.

#### B. Surgical Measures

I. Blunt injuries—Minor renal injuries from blunt trauma account for 85% of cases and do not usually require operation. Bleeding stops spontaneously with bed rest and hydration. Cases in which operation is indicated include those associated with persistent retroperitoneal bleeding, urinary extravasation, evidence of nonviable renal parenchyma, and renal pedicle injuries (<5% of all renal injuries). Aggressive preoperative staging allows complete definition of injury before operation.

 2. Penetrating injuries—Penetrating injuries should be surgically explored. A rare exception to this rule is when staging has been complete and only minor parenchymal injury, with no urinary extravasation, is noted. In 80% of cases of penetrating injury, associated organ injury requires operation; thus, renal exploration is only an extension of this procedure.

## **Nonoperative Management**

- Nonoperative management has become the standard of care in hemodynamically stable, well-staged patients with grade I to III renal injuries, regardless of mechanism.
- Superselective embolization therapy for renal trauma provides an effective and minimally invasive means to stop active bleeding from parenchymal lacerations and even segmental arterial injury.

## **Operative Management**

 Surgical exploration of the acutely injured kidney is best done by a transabdominal approach, which allows complete inspection of intra-abdominal organs and bowel.

# **Surgical Exploration**

#### Absolute indications include

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

#### Relative indications are:

- 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).

### **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, closure of the collecting system if possible, coverage or reapproximation of the parenchymal defect, and judicious use of drains

## 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.
- So total nephrectomy would be indicated immediately in extensive renal injuries when the patient's life would be threatened by attempted renal repair.

## **Treatment of Complications**

- Retroperitoneal urinoma or perinephric abscess demands prompt surgical drainage.
- Malignant hypertension requires vascular repair or nephrectomy.
- Hydronephrosis may require surgical correction or nephrectomy.
- Angioembolization done by interventional radiology provides excellent control of active bleeding from the kidney.
- Delayed renal bleeding should be initially managed by bed rest and hydration. If the bleeding persist, angiography can often localize the bleeding vessel and embolization can often gain control.

## Prognosis

- With careful follow-up, most renal injuries have an excellent prognosis, with spontaneous healing and return of renal function.
- Follow-up CT and renal scan and monitoring of blood pressure ensure detection and appropriate management of late hydronephrosis and hypertension.

