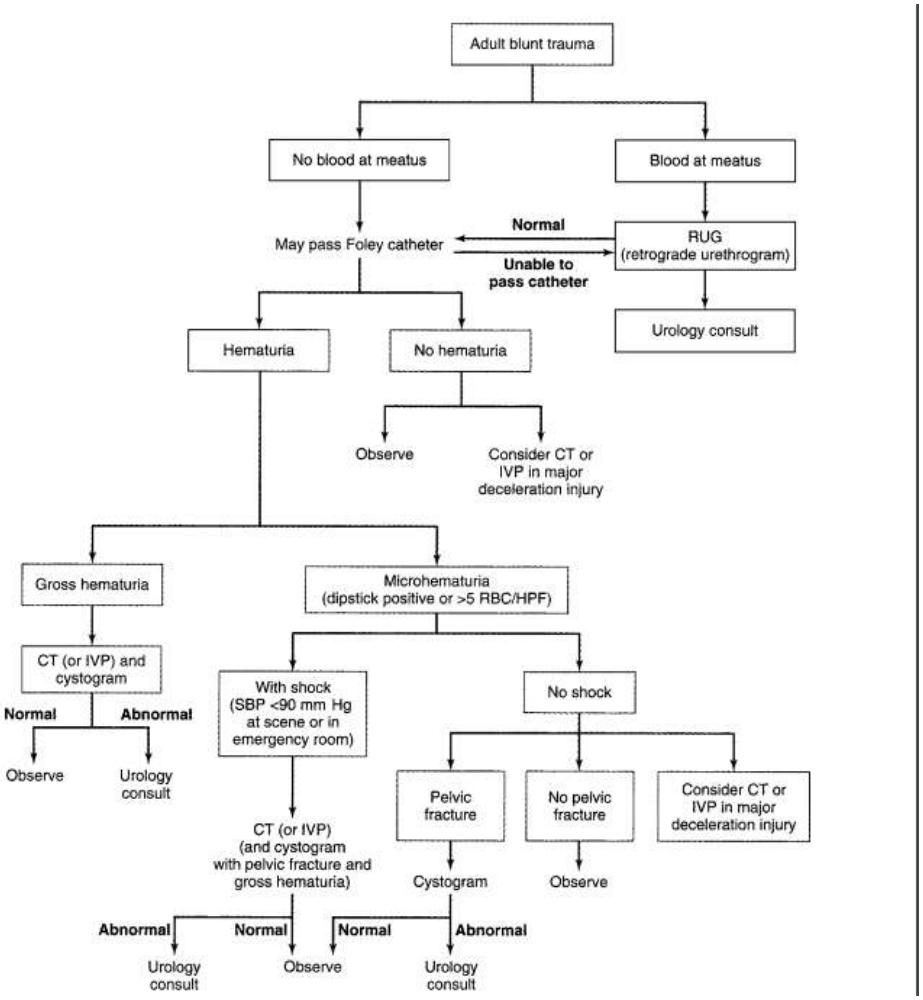
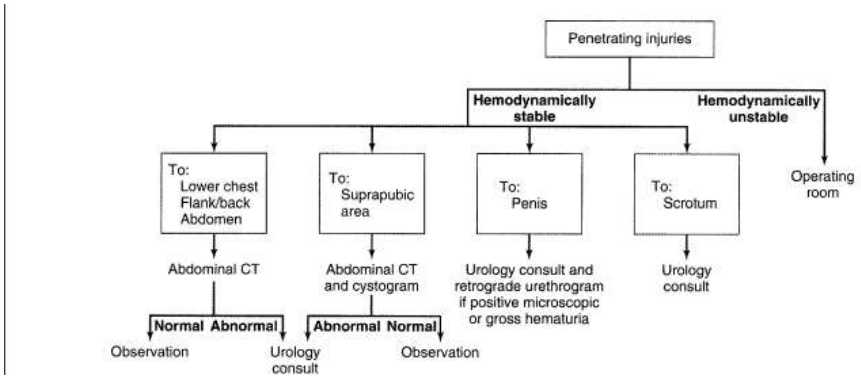
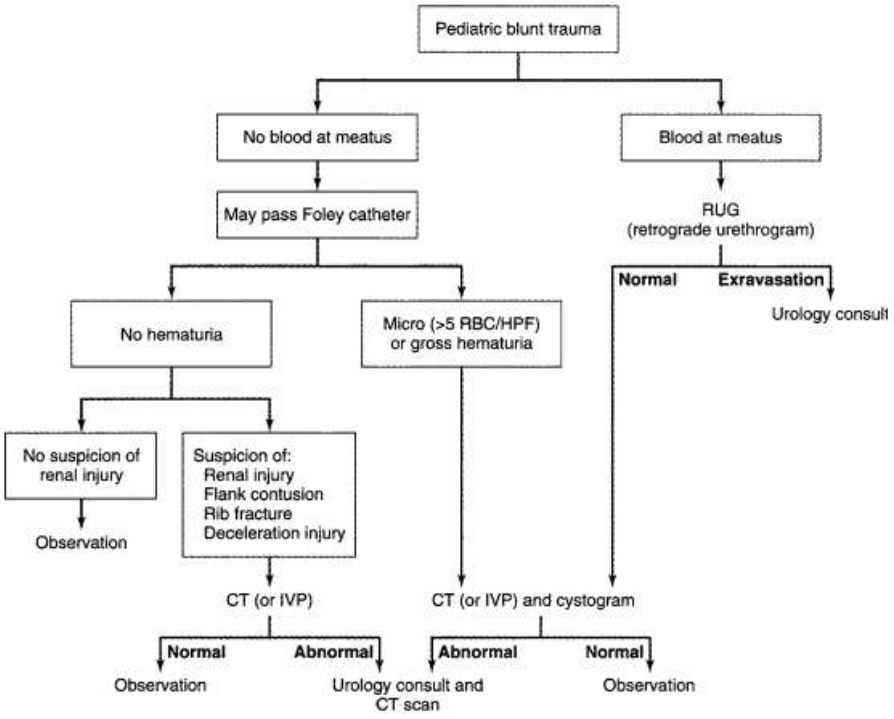
Injuries to the Genitourinary Tract

EMERGENCY DIAGNOSIS AND MANAGEMENT

About 10% of all injuries seen in the emergency room involve the genitourinary system to some extent. Many of them are subtle and difficult to define and require great diagnostic expertise. Early diagnosis is essential to prevent serious complications. Initial assessment should include control of hemorrhage and shock along with resuscitation as required. Resuscitation may require intravenous lines and a urethral catheter in seriously injured patients. In men, before the catheter is inserted, the urethral meatus should be examined carefully for the presence of blood. The history should include a detailed description of the accident. In cases involving gunshot wounds, the type and caliber of the weapon should be determined, since high-velocity projectiles cause much more extensive damage. The abdomen and genitalia should be examined for evidence of contusions or subcutaneous hematomas, which might indicate deeper injuries to the retroperitoneum and pelvic structures. Fractures of the lower ribs are often associated with renal injuries, and pelvic fractures often accompany bladder and urethral injuries. Diffuse abdominal tenderness is consistent with perforated bowel, free intraperitoneal blood or urine, or retroperitoneal hematoma. Patients who do not have life-threatening injuries and whose blood pressure is stable can undergo more deliberate radiographic studies. This provides more definitive staging of the injury.







Special Examinations (see figures above).

Urinary tract injury is suspected on the basis of the history and physical examination, additional studies are required to establish its extent.

A. Catheterization and Assessment of Injury Assessment of the injury should be done in an orderly fashion so that accurate and complete information is obtained. This process of defining the extent of injury is termed staging. The algorithms outline the staging process for urogenital trauma.

1. Catheterization—Blood at the urethral meatus in men indicates urethral injury; catheterization should not be attempted if blood is present, but retrograde urethrography should be done immediately. If no blood is present at the meatus, a urethral catheter can be carefully passed to the bladder to recover urine; microscopic or gross hematuria indicates urinary system injury. If catheterization is traumatic despite the greatest care, the significance of hematuria cannot be determined, and other studies must be done to investigate the possibility of urinary system injury.

2. Computed tomography—Abdominal computed tomography (CT) with contrast media is the best imaging study to detect and stage renal and retroperitoneal injuries. It can define the size and extent of the retroperitoneal hematoma, renal lacerations, urinary extravasation, and renal arterial and venous injuries; additionally, it can detect intra-abdominal injuries (liver, spleen, pancreas, bowel). Spiral CT scanning, now common, is very rapid, but it may not detect urinary extravasation or ureteral and renal pelvic injuries. We recommend repeat scanning 10 minutes after the initial study to aid the diagnosis of these conditions.

3. Retrograde cystography—Filling of the bladder with contrast material is essential to establish whether bladder perforations exist. At least 300 mL of contrast medium should be instilled for full vesical distention. A film should be obtained with the bladder filled and a second one after the bladder has emptied itself by gravity drainage. These two films establish the degree of bladder injury as well as the size of the surrounding pelvic hematomas.

Cystography with CT scan is excellent for establishing bladder injury. At the time of scanning, this likewise must be done with retrograde filling of the bladder with 300 mL of contrast media to ensure adequate distention to detect injury.

4. Urethrography—A small (12F) catheter can be inserted into the urethral meatus and 3 mL of water placed in the balloon to hold the catheter in position. After retrograde injection of 20 mL of water-soluble contrast material, the urethra will be clearly outlined on film, and extravasation in the deep bulbar area in case of straddle injury—or free extravasation into the retropubic space in case of prostatomembranous disruption—will be visualized.

5. Arteriography—Arteriography may help define renal parenchymal and renal vascular injuries. It is also useful in the detection of persistent bleeding from pelvic fractures for purposes of embolization with Gelfoam or autologous clot.

6. Intravenous urography—Intravenous urography can be used to detect renal and ureteral injury. This is best done with high-dose bolus injection of contrast media (2.0 mL/kg) followed by appropriate films.

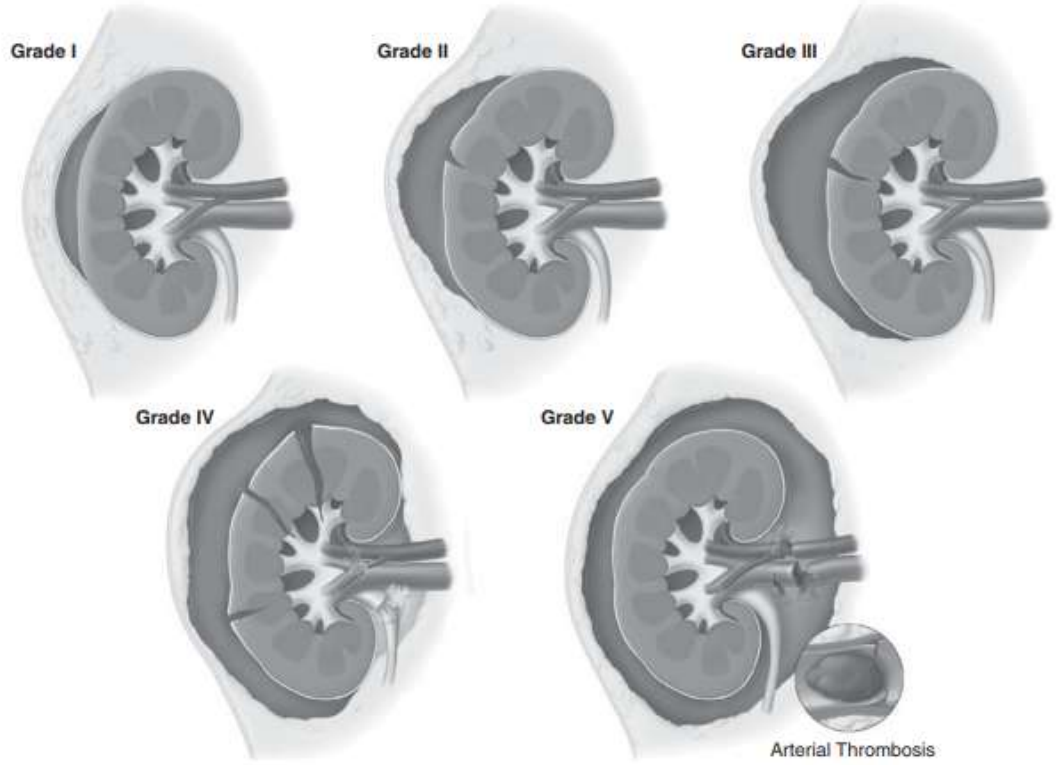
B. Cystoscopy and Retrograde Urography Cystoscopy and retrograde urography may be useful to detect ureteral injury, but are seldom necessary, since information can be obtained by less invasive techniques.

C. Abdominal Sonography Abdominal sonography has not been shown to add substantial information during initial evaluation of severe abdominal trauma.

INJURIES TO THE KIDNEY

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 (Figure 18–4) 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; any such wound in the flank area should be regarded as a cause of renal injury until proved otherwise. Associated abdominal visceral injuries are present in 80% of renal penetrating wounds.

Pathology and Classification (see figure above)



A. 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. Pathologic classification of renal injuries is as follows:

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.

B. 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. Follow-up excretory urography is indicated in all cases of major renal trauma.

3. Arteriovenous fistula—Arteriovenous fistulas may occur after penetrating injuries but are not common.

4. Renal vascular hypertension—The blood flow in tissue rendered nonviable by injury is compromised; this results in renal vascular hypertension in <1% of cases. Fibrosis from surrounding trauma has also been reported to constrict the renal artery and cause renal hypertension.

Clinical Findings and Indications for Studies

Microscopic or gross hematuria following trauma to the abdomen indicates injury to the urinary tract. It bears repeating that stab or gunshot wounds to the flank area should alert the physician to possible renal injury whether or not hematuria is present. Some cases of renal vascular injury are not associated with hematuria. These cases are almost always due to rapid deceleration accidents and are an indication for imaging studies. The degree of renal injury does not correspond to the degree of hematuria, since gross hematuria may occur in minor renal trauma and only mild hematuria in major trauma. However, not all adult patients sustaining blunt trauma require full imaging evaluation of the kidney. Miller and McAninch (1995) made the following recommendations based on findings in >1800 blunt renal trauma injuries: Patients with gross hematuria or microscopic hematuria with shock (systolic blood pressure <90 mm Hg) should undergo radiographic assessment; patients with microscopic hematuria without shock need not. However, should physical examination or associated injuries prompt reasonable suspicion of a renal injury, renal imaging should be undertaken. This is especially true of patients with rapid deceleration trauma, who may have renal injury without the presence of hematuria.

A. 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. Catheterization usually reveals hematuria. Retroperitoneal bleeding may cause abdominal distention, ileus, and nausea and vomiting.

B. 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. If the retroperitoneum has been torn, free blood may be noted in the peritoneal cavity but no palpable mass will be evident. The abdomen may be distended and bowel sounds absent.

C. 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.

D. Staging and X-Ray

Findings Staging of renal injuries allows a systematic approach to these problems. Adequate studies help define the extent of injury and dictate appropriate management. For example, blunt trauma to the abdomen associated with gross hematuria and a normal urogram requires no additional renal studies; however, nonvisualization of the kidney requires immediate arteriography or CT scan to determine whether renal vascular injury exists. Ultrasonography and retrograde urography are of little use initially in the evaluation of renal injuries. Staging begins with an abdominal CT scan, 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. If CT scan is not available, an intravenous pyelogram can be obtained. 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 on an excretory urogram are total pedicle avulsion, arterial thrombosis, severe contusion causing vascular spasm, and absence of the kidney (either congenital or from operation). Radionuclide renal scans have been used in staging renal trauma. However, in emergency management, this technique is less sensitive than arteriography or CT.

Differential Diagnosis

Trauma to the abdomen and flank areas is not always associated with renal injury. In such cases, there is no hematuria, and the results of imaging studies are normal.

Complications

A. 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. Complete

staging must be done early. 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.

B. 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

1. 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.

C. 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. This approach, in the trauma setting, is most often used when nonoperative management has been selected and renal parenchymal bleeding persists or develops after days or weeks of observation.

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.

INJURIES TO THE URETER

Ureteral injury is rare but may occur, usually during the course of a difficult pelvic surgical procedure or as a result of stab or gunshot wounds. Rapid deceleration accidents may avulse the ureter from the renal pelvis. Endoscopic basket manipulation of ureteral calculi may result in injury.

Etiology

Large pelvic masses (benign or malignant) may displace the ureter laterally and engulf it in reactive fibrosis. This may lead to ureteral injury during dissection, since the organ is anatomically malpositioned. Inflammatory pelvic disorders may involve the ureter in a similar way. Extensive carcinoma of the colon may invade areas outside the colon wall and directly involve the ureter; thus, resection of the ureter may be required along with resection of the tumor mass. Devascularization may occur with extensive pelvic lymph node dissections or after radiation therapy to the pelvis for pelvic cancer. In these situations, ureteral fibrosis and subsequent stricture formation may develop along with ureteral fistulas. Endoscopic manipulation of a ureteral calculus with a stone basket or ureteroscope may result in ureteral perforation or avulsion.

Pathogenesis and Pathology

The ureter may be inadvertently ligated and cut during difficult pelvic surgery. In such cases, sepsis and severe renal damage usually occur postoperatively. If a partially divided ureter is unrecognized at operation, urinary extravasation and subsequent buildup of a large urinoma will ensue, which usually leads to ureterovaginal or ureterocutaneous fistula formation. Intraperitoneal extravasation of urine can also occur, causing ileus and peritonitis. After partial transection of the ureter, some degree of stenosis and reactive fibrosis develops, with concomitant mild-to-moderate hydronephrosis.

Clinical Findings

A. Symptoms If the ureter has been completely or partially ligated during operation, the postoperative course is usually marked by fever of 38.3°C–38.8°C (101°F–102°F) as well as flank and lower quadrant pain. Such patients often experience paralytic ileus with nausea and vomiting. If ureterovaginal or cutaneous fistula develops, it usually does so within the first 10 postoperative days. Ureteral injuries from external violence should be suspected in patients who have sustained stab or gunshot wounds to the retroperitoneum. The midportion of the ureter seems to be the most common site of penetrating injury. There are usually associated vascular and other abdominal visceral injuries.

B. Signs

The acute hydronephrosis of a totally ligated ureter results in severe flank pain and abdominal pain with nausea and vomiting early in the postoperative course and with

associated ileus. Signs and symptoms of acute peritonitis may be present if there is urinary extravasation into the peritoneal cavity. Watery discharge from the wound or vagina may be identified as urine by determining the creatinine concentration of a small sample—urine has many times the creatinine concentration found in serum—and by intravenous injection of 10 mL of indigo carmine, which will appear in the urine as dark blue.

C. Laboratory Findings

Ureteral injury from external violence is manifested by microscopic hematuria in 90% of cases. Urinalysis and other laboratory studies are of little use in diagnosis when injury has occurred from other causes.

D. Imaging Findings

Diagnosis is by excretory urography or delayed abdominal spiral CT scan. A plain film of the abdomen may demonstrate a large area of increased density in the pelvis or in an area of retroperitoneum where injury is suspected. After injection of contrast material, delayed excretion is noted with hydronephrosis. Partial transection of the ureter results in more rapid excretion, but persistent hydronephrosis is usually present, and contrast extravasation at the site of injury is noted on delayed films (figure below). In acute injury from external violence, the excretory urogram usually appears normal, with very mild fullness down to the point of extravasation at the ureteral transection. Retrograde ureterography demonstrates the exact site of obstruction or extravasation.

E. Ultrasonography

Ultrasonography outlines hydroureter or urinary extravasation as it develops into a urinoma and is perhaps the best means of ruling out ureteral injury in the early postoperative period.

F. Radionuclide Scanning

Radionuclide scanning demonstrates delayed excretion on the injured side, with evidence of increasing counts owing to accumulation of urine in the renal pelvis. Its great benefit, however, is in the assessment of renal function after surgical correction.

Differential Diagnosis

Postoperative bowel obstruction and peritonitis may cause symptoms similar to those of acute ureteral obstruction from injury. Fever, "acute abdomen," and associated nausea and vomiting following difficult pelvic surgery are definite indications for screening sonography or excretory urography to establish whether ureteral injury has occurred. Deep wound infection must be considered postoperatively in patients with fever, ileus, and localized tenderness. The same findings are consistent with urinary extravasation and urinoma formation. Acute pyelonephritis in the early postoperative period may also result in findings similar to those of ureteral injury. Sonography shows normal results, and urography shows no evidence of obstruction.

Complications

Ureteral injury may be complicated by stricture formation with resulting hydronephrosis in the area of injury. Chronic urinary extravasation from unrecognized injury may lead to formation of a large retroperitoneal urinoma. Pyelonephritis from hydronephrosis and urinary infection may require prompt proximal drainage.

Treatment

Prompt treatment of ureteral injuries is required. The best opportunity for successful repair is in the operating room when the injury occurs. If the injury is not recognized until 7–10 days after the event and no infection, abscess, or other complications exist, immediate reexploration and repair are indicated. Proximal urinary drainage by percutaneous nephrostomy or formal nephrostomy should be considered if the injury is recognized late or if the patient has significant complications that make immediate reconstruction unsatisfactory. The goals of ureteral repair are to achieve complete debridement, a tension-free spatulated anastomosis, watertight closure, ureteral stenting (in selected cases), and retroperitoneal drainage.

A. Lower Ureteral Injuries Injuries to the lower third of the ureter allow several options in management. The procedure of choice is reimplantation into the bladder combined with a psoas-hitch procedure to minimize tension on the ureteral anastomosis. An antireflux procedure should be done when possible. Primary ureteroureterostomy can be used in lower-third injuries when the ureter has been ligated without transection. The ureter is usually long enough for this type of anastomosis. A bladder tube flap can be used when the ureter is shorter. Transureteroureterostomy may be used in lower-third injuries if extensive urinoma and pelvic infection have developed. This procedure allows anastomosis and reconstruction in an area away from the pathologic processes.

B. Midureteral Injuries Midureteral injuries usually result from external violence and are best repaired by primary ureteroureterostomy or transureteroureterostomy.

C. Upper Ureteral Injuries Injuries to the upper third of the ureter are best managed by primary ureteroureterostomy. If there is extensive loss of the ureter, autotransplantation of the kidney can be done as well as bowel replacement of the ureter.

D. Stenting Most anastomoses after repair of ureteral injury should be stented. The preferred technique is to insert a silicone internal stent through the anastomosis before closure. These stents have a J memory curve on each end to prevent their migration in the postoperative period. After 3–4 weeks of healing, stents can be endoscopically removed from the bladder. The advantages of internal stenting are maintenance of a straight ureter with a constant caliber during early healing, the presence of a conduit for urine during healing, prevention of urinary extravasation, maintenance of urinary diversion, and easy removal.

Prognosis

The prognosis for ureteral injury is excellent if the diagnosis is made early and prompt corrective surgery is done. Delay in diagnosis worsens the prognosis because of infection, hydronephrosis, abscess, and fistula formation.

INJURIES TO THE BLADDER

Bladder injuries occur most often from external force and are often associated with pelvic fractures. (About 15% of all pelvic fractures are associated with concomitant bladder or urethral injuries.) Iatrogenic injury may result from gynecologic and other extensive pelvic procedures as well as from hernia repairs and transurethral operations.

Pathogenesis and Pathology

The bony pelvis protects the urinary bladder very well. When the pelvis is fractured by blunt trauma, fragments from the fracture site may perforate the bladder. These perforations usually result in extraperitoneal rupture. If the urine is infected, extraperitoneal bladder perforations may result in deep pelvic abscess and severe pelvic inflammation. When the bladder is filled to near capacity, a direct blow to the lower abdomen may result in bladder disruption. This type of disruption is ordinarily intraperitoneal. Since the reflection of the pelvic peritoneum covers the dome of the bladder, a linear laceration will allow urine to flow into the abdominal cavity. If the diagnosis is not established immediately and if the urine is sterile, no symptoms may be noted for several days. If the urine is infected, immediate peritonitis and acute abdomen will develop.

Clinical Findings

Pelvic fracture accompanies bladder rupture in 90% of cases. The diagnosis of pelvic fracture can be made initially in the emergency room by lateral compression on the bony pelvis, since the fracture site will show crepitus and be painful to the touch.

A. Symptoms There is usually a history of lower abdominal trauma. Blunt injury is the usual cause. Patients ordinarily are unable to urinate, but when spontaneous voiding occurs, gross hematuria is usually present. Most patients complain of pelvic or lower abdominal pain.

B. Signs Heavy bleeding associated with pelvic fracture may result in hemorrhagic shock, usually from venous disruption of pelvic vessels. Evidence of external injury from a gunshot or stab wound in the lower abdomen should make one suspect bladder injury, manifested by marked tenderness of the suprapubic area and lower abdomen. An acute abdomen may occur with intraperitoneal bladder rupture. On rectal examination, landmarks may be indistinct because of a large pelvic hematoma.

C. Laboratory Findings Catheterization usually is required in patients with pelvic trauma but not if bloody urethral discharge is noted. Bloody urethral discharge indicates urethral injury, and a urethrogram is necessary before catheterization. When catheterization is done, gross or, less commonly, microscopic hematuria is usually present. Urine taken from the bladder at the initial catheterization should be cultured to determine whether infection is present.

D. X-Ray Findings A plain abdominal film generally demonstrates pelvic fractures. There may be haziness over the lower abdomen from blood and urine extravasation. A CT scan should be obtained to establish whether kidney and ureteral injuries are present. Bladder disruption is shown on cystography. The bladder should be filled with 300 mL of contrast material and a plain film of the lower abdomen obtained. Contrast medium should be allowed to drain out completely, and a second film of the abdomen should be obtained. The drainage film is extremely important, because it demonstrates areas of extraperitoneal extravasation of blood and urine that may not appear on the filling film. With intraperitoneal extravasation, free contrast medium is visualized in the abdomen, highlighting bowel loops. CT cystography is an excellent method for detecting bladder rupture; however, retrograde filling of the bladder with 300 mL of contrast medium is necessary to distend the bladder completely. Incomplete distention with consequent missed diagnosis of bladder rupture often occurs when the urethral catheter is clamped during standard abdominal CT scan with intravenous contrast injection. Complications

A pelvic abscess may develop from extraperitoneal bladder rupture; if the urine becomes infected, the pelvic hematoma becomes infected too. Intraperitoneal bladder rupture with extravasation of urine into the abdominal cavity causes delayed peritonitis. Partial incontinence may result from bladder injury when the laceration extends into the bladder neck. Meticulous repair may ensure normal urinary control.

Treatment

A. Emergency Measures Shock and hemorrhage should be treated.

B. Surgical Measures A lower midline abdominal incision should be made. As the bladder is approached in the midline, a pelvic hematoma, which is usually lateral, should be avoided. Entering the pelvic hematoma can result in increased bleeding from release of tamponade and in infection of the hematoma, with subsequent pelvic abscess. The bladder should be opened in the midline and carefully inspected. After repair, a suprapubic cystostomy tube is usually left in place to ensure complete urinary drainage and control of bleeding.

1. Extraperitoneal bladder rupture—Extraperitoneal bladder rupture can be successfully managed with urethral catheter drainage only. (Typically 10 days will provide adequate

healing time.) Large blood clots in the bladder or injuries involving the bladder neck should be managed surgically. As the bladder is opened in the midline, it should be carefully inspected and lacerations closed from within. Polyglycolic acid or chromic absorbable sutures should be used. Extraperitoneal bladder lacerations occasionally extend into the bladder neck and should be repaired meticulously. Fine absorbable sutures should be used to ensure complete reconstruction so that the patient will have urinary control after injury. Such injuries are best managed with indwelling urethral catheterization and suprapubic diversion.

2. Intraperitoneal rupture—Intraperitoneal bladder ruptures should be repaired via a transperitoneal approach after careful transvesical inspection and closure of any other perforations. The peritoneum must be closed carefully over the area of injury. The bladder is then closed in separate layers by absorbable suture. All extravasated fluid from the peritoneal cavity should be removed before closure. At the time of closure, care should be taken that the suprapubic cystostomy is in the extraperitoneal position.

3. Pelvic fracture—Stable fracture of the pubic rami is usually present. In such cases, the patient can be ambulatory within 4–5 days without damage or difficulty. Unstable pelvic fractures requiring external fixation have a more protracted course.

4. Pelvic hematoma—There may be heavy uncontrolled bleeding from rupture of pelvic vessels even if the hematoma has not been entered at operation. At exploration and bladder repair, packing the pelvis with laparotomy tapes often controls the problem. If bleeding persists, it may be necessary to leave the tapes in place for 24 hours and operate again to remove them. Embolization of pelvic vessels with Gelfoam or skeletal muscle under angiographic control is useful in controlling persistent pelvic bleeding.

Prognosis

With appropriate treatment, the prognosis is excellent. The suprapubic cystostomy tube can be removed within 10 days, and the patient can usually void normally. Patients with lacerations extending into the bladder neck area may be temporarily incontinent, but full control is usually regained. At the time of discharge, urine culture should be performed to determine whether catheter-associated infection requires further treatment.

INJURIES TO THE URETHRA

Urethral injuries are uncommon and occur most often in men, usually associated with pelvic fractures or straddle-type falls. They are rare in women. Various parts of the urethra may be lacerated, transected, or contused. Management varies according to the level of injury. The urethra can be separated into two broad anatomic divisions: the posterior urethra, consisting of the prostatic and membranous portions, and the anterior urethra, consisting of the bulbous and pendulous portions.

INJURIES TO THE POSTERIOR URETHRA

Etiology.

The membranous urethra passes through the pelvic floor and voluntary urinary sphincter and is the portion of the posterior urethra most likely to be injured. When pelvic

fractures occur from blunt trauma, the membranous urethra is sheared from the prostatic apex at the prostatomembranous junction. The urethra can be transected by the same mechanism at the interior surface of the membranous urethra.

Clinical Findings

A. Symptoms Patients usually complain of lower abdominal pain and inability to urinate. A history of crushing injury to the pelvis is usually obtained.

B. Signs Blood at the urethral meatus is the single most important sign of urethral injury. The importance of this finding cannot be overemphasized, because an attempt to pass a urethral catheter may result in infection of the periprostatic and perivesical hematoma and conversion of an incomplete laceration to a complete one. The presence of blood at the external urethral meatus indicates that immediate urethrography is necessary to establish the diagnosis. Suprapubic tenderness and the presence of pelvic fracture are noted on physical examination. A large developing pelvic hematoma may be palpated. Perineal or suprapubic contusions are often noted. Rectal examination may reveal a large pelvic hematoma with the prostate displaced superiorly. Rectal examination can be misleading, however, because a tense pelvic hematoma may resemble the prostate on palpation. Superior displacement of the prostate does not occur if the puboprostatic ligaments remain intact. Partial disruption of the membranous urethra (currently 10% of cases) is not accompanied by prostatic displacement.

C. X-Ray Findings Fractures of the bony pelvis are usually present. A urethrogram (using 20–30 mL of water-soluble contrast material) shows the site of extravasation at the prostatomembranous junction. Ordinarily, there is free extravasation of contrast material into the perivesical space (Figure below). Incomplete prostatomembranous disruption is seen as minor extravasation, with a portion of contrast material passing into the prostatic urethra and bladder.

D. Instrumental Examination The only instrumentation involved should be for urethrography. Catheterization or urethroscopy should not be done, because these procedures pose an increased risk of hematoma, infection, and further damage to partial urethral disruptions.

Differential Diagnosis Bladder rupture may be associated with posterior urethral injuries in approximately 20% of cases. Cystography cannot be done preoperatively, since a urethral catheter should not be passed. Careful evaluation of the bladder at operation is necessary.

Complications Stricture, impotence, and incontinence as complications of prostatomembranous disruption are among the most severe and debilitating mishaps that result from trauma to the urinary system. Stricture following primary repair and anastomosis occurs in about 50% of cases. If the preferred suprapubic cystostomy approach with delayed repair is used, the incidence of stricture can be reduced to about 5%. The incidence of impotence after primary repair is 30–80% (mean, about 50%). This figure can be reduced to 30–35% by suprapubic drainage with delayed urethral reconstruction. Total urinary incontinence occurs in <2% of patients and is typically associated with severe sacral fracture and S2–4 nerve injury.

Treatment

A. Emergency Measures Shock and hemorrhage should be treated.

B. Surgical Measures Urethral catheterization should be avoided.

1. Immediate management—Initial management should consist of suprapubic cystostomy to provide urinary drainage. A midline lower abdominal incision should be made, with care being taken to avoid the large pelvic hematoma. The bladder and prostate are usually elevated superiorly by large periprostatic and perivesical hematomas. The bladder often is distended by a large volume of urine accumulated during the period of resuscitation and operative preparation. The urine is often clear and free of blood, but gross hematuria may be present. The bladder should be opened in the midline and carefully inspected for lacerations. If a laceration is present, the bladder should be closed with absorbable suture material and a cystostomy tube inserted for urinary drainage. This approach involves no urethral instrumentation or manipulation. The suprapubic cystostomy is maintained in place for about 3 months. This allows resolution of the pelvic hematoma, and the prostate and bladder will slowly return to their anatomic positions. Incomplete laceration of the posterior urethra heals spontaneously, and the suprapubic cystostomy can be removed within 2–3 weeks. The cystostomy tube should not be removed before voiding cystourethrography shows that no extravasation persists.

2. Delayed urethral reconstruction—Reconstruction of the urethra after prostatic disruption can be undertaken within 3 months, assuming there is no pelvic abscess or other evidence of persistent pelvic infection. Before reconstruction, a combined cystogram and urethrogram should be done to determine the exact length of the resulting urethral stricture. This stricture usually is 1–2 cm long and situated immediately posterior to the pubic bone. The preferred approach is a single-stage reconstruction of

the urethral rupture defect with direct excision of the strictured area and anastomosis of the bulbous urethra directly to the apex of the prostate. A 16F silicone urethral catheter should be left in place along with a suprapubic cystostomy. Catheters are removed within a month, and the patient is then able to void.

3. Immediate urethral realignment—Some surgeons prefer to realign the urethra immediately. Persistent bleeding and surrounding hematoma create technical problems. The incidence of stricture, impotence, and incontinence appears to be higher than with immediate cystostomy and delayed reconstruction. However, several authors have reported success with immediate urethral realignment.

C. General Measures After delayed reconstruction by a perineal approach, patients are allowed ambulation on the first postoperative day and usually can be discharged within 3 days.

D. Treatment of Complications Approximately 1 month after the delayed reconstruction, the urethral catheter can be removed and a voiding cystogram obtained through the suprapubic cystostomy tube. If the cystogram shows a patent area of reconstruction free of extravasation, the suprapubic catheter can be removed; if there is extravasation or stricture, suprapubic cystostomy should be maintained. A follow-up urethrogram should be obtained within 2 months to watch for stricture development. Stricture, if present (<5%), is usually very short, and urethrotomy under direct vision offers easy and rapid cure. The patient may be impotent for several months after delayed repair. Impotence is permanent in about 10% of patients. Implantation of a penile prosthesis is indicated if impotence is still present 2 years after reconstruction. Incontinence after posterior urethral rupture and delayed repair is rare (<2%) and is usually related to the extent of injury rather than to the repair.

Prognosis If complications can be avoided, the prognosis is excellent. Urinary infections ultimately resolve with appropriate management.

INJURIES TO THE ANTERIOR URETHRA

Etiology

The anterior urethra is the portion distal to the urogenital diaphragm. Straddle injury may cause laceration or contusion of the urethra. Self-instrumentation or iatrogenic instrumentation may cause partial disruption.

Pathogenesis and Pathology

A. Contusion Contusion of the urethra is a sign of crush injury without urethral disruption. Perineal hematoma usually resolves without complications.

B. Laceration A severe straddle injury may result in laceration of part of the urethral wall, allowing extravasation of urine. If the extravasation is unrecognized, it may extend into the scrotum, along the penile shaft, and up to the abdominal wall. It is limited only by Colles' fascia and often results in sepsis, infection, and serious morbidity.

Clinical Findings

A. Symptoms There is usually a history of a fall, and in some cases, a history of instrumentation. Bleeding from the urethra is usually present. There is local pain into the perineum and sometimes massive perineal hematoma. If voiding has occurred and extravasation is noted, sudden swelling in the area will be present. If diagnosis has been delayed, sepsis and severe infection may be present.

B. Signs The perineum is very tender; a mass may be found, as may blood at the urethral meatus. Rectal examination reveals a normal prostate. The patient usually has a desire to void, but voiding should not be allowed until assessment of the urethra is complete. No attempt should be made to pass a urethral catheter, but if the patient's bladder is overdistended, percutaneous suprapubic cystostomy can be done as a temporary procedure. When presentation of such injuries is delayed, there is massive urinary extravasation and infection in the perineum and the scrotum. The lower abdominal wall may also be involved. The skin is usually swollen and discolored.

C. Laboratory Findings Blood loss is not usually excessive, particularly if secondary injury has occurred. The white count may be elevated with infection.

D. X-Ray Findings A urethrogram, with instillation of 15–20 mL of water-soluble contrast material, demonstrates extravasation and the location of injury. A contused urethra shows no evidence of extravasation.

Complications

Heavy bleeding from the corpus spongiosum injury may occur in the perineum as well as through the urethral meatus. Pressure applied to the perineum over the site of the injury usually controls bleeding. If hemorrhage cannot be controlled, immediate operation is required. The complications of urinary extravasation are chiefly sepsis and infection. Aggressive debridement and drainage are required if there is infection. Stricture at the site of injury is a common complication, but surgical reconstruction may not be required unless the stricture significantly reduces urinary flow rates.

Treatment

A. General Measures Major blood loss usually does not occur from straddle injury. If heavy bleeding does occur, local pressure for control, followed by resuscitation, is required.

B. Specific Measures

1. Urethral contusion—The patient with urethral contusion shows no evidence of extravasation, and the urethra remains intact. After urethrography, the patient is allowed to void; and if the voiding occurs normally, without pain or bleeding, no additional treatment is necessary. If bleeding persists, urethral catheter drainage can be done.

2. Urethral lacerations—Instrumentation of the urethra following urethrography should be avoided. A small midline incision in the suprapubic area readily exposes the dome of the bladder so that a suprapubic cystostomy tube can be inserted, allowing complete urinary diversion while the urethral laceration heals. Percutaneous cystostomy may also be used in such injuries. If only minor extravasation is noted on the urethrogram, a voiding study can be performed within 7 days after suprapubic catheter drainage to search for extravasation. In more extensive injuries, one should wait 2–3 weeks before

doing a voiding study through the suprapubic catheter. Healing at the site of injury may result in stricture formation. Most of these strictures are not severe and do not require surgical reconstruction. The suprapubic cystostomy catheter may be removed if no extravasation is documented. Follow-up with documentation of urinary flow rates will show whether there is urethral obstruction from stricture.

3. Urethral laceration with extensive urinary extravasation—After major laceration, urinary extravasation may involve the perineum, scrotum, and lower abdomen. Drainage of these areas is indicated. Suprapubic cystostomy for urinary diversion is required. Infection and abscess formation are common and require antibiotic therapy.

4. Immediate repair—Immediate repair of urethral lacerations can be performed, but the procedure is difficult and the incidence of associated stricture is high.

C. Treatment of Complications Strictures at the site of injury may be extensive and require delayed reconstruction. Prognosis Urethral stricture is a major complication but, in most cases, does not require surgical reconstruction. If, when stricture resolves, urinary flow rates are poor and urinary infection and urethral fistula are present, reconstruction is required.

INJURIES TO THE PENIS

Disruption of the tunica albuginea of the penis (penile fracture) can occur during sexual intercourse. At presentation, the patient has penile pain and hematoma. This injury should be surgically corrected. Gangrene and urethral injury may be caused by obstructing rings placed around the base of the penis. These objects must be removed without causing further damage. Penile amputation is seen occasionally, and in a few patients, the penis can be surgically replaced successfully by microsurgical techniques. Total avulsion of the penile skin occurs from machinery injuries. Immediate debridement and skin grafting are usually successful in salvage. Injuries to the penis should suggest possible urethral damage, which should be investigated by urethrography.

INJURIES TO THE SCROTUM

Superficial lacerations of the scrotum may be debrided and closed primarily. Blunt trauma may cause local hematoma and ecchymosis, but these injuries resolve without difficulty. One must be certain that testicular rupture has not occurred. Total avulsion of the scrotal skin may be caused by machinery accidents or other major trauma. The testes and spermatic cords are usually intact. It is important to provide coverage for these structures: this is best done by immediate surgical debridement and by placing the testes and spermatic cords in the subcutaneous tissues of the upper thighs. Later reconstruction of the scrotum can be done with a skin graft or thigh flap.

INJURIES TO THE TESTIS

Blunt trauma to the testis causes severe pain and, often, nausea and vomiting. Lower abdominal tenderness may be present. A hematoma may surround the testis and make delineation of its margin difficult. Ultrasonography can be used as an aid to better define the organ. If rupture has occurred, the sonogram will delineate the injury, which should be surgically repaired.

QUESTIONS FOR CHECK-UP

1. Kidney trauma. Scheme of patient's examination.
2. Kidney trauma. Symptoms. Laboratory, instrumental diagnostics.
3. Kidney trauma. Treatment tactics.
4. Ureteral trauma. Scheme of patient's examination.
5. Ureteral trauma. Symptoms. Laboratory, instrumental diagnostics.
6. Ureteral trauma. Treatment tactics.
7. Vesical trauma. Scheme of patient's examination.
8. Vesical trauma. Symptoms. Laboratory, instrumental diagnostics.
9. Vesical trauma. Treatment tactics.
10. Urethral trauma. Scheme of patient's examination.
11. Urethral trauma. Symptoms. Laboratory, instrumental diagnostics.
12. Urethral trauma. Treatment tactics.

Recommended education resources:

1. uroweb.ru
2. uroweb.org
3. "SMITH & TANAGHO'S GENERAL UROLOGY", 2017