Urinary tract pathology

Urinary tract

Structure [Figs. 13-1, 13-2]

- **Kidneys (left and right)**
  - cortex (glomeruli and tubules)
  - medulla (tubules, loops of Henle, and collecting ducts)
  - calices and pelvis forming the collecting system connect to ureter
- **Ureters (left and right)**
- **Bladder**
- **Urethra**

- Transitional type epithelium lines the collecting system, ureters, bladder, and urethra

Function

- **Production of urine**
  - urine is an ultrafiltrate of plasma
  - normal amount of urine produced is 1.5 litres per day (24 hr)
  - filtration barrier consists of
    - endothelial cell, basement membrane, epithelial cell
- **Hormone production**
  - renin
  - erythropoietin
- **Regulation of body’s salt and water**
- **Maintaining acid-base balance of plasma**
- **Excretion of waste (urea, creatinine)**

Pathology outline

- **Kidney**
  - renal syndromes
    - nephritic syndrome
    - nephrotic syndrome
    - asymptomatic hematuria, asymptomatic proteinuria
    - acute renal failure
    - chronic renal failure
    - renal tubular defects
  - infections
  - stones
  - neoplasms
- **Bladder**
  - infections
  - neoplasms

Terminology

- **Oliguria**
  - decreased urine production
- **Anuria**
  - no urine production
- **Polyuria**
  - increased urine production
- **Hematuria**
  - passage of blood in urine
- **Proteinuria**
  - protein in urine
Urinary tract pathology
Renal syndromes

- **Acute nephritic syndrome**
  - syndrome includes
    - oliguria
    - hematuria
    - proteinuria
    - edema
    - hypertension
  - typically occurs 2-3 wks after throat infection with Gp A strep

- **Nephrotic syndrome**
  - syndrome characterized by loss of large amounts of protein in urine with resulting hypoalbuminemia and edema
  - variety of causes including
    - minimal change glomerulonephritis
    - membranous glomerulonephritis
    - membranoproliferative glomerulonephritis
    - focal segmental glomerulosclerosis
    - systemic diseases (diabetes mellitus, SLE)
  - prone to infections and thrombi due to loss of proteins involved in immunity and coagulation

- **Acute renal failure**
  - acute onset of decreased urine production
  - develops over days to weeks
  - decreased renal function, oliguria, electrolyte disturbances
  - usually reversible
    - if not reversible, require dialysis or transplant
  - causes divided on basis of location of disorder
    - prerenal
      - eg. decreased renal perfusion due to congestive heart failure
    - renal
      - eg. glomerular disease such as acute glomerulonephritis
    - postrenal
      - eg. Ureteric obstruction due to stones

- **Chronic renal failure**
  - insidious decrease in renal function due to damaged kidneys
  - usually several stages as renal function decreases
    - diminished renal reserve
    - renal insufficiency
    - renal failure
    - end stage renal failure
  - end stage kidney refers to common appearance of a terminally damaged kidney that may be due to a number of causes
    - require dialysis or transplant

Glomerular diseases

- Group of diseases featuring damage to the glomerulus
- Divided into primary and secondary
- Present with one of 5 glomerular syndromes

- **Main primary diseases**
  - minimal change glomerulopathy
  - primary membranous nephropathy
  - acute post-streptococcal glomerulonephritis

- **Main secondary causes**
  - immunologic diseases (SLE)
  - metabolic disorders (diabetes mellitus)
Urinary tract pathology
Glomerular diseases

- Primary membranous nephropathy
  - characterized by diffuse (membranous) thickening of glomerular basement membrane due to immune complex deposition
  - most common cause of nephrotic syndrome in adults
  - not responsive to corticosteroids
  - progresses to end-stage renal failure over 10-15 years
- Minimal change glomerulopathy (lipoid nephrosis)
  - glomerular disease of unknown origin
  - most common cause of nephrotic syndrome in children
  - unknown etiology
  - responsive to corticosteroids, may recur
- Acute glomerulonephritis
  - immune mediated inflammation of the glomerulus
  - follows Group A streptococcal infection in 90% of cases
  - typically 1 to 4 weeks after a strep throat or skin infection
  - classic nephritic picture (fever, nausea, oliguria, hematuria, mild proteinuria, peri-orbital edema
  - usually self limited in children
    - 90% of children recover in 2 to 3 months with conservative therapy
    - 5-8% of children have abnormal urinary findings for 6 to 8 months
  - worse prognosis in adults
    - 60% recover promptly
    - >30% have prolonged abnormal renal function
- Diabetes mellitus
  - disorder of the hormone insulin resulting in uncontrolled hyperglycemia
  - diabetics develop kidney damage
    - glomerulosclerosis
    - arteriosclerosis
    - pyelonephritis
    - papillary necrosis
  - first indication of renal damage is appearance of albumin in urine
  - progression can be slowed by controlling hyperglycemia and hypertension

Congenital disorders

- Adult polycystic kidney disease
  - progressive number of variable sized cysts with age
  - kidneys are greatly enlarged
  - autosomal dominant inheritance
  - most common inherited disease of the kidney
- Autosomal recessive polycystic kidney disease
  - large numbers of small cysts within kidney
  - fatal
- Cystic renal dysplasia
  - congenital disorder of development of the kidney
  - usually unilateral, affects children
Urinary tract pathology

Acute pyelonephritis
- Bacterial infection of the kidney
- Routes of infection [Fig. 13-13]
  - ascend through the urinary tract (85%)
    - gram negative bacteria (E. coli most common)
  - via the blood stream
    - gram positive bacteria
- Predisposing factors include bladder obstruction, urinary stones, vesicoureteral reflux, pregnancy
- Treat with antibiotics

Renal stones
- Relatively common
- Four main types of renal stones
  - calcium stones, struvite stones, uric acid stones, cystine stones
- Calcium containing stones are most common
  - see on x-ray
  - some are due to hypercalcemia
- Struvite stones arise in setting of chronic urinary tract infection
- Present with renal colic

Infections
- Pyelonephritis
  - bacterial infection of the kidney
- Cystitis
  - inflammation of the bladder
- hematogenous spread
  - sepsis
- ascending infection
  - urethra to bladder

Circulatory changes
- Acute tubular necrosis
  - sudden severe drop in bp causing death of renal tubular cells
  - acute renal failure
  - may resolve if able to restore adequate perfusion to kidney
- Benign nephrosclerosis
  - ischemic damage to glomeruli with resulting loss of glomeruli
- Hypertension
  - systemic hypertension results in fibrinoid necrosis of vessel walls
  - malignant hypertension refers to a relatively sudden and large increase in pressure
    - causes characteristic damage to renal arterioles
Urinary tract pathology

Renal neoplasms [Fig. 13-17]

• Renal Cell Carcinoma
  – malignant neoplasm of renal epithelial cells
  – most common renal tumor
  – presents with flank pain, hematuria, mass
  – most are sporadic
    • loss of one allele of a tumor suppressor gene in 98% of sporadic
  – paraneoplastic syndromes
    • relatively common with renal cell carcinomas
      – eg. hypercalcemia due to parathyroid hormone related peptide
  – 5 yr. survival 45 %
    • early diagnosis confers better prognosis
    • invasion of renal vein or perinephric fat confers worse prognosis

• Wilm’s tumor
  – malignant neoplasm of primitive renal tissue (blasteme)
  – most common solid tumor of children
  – most are sporadic
  – usually diagnosed between 2 and 5 years of age
  – surgery combined with chemotherapy gives excellent results

• Transitional cell carcinoma
  – malignant neoplasm of transitional epithelial cells in renal pelvis
  – usually low grade exophytic tumors
  – prognosis depends worse for high grade tumors

Urinary bladder infections

• Infections of urinary bladder are common
• Usually caused by gram negative bacteria (E. coli, proteus)
• More common in females (short urethra)
• Increased frequency if catheter, obstruction etc.
  – chronic cystitis common in elderly males with BPH
• Other causes
  – Schistosomiasis (common in Egypt)
  – CMV infection in immunocompromised individuals

Urinary bladder neoplasms

• Transitional cell carcinoma
  – malignant neoplasm of transitional epithelium in the bladder
  – most common urinary tract malignancy
  – present with hematuria, dysuria, pain
  – most important risk factor is smoking
  – other risk factors include aniline dyes, Schistosomiasis
  – papillary vs. sessile describe gross appearance
    • exophytic papillary tumor usually low grade, good prognosis
    • sessile tumor usually high grade, worse prognosis
  – often multifocal
  – treatment is surgical
Male reproductive tract pathology

Male reproductive system

Structure [Fig. 14-1]
• 2 Gonads (testes)
• Duct system
  – epididymis
  – vas deferens
• Accessory glands
  – seminal vesicles
  – prostate
• Copulatory organ
  – penis

Function [Fig. 14-2]
• Sperm production
  – occurs within seminiferous tubules in the testes
  – seminiferous tubules lined by germ cells
  – sperm continually produced from germ cells
• Hormone production
  – Testosterone
  • produced by Leydig cells in the testes

Male reproductive system pathology

Overview of pathology
• Developmental disorders
  – cryptorchidism
• Infections
  – orchitis, epididymitis, urethritis
• Neoplasms
  – germ cell tumors
    • seminoma
    • embryonal carcinoma

Developmental disorders
• Cryptorchidism
  – during fetal development or shortly after birth normal testicles descend through the inguinal canal into the scrotum
  – cryptorchidism is failure of the testicles to descend into the scrotum
  – may be corrected surgically
  – associated with
    • 10X risk of malignant transformation
    • infertility
Male reproductive system pathology

Infections [Fig. 14-4]
- Epididymoorchitis, urethritis
  - inflammation of the epididymis and testes and/or urethra
  - hematogenous or ascending routes
  - Sexually transmitted diseases
    - Gonorrhea, Chlamydia
- Uropathogens
  - gram negative bacteria (E. coli)
  - viruses
    - mumps (1/3 of those with mumps develop orchitis)
- Balanitis
  - inflammation of the glans penis

Sexually transmitted diseases
- Genital herpes
  - Herpes simplex virus type 2
  - vesicular eruptions, pain
  - remains dormant in neural ganglion cells, may recur
- Gonorrhea
  - Neisseria gonorrhoeae (bacteria)
  - purulent urethritis
  - antibiotics to cure
  - complications
    - prostatitis, epididymitis (infertility if scarring)
    - arthritis
- Non-specific urethritis
  - Chlamydia, mycoplasma (types of bacteria)
  - no purulent discharge
- Syphilis
  - Treponema pallidum (spirochete bacteria)
    - primary stage
      - painless chancre
    - secondary stage systemic spread if untreated
      - fever, malaise, rash
    - tertiary stage
      - small vessel vasculitis
      - cardiac and CNS complications
    - treatment with antibiotics

Testicular neoplasms
- Germ cell tumors (90%)
  - seminoma
  - non-seminoma
    - embryonal
    - teratocarcinoma
    - choriocarcinoma
  - mixed (seminoma and non-seminoma)
  - teratoma
  - yolk sac tumor
- Sex cord stromal tumors (5%)
  - Leydig cell tumor
  - Sertoli cell tumor
Male reproductive system pathology

Testicular neoplasms

- Important points
  - relatively uncommon
  - cryptorchidism has higher incidence of testicular tumors
  - most common malignant neoplasms of young adult males
  - most tumors are of germ cell origin
  - most tumors are malignant
  - different testicular neoplasms produce different substances ("tumour markers") that can be measured in the blood
  - measurement of the levels of these various substances helps to identify the presence of a testicular neoplasm
  - chemotherapy and surgery produce excellent results

- Seminoma
  - peak inc. 40 yr.
  - presents as a scrotal mass
  - usually diagnosed early before metastasis to lymph nodes
  - no serologic tumor markers
  - treat with surgery, radiation, chemotherapy
  - cure rate 90%

- Non-seminomatous germ cell tumors
  - presents as scrotal mass
  - may produce HCG, AFP depending on cell type
  - treat with surgery and chemotherapy
  - 85% 5 year survival

Prostate

- Benign prostatic hyperplasia
  - benign hyperplasia of prostate epithelium and stroma
  - common in elderly males
  - causes urgency, frequency, dribbling
  - increased incidence of bladder infections

- Prostatic carcinoma
  - malignant neoplasm of glandular epithelium in the prostate
  - most common cancer in males, usually elderly males
  - third most common cause of cancer-related deaths in males
  - no definitive risk factors (testosterone implicated)
  - adenocarcinomas

- Prostatic carcinoma
  - typically located in posterior part of prostate
    - prostate can be palpated by digital rectal exam [Fig. 14-10]
  - lymphatic and vascular spread
  - Prostate Specific Antigen (PSA)
    - prostate cells produce PSA, secrete into semen, small amount ends up in blood
    - prostate cancer cells produce PSA, more ends up in blood
    - useful to screen population at risk, other causes of increased PSA
  - prostate biopsies
  - surgery +/- radiation, chemotherapy
  - prognosis depends on stage and grade