Kidneys and Urinary Tract
Content Outline
(Effective February 2007)
(16%-24%)

Anatomy
Coverings
true capsule
  • perirenal fat – surrounds capsule
  • Gerota’s fascia – separates perirenal from extraperitoneal fat
  • pararenal fat – around Gerota’s fascia

Location
  • Retroperitoneal
  • Right lower than left & right ureter shorter than left
  • Relationships of both to surrounding organs
  • Posterior boundaries
    – diaphragm – postero-superior
    – psoas muscle – postero-medial
    – transverses abdominus muscle – postero-lateral
    – quadratus lumborum muscle – posterior
Size

- adult 9 – 12 cm.
- neonatal 3.3 – 5 cm.
- symmetry/ height
- renal cortex > 1 cm.
- maximal difference 2 cm

Parenchyma – functional part

cortex
- filtration takes place
- Columns of Bertin
  - cortical tissue between pyramids → < 3 cm. width and same echogenicity and communicates with cortex
- renal corpuscle (Bowman's capsule and glomerulus)
- convoluted tubules
- renal lobe – parenchyma served by one papilla

Parenchyma – functional part

medulla
- medullary pyramids 12 – 1
- base faces cortex
- papilla enter minor calyx
- papillary ducts of Bellini – surface of papillae
- where reabsorption takes place
Renal sinus

- pelvis
- calyces (major & minor)
- hilus
- fat
- nerves
- lymph
- blood
- Vessels

• Extrarenal pelvis
  - triangular shaped
  - longer than intrarenal pelvis and larger calyces
  - axis points infero-medial
• Prominent column of Bertin
  - “Split sinus” sign
  - maximum 3 cm. width
• Sinus lipomatosis
  - increased fat in sinus
  - thickened sinus
  - cortex may be normal or diminished

Vascular Supply

- Renal arteries
- Segmental arteries
  - supply each renal pole
- Interlobar arteries
- Arcuate arteries
- Subcapsular arteries
Venous drainage
1. Efferent arterioles
2. peritubular capillaries
3. interlobular veins
4. arcuate veins
5. interlobar veins
6. segmental veins
   reninal vein
7. renal vein
8. IVC
   • Stellate veins drain renal capsule and drain into intralobular veins.

Lymph Drainage
• Subinguinal
• common, internal
• external iliac groups
• paraortic nodes flow
• thoracic duct.

Production & Excretion of Urine
Filtered fluid collected by Bowman’s capsule
   → proximal convoluted tubule → descending loop of Henle → loop of Henle
   → ascending loop of Henle → distal convoluted tubule → straight collecting duct → urine exits pyramid through papilla of Bellini → minor calyx → major calyx → renal pelvis → ureter → urinary bladder → urethra.
Laboratory values

Serum creatinine
- amino acid found in muscle and filtered by kidneys
  (muscle fairly consistent)
- increase signifies with diminished renal function
BUN (Blood, urea, nitrogen)
- urea is waste product of protein metabolism, usually
  filtered out by kidneys
Electrolytes
- elevated in acute renal failure & glomerulonephritis

Laboratory values

Urinalysis
- uric acid (UA)
- protein (proteinuria) → glomerular damage
- specific gravity
  - Low = failure, pyelonephritis, glomerular nephritis
  - higher = higher quantity dissolved solutes = decreased renal output
- PH → bacteriuria, calculi, chronic failure
- Cells
- Cell casts
- Volume
- Hematuria

Indications
(including clinical symptoms, clinical correlation and
associated complications)
Congenital Variants

- Ectopic – usually pelvis
- Horseshoe – both joined at superior or inferior poles
- Agenesis – uni or bilateral – adrenals fall down to mimic kidneys
- Duplicate vessels and ureters
- Persistent fetal lobulation

- Dromedary hump – left
- Duplex collecting system
- Supernumerary
- Hypoplasia vs. dysplasia
  ↓  ↓
  • congenital    acquired

Technique
Ureter

**Congenital Anomalies**
- duplication of ureters
- Ureterocele
- ectopic ureterocele.

Sonographic is not the imaging modality of choice to evaluate the bladder; cystoscopy is used usually.

**Bladder**
- retroperitoneal
- apex – superior
- body
- neck – inferior
- trigone – posterior where ureters enter (posterolateral)

**Male**
- anterior to seminal vesicles and rectum
- superior to prostate gland

**Female**
- anterior to vagina, posterior cul-de-sac and rectum

**Wall Layers**
3 – 6 mm distended
- Inner mucosa
- Submucosa
- Muscularis
- Outer serosa
**Ligamentous Attachments**

- Pubovesical – female – anteriorly and attaches to pubic bone
- Puboprostatic – male - anteriorly and attaches to pubic bone
- Lateral ligament – fuses with tendinous arch of obturator internus muscle

**Urethra**

Male - 20 cm. long
  - Prostatic – passes through prostate and receives secretions
  - Short membranous – pierces urogenital diaphragm
  - Penile – length of penis
- Female – 3.5 cm. long

**Renal Parenchymal Disease**

**Acute Renal Failure**

secondary to hypoperfusion
  - acute glomerulonephritis
  - acute interstitial nephritis
  - acute tubular necrosis (ATN)
    - most common medical renal disease to produce acute renal failure
- renal vein thrombosis
- renal artery occlusion.
## Hydronephrosis

- Dilated pyelocalyceal system
- Renal sinus and parenchyma become compressed with progressive obstruction

### Causes
- UPJ obstruction
- UVJ obstruction
- Focal masses

## Renal Parenchymal Disease

### Chronic and Acute processes

## Masses

### Benign

- **Angiomyolipoma**
  - Composed of fat cells intermixed with smooth muscle cells and aggregates of thick-walled blood vessels.
  - Focal, solid hyperechoic mass
- **Adenoma**
- **Oncocytoma**
# Masses

## Malignant

- **Wilms' Tumor or Nephroblastoma**
  - the most common solid renal mass found during childhood
  - Seventy-five percent occur before the fifth birthday
- Lymphoma
  - usually a secondary process
  - Non-Hodgkin's lymphoma is more common

## Renal Cell Carcinoma

- 85% of all kidney tumors
- > males than females
- solid parenchymal mass
- Staging is as follows:
  - **Grade I:** confined to kidney
  - **Grade II:** spread to perinephric fat, but within Gerota’s fascia
  - **Grade III:** spread to renal vein, IVC, regional lymph nodes
  - **Grade IV:** invasion of neighboring structures; distant metastases

## Transitional Cell Carcinoma

- tumor of the renal pelvis
  - frequently found in the bladder
- 4 x higher in men
- Present as a mass in the renal pelvis
  - low level echoes
  - widening of central sinus echoes
  - hypoechoic central area.
Masses
Pseudomasses

Cysts
Simple and complex

Renal Cyst

Simple
- 50% of adults >50 years of age.
- No internal echoes
- Acoustic enhancement
- Clear demarcation of back wall

Parapelvic Cyst
- renal hilum
- No communicate with collecting system.
**Congenital Cystic Disease**

- Polycystic Renal Disease → infantile and adult
- Infantile → autosomal-recessive disease
- Adult → autosomal dominant
  - Present with hypertension in the 30-40 year

**Infection**

- Pyonephrosis
  - severe urosepsis
  - secondary to longstanding ureteral obstruction

**Hematomas**
Calculi

Urinary tract obstruction

Anomalies

• Renal Infarction
• Renal Artery Stenosis
• Nephrocalcinosis
  – Echogenic pyramids
• Xanthogranulomatous Pyelonephritis
  – chronic obstruction and infection.
• Emphysematous Pyelonephritis
  – air in the parenchyma
Kidney Transplants
Pre-surgical

Medical applications of sonography:
• Obstruction (dilation does not mean obstruction)
  – Presence or absence of hydrenephrosis
• Vascular to rule out thrombosis of vein or artery
  – Doppler—diastolic flow for rejection
• Rejection
  – increased renal size, prominent hypoechoic medullary pyramids, effacement of renal sinus fat, thickening of renal pelvis
• Perirenal space (fluid collections) Lymphocele
• Renal size

Kidney Transplants
Post-surgical evaluation

Urinary Bladder
Masses
Urinary Bladder Calculi

Urinary Bladder

• diverticulum
  – herniation of bladder wall
  – congenital or acquired
• Inflammation
  – normal in early stage
  – hypoechoic thickening, then fibrous and scarred in late stage

Inflammatory processes
  evaluation of the ureters, urethra, and urachal anomalies

Embryology

• Bladder is initially continuous with allantois, which develops into fibrous cord called urachus (median umbilical ligament).
• Urachus can become patent, extending from bladder to umbilicus.
Xanthogranulomatous disease