Gross anatomy of the urinary system

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• Kidneys, ureters, urinary bladder & urethra

• Urine flows from each kidney, down its ureter to the bladder and to the outside via the urethra
• Filter the blood and return most of water and solutes to the bloodstream

Overview of Kidney Functions
• Regulation of blood ionic composition
  – Na+, K+, Ca+2, Cl- and phosphate ions
• Regulation of blood pH, osmolarity & glucose
• Regulation of blood volume
  – conserving or eliminating water
• Regulation of blood pressure
  – secreting the enzyme rennin
  – adjusting renal resistance
• Release of erythropoietin & calcitriol
• Excretion of wastes & foreign substances

Kidneys: Shape & Location
• Paired kidney-bean-shaped organ
• 4-5 in long, 2-3 in wide, 1 in thick
• Found on the upper part of the posterior abdominal wall
  – retroperitoneal along with adrenal glands & ureters
• Protected by 11th & 12th ribs with right kidney at a lower level
  – Right kidney could be palpable

The kidneys extend from T12 to L3, with the right kidney somewhat lower than the left because of its relationship with the liver. Although they are similar in shape and size, the left kidney is longer and more slender organ than the right kidney and nearer to the midline.
External Anatomy of Kidney

- **Superior & inferior poles**
  - Lower pole of R. kidney could be palpable
    - The superior pole of the right kidney is anterior to rib 12 but the same region of left kidney is anterior to rib 11 & 12.

- **Lateral border**
- **Medial border** –
  3 fingers from midline
  - **Hilum**
    - Anterior and posterior libs
    - Content
      - Renal v. –renal aa. –ureter –renal a. (VAUA, from front to back)
      - Sympathetic fibers and lymph vessels
    - Renal sinus –cavity internal to the hilum
      - Content
      - Same as hilum + drainage system

Kidney Coverings

- **Renal capsule**
  - (fibrous capsule) = transparent membrane maintains organ shape
- **Perirenal fat**
  - helps protect from trauma
  - Immediately outside of renal capsule which completely surrounded the kidney
- **Renal fascia**
  - dense, irregular connective tissue that holds against back body wall
    - Encloses the kidney & the suprarenal gland
    - Continuous with fascia transversalis (at the lateral margins of each kidney the anterior and posterior layers of the renal fascia fuse. This fused layer connect with fascia transversalis)

- **Pararenal fat**
  - (paranephricfat) = protection
    - Part of retroperitoneal fat
    - This fat accumulates posterior and posterolateral to each kidney
Internal Anatomy of the Kidneys

• Parenchyma of kidney
  – renal cortex = superficial layer of kidney
  – renal medulla
    • inner portion consisting of 8-18 cone-shaped renal pyramids separated by renal columns (renal column = extensions of renal cortex project into the inner aspect of the kidney. dividing the renal medulla into discontinuous aggregation of triangles)
    • renal papilla point toward center of kidney
      - Apex of renal pyramid
        - and the base of renal pyramid is directed toward the cortex

• Drainage system fills renal sinus cavity
  – minor calyces – cuplike structure
    • collect urine from the papillary ducts of the papilla
      - One minor calyx for each renal papilla
  – minor calyces empty into major calyces
    • Each major calyx empties 2-3 minor calyces
  – Major calyces empty into the renal pelvis which empties into the ureter

Internal Anatomy of Kidney

• What is the difference between renal hilus & renal sinus?
• Outline a major calyx & the border between cortex & medulla.
Kidney-blood supply

• Blood supply
  – Renal aa. –aorta –L2 (the left renal artery usually arises little higher than the right and the right is longer and passes posterior to IVC)
  – Renal vv. –IVC
    • Anterior to renal arteries
    • The right renal vein is shorter than left because IVC runs along right side of vertebrae column

• Lymph drainage
  – Lateral aortic lymph nodes

• Nerve supply
  – Sympathetic –renal plexus
    – Afferents – T10-T12 spinal segments

Kidney-relations

• Posteriorly
  – Ribs, muscles, nerves ...
  Posteriorly the right and left kidneys are related to similar structures
  Posterosuperiorly: diaphragm
  Posteroinferiorly: moving in a medial to lateral direction, are the psoas major, quadratus lumborum and transverses abdominis muscles.

The longer left renal vein crosses the midline anterior to the abdominal aorta and posterior to the superior mesenteric artery and can be compressed by an aneurysm in either of these two vessels.
Also the subcostal vessels and nerves and iliohypogastric and ilio-inguinal nerves passing posterior to the kidneys.

- **Anteriorly**
  - **Viscera ..**

**Right kidney**

The anterior surface of the right kidney is related to numerous structures, some of which are separated from kidney by a layer of peritoneum and some of which are directly against the kidney:

- A small part of the superior pole is covered by the right suprarenal gland.
- Moving inferiorly, a large part of the rest of upper part of the anterior surface is against the liver and is separated from it by a layer of peritoneum.
- Medially: the descending part of the duodenum.
- The inferior pole of kidney, on its lateral side is directly associated with the right colic flexure and on its medial side is covered by a segment of intraperitoneal of small intestine.

**Left kidney**

The anterior surface of the left kidney is also related to numerous structures, some with intervening layer of peritoneum and some directly against kidney.

- A small part of the superior pole, on its medial side, is covered by the left suprarenal gland.
- The rest of superior pole is covered by intraperitoneal stomach and spleen.
- Middle part is covered by pancreas.
- On its lateral side, the lower half of the kidney is covered by the left colic flexure and the beginning of the descending colon, and on its medial side by the parts of the intraperitoneal jejunum.
Kidney Surface Anatomy

- **Kidneys**
  - From T12 – L3 spines
  - Right kidney at a lower level
- **Inferior pole of R. kidney**
  - Could be palpable at lumbar region
  - Moves about 1 in up and down during respiration
- **Hilum**
  - Anteriorly – at transpyloric line (L1)
  - Posteriorly – three fingers from midline

Transpyloric line: A plane located halfway between the **suprasternal notch** and the upper border of the **symphysis pubis**; this indicates the margin of the transpyloric plane, which in most cases cuts through the **pylorus**, the tips of the ninth costal cartilages and the lower border of the first lumbar vertebra. (Wikipedia)

**Ureters**

- **10 to 12 in long**
- **Varies in diameter from 1-10 mm**
- **Extends from renal pelvis to bladder**
- **Retroperitoneal**
- **Enters posterior wall of bladder**
- **Three Constrictions (arrows)**
  - Kidney stones can become lodge at these constrictors
  - At junction with renal pelvis
  - At crossing the pelvic brim
    - Where cross common iliac vessels
  - At entering the urinary bladder (oblique entrance)
- **Physiological valve**
  - Only
  - Bladder wall compresses ureteral opening as it expands during filling
  - Flow results from peristalsis, gravity & hydrostatic pressure
Ureters: Relations

• Anteriorly
  – Viscera, BVs (gonadal vessels: testicular or ovarian artery), mesentery
• Posteriorly
  – Lumbar transverse processes, psoas m., bifurcation of common iliac a.

• Blood supply
  – Upper end –renal vs.
  – Middle part –gonadal vs.
  – Lower end –superior vesical v.

All arteries reaching the ureters divide into ascending and descending branches which form longitudinal anastomoses.

• Lymph drainage
  – Lateral aortic nodes & iliac nodes

• Nerve supply
  – Renal & gonadal plexuses in abdomen
  – Hypogastric plexus in Pelvis
  – Afferents –L1-L2 segments
Urinary Bladder
- Hollow, distensible muscular organ with capacity of about 500 ml
- In adults it is located in the pelvis behind the pubic symphysis
  - Upon distention, the superior surface extend to the abdomen
  - In infancy bladder have higher position
- Empty bladder lies within the abdomen

Urinary Bladder
- Shape and surfaces
- It is pyramidal in shape
  - Apex – anteriorly
    - Median umbilical ligament (points anteriorly Behind the upper part of pubic symphysis and Connected to umbilicus by median umbilical lig )
  - Base (posterior surface) – triangular in shape
    - Superolateral angles – Ureteral openings
    - Inferior angle – Urethral opening
  - Superior surface
    - Covered by peritoneum
      - Is the weakest surface of bladder and is slightly domed
      - When bladder empty it balloons upward as the bladder fills
  - Inferolateral surfaces
    - Faces the pubic symphysis & lateral pelvic wall
      - are supported by levator ani muscles of pelvic diaphragm and adjacent obturator internus muscles
  - Neck – inferiorly
    - Puboprostatic ligaments (male)
    - Pubovesical ligament (female)
Urinary Bladder: Internal Structure

• Mucus membrane folds
  – Disappear on distention
• Trigone
  is the mucus membrane of the bladder base
  – Always smooth flat area
  – Bordered by 2 ureteral openings (above) & urethral opening (below)
  – Interureteric crest (superiorly)
    Interureteric crest: is a muscular ridge which runs From the opening of one ureters to that of the other

• Uvula vesicae
  (in male)
  – Elevation behind the urethral opening
  – Caused by the median lobe of the prostate
• Detrusor muscle
  (bladder smooth m.)
  – Three layers
• Inner & outer longitudinal
• Middle circular
  – At neck – sphincter vesicae
  (internal urethral sphincter)

Urinary Bladder-Relations in Male

• Anteriorly – abdominal wall, retropubic pad of fat & pubic symphysis
  retropubic pad: space btw pubic symphysis and urinary bladder
• Laterally – obturator internus & levator ani
• Inferiorly – prostate
• Superiorly – peritoneal cavity & parts of intestine
• Posteriorly – rectovesical pouch, vas deferens, seminal vesicles, rectovesical fascia
  rectovesical fascia: btw rectum and urinary bladder
Urinary Bladder-Relations in Female
- Anteriorly – abdominal wall, retropubic pad of fat & pubic symphysis
- Laterally – obturator internus & levator ani mm.
- Inferiorly – urogenital diaphragm
- Superiorly – uterovesical pouch & uterus
- Posteriorly – vagina

*During pregnancy*, many women experience at least some degree of *urinary* incontinence, which is the involuntary loss of *urine*. Because vagine causes pressure on the bladder.

**Urinary Bladder**
- **Blood supply**
  - Superior and Inferior vesical a. – internal iliac a.
  - Vesical venous plexus – prostatic venous plexus – internal iliac v.
- **Lymphatics**
  - Internal & external iliac nodes

- **Nerve supply**
  - Inferior hypogastric plexus
    - Sympathetic: L1-L2 ganglia (sympathetic trunk) – hypogastric plexus
      - Contraction of sphincter vesicae
    - Parasympathetic: S2-S4 – pelvic splanchnic nn.
      - Contraction of detrusor m
  - Afferent fibers
    - Parasympathetic (most) – S2-S4 segments
    - Sympathetic (some) – L1-L2 segments
Female Urethra

- Length of 1.5 in. from the
- Traverse the sphincter urethrae in the urogenital diaphragm
- Internal urethral orifice – at bladder neck
- External urethral orifice (meatus) – at the vestibule
  - 1 in. posterior to clitoris & anterior to vaginal opening
  - On sides has openings of the paraurethral glands (skene's glands)

Male Urethra

- Length 8 in. from bladder neck to glans penis
- Parts
  - Prostatic urethra (it's connection btw the urinary and reproductive tracts in men)
    - 1.25 in. – widest part
  - Urethral crest
    - Prostatic utricle
      » On both sides has the openings of ejaculatory ducts
  - Prostatic sinus
- Membranous urethra
  - 0.5 in. – in urogenital diaphragm
  - Penile urethra
    - 6 in. – narrowest part
  - Traverse the pulp & corpus spongiosum of the penis
  - Receives the bulbourethral ducts – proximally
  - Fossa terminalis – dilated distal part