

Urinary System

1. Other Names:

- Excretory System

2. Definition/Location:

- The urinary system consists of the right and left kidney, right and left ureters, the urinary bladder, and the urethra (Curry-Tempkin, p.180, C1/P1/S1).
- As part of the excretory system, kidneys function to rid of metabolic waste (Tempkin, p.102, P2/S1).
- The renal tubules, or nephrons, are the functional unit of the kidney and include the glomerulus and Bowman's capsule (Hagen-Ansert, p. 292, P2/S6).
- The urinary system is located posterior to the peritoneum lining the abdominal cavity in an area called the retroperitoneum (Hagen-Ansert, p.292, C1/P1/S1).
- The right kidney lies slightly lower than the left kidney because the large right lobe of the liver pushes it inferiorly (Hagen-Ansert, p. 292, C1/P1/S4).
- Anterior to the right kidney are the right adrenal gland, right lobe of the liver, second part of the duodenum, hepatic flexure of the colon, and jejunum or ileum of the small bowel (Curry-Tempkin, p. 180, C2/P4/S1).
- Posterior to both kidneys are the diaphragm, the psoas muscle, the transverse muscle, and the quadratus lumborum muscle (Curry-Tempkin, p. 180, C2/P6/S1).
- On the medial surface of each kidney is a vertical indentation called the renal hilum, where the renal vessels and ureters enter and exit. Within the hilum of the kidney are other vascular structures, ureters, and the lymphatics (Hagen-Ansert, p. 292, C2/P1/S1-2).
- The ureters are tubular, retroperitoneal structures that begin as an expanded area, the renal pelvis, in the hilum of each kidney. The ureters expand inferiorly along the psoas muscle. They travel from the renal hilum into the abdominopelvic cavity, and finally enter the urinary bladder posteriorly (Curry-Tempkin, p.180, C2/P7/S1-3).
- The urinary bladder is a large, muscular bag, with a posterior and lateral opening for the ureters and one anterior opening for the urethra (Hagen – Ansert, p. 294 C2/P2/S1).
- The urethra is a membranous canal that conveys urine out of the urinary bladder. It exits inferiorly via the neck the neck of the urinary bladder (Curry-Tempkin, p. 181, C2/P3/S1).
- The arterial supply to the kidney is through the main renal artery (Hagen – Ansert, p. 294, C2/P4/S1).

- Five to six veins join to form the main renal vein. The renal vein drains into the lateral walls of the inferior vena cava (Hagen – Ansert, p.294, C2/P5/S3).
- The arterial supply to the ureters is from the following three sources: the renal artery, the testicular or ovarian artery and the superior vesicles artery (Hagen-Ansert, p. 295, C1/P1/S1).

3. Ultrasound Appearance: (Tempkin p. 102, “Sonographic Appearance”)

- Because of fat, the renal sinus is echogenic with variable contour. Parenchyma surrounds the sinus.
- The cortex is homogenous, with mid-gray, or medium to low level echoes with even texture that may appear hyperechoic or isoechoic to the liver and spleen (Curry Tempkin, p. 192, C2/P2/S1).
- The medullary pyramids appear triangular and are hypoechoic to the more urine-filled anechoic areas.
- Arcuate vessels can be seen at the corticomedullary junction as echogenic dots.
- The ureters are normally not visible sonographically. However it is possible to observe the effect of the ureters ejecting urine into the bladder, called uretral jets (Curry Tempkin, p. 196, C1/P4/S1). (Curry-Tempkin, p. 199, Fig. 12-28).

4. Normal Size Range(s):

- Normal adult kidneys are 9 to 12 cm long, 2.5 to 4 cm thick, and 4 to 6 cm in diameter (Tempkin, p. 101, P11/1) also (Curry-Tempkin, p. 203 “Normal Measurements”).
- The ureters range from 25 to 30cm in length. The diameter ranges between 4 and 7mm (Curry-Tempkin, p. 183, C2/P4/S1).
- The wall of a distended bladder will normally measure 3 to 6mm, depending on the degree of bladder distension (Curry-Tempkin, p. 184, C1/P1/S3).
- The male urethra is 20 cm in length; the female is considerably shorter, approx. 3.5cm in length (Curry-Tempkin, p. 184, C1/P1/S4).

5. Pertinent Lab Data: (Curry Tempkin, p. 202, “Laboratory Values”)

- Blood Urea Nitrogen (BUN): BUN is 26 mg/dl
- Creatinine (Cr): Cr is 1.1 mg/dl

6. Common Pathologies:

- **Renal cysts:** Sonographic features include a well-defined anechoic mass lesion with smooth walls with good through-transmission and no color flow within the cyst (Hagen-Ansert, p. 314, C2/P1/S1).
- **Urolithiasis (renal stones):** Sonographic findings include renal stones with very echogenic foci with posterior acoustic shadowing (Hagen-Ansert, p.350, C2/P3/S1). If the stone causes obstruction, there will be hydronephrosis, and depending on the location of the stone, the ureters may be dilated superior to the level of obstruction (Hagen-Ansert, p. 352, C1/P1/S1). Stones may also

be imaged when the bladder is distended with fluid (Hagen-Ansert, p. 352, C1/P1/S5).

- **Renal cell carcinoma:** Sonographically, it usually presents as a solid parenchymal mass, frequently with areas of hemorrhage and necrosis; not usually echogenic unless the mass is very small or calcification is present usually isoechoic or hypoechoic or complex on ultrasound (Hagen-Ansert, p. 320, C1/P1/S1).
- **Wilm's Tumor:** Tumor may spread beyond the renal capsule and invade the venous channel, with tumor cells extending into the IVC and right atrium and with eventual metastasis into the lungs (Hagen-Ansert, p.322, C2/P3/S1).
- **Hydronephrosis:** When hydronephrosis is suspected, the bladder should be examined. If it is full, a postvoid longitudinal scan of each kidney should be done to show that hydronephrosis has disappeared or remained the same. At the level of obstruction, the sonographer should sweep the transducer back and forth in two planes to see if a mass or stone can be distinguished (Hagen-Ansert, p.333, C1/P3/S1).

7. Patient Prep: (Tempkin, p. 103, "Patient Prep")

- None

8. Transducer (Probe) Frequency:

- 3.0 MHz or 3.5 MHzs
- 5.0 for very thin patient

9. Protocol: (Tempkin, p.108, "Required Images")

- Longitudinal image of right and left kidney with superior to inferior measurements.
- Longitudinal image of right and left kidney without measurements.
- Longitudinal image of right and left kidney superior pole.
- Longitudinal image of the right and left kidney inferior pole.
- Longitudinal image of right kidney just medial to long axis.
- Longitudinal image of left kidney just posterior to the long axis.
- Longitudinal image of right kidney just lateral to the long axis to include part of the liver for parenchyma comparison.
- Transverse image of right and left kidney superior pole.
- Transverse image of right and left kidney midportion to include hilum with anterior to posterior measurements.
- Transverse image of right and left kidney midportion to include hilum without measurements.
- Transverse image of right and left kidney inferior pole.

10. Image References:

- Hagen-Ansert, p.29, Fig. 10-4, Vascular relationship to the kidneys
- Hagen- Ansert, p. 298, Fig. 10-6d, Liver, right kidney, and gallbladder
- Curry-Tempkin, p.199, Fig.12-28, Ureteral jets

- Hagen-Ansert, p.314, Fig. 10-36, Renal Cyst
- Hagen-Ansert, p.322, Fig. 10-51, Renal Cell Carcinoma
- Hagen –Ansert, p.325, ig. 10-57, Wilm’s Tumor

11. References:

- Curry, R.A. and Tempkin, B.B. (2004). Sonography: Introduction to Normal Structures and Function (2nd ed.). St. Louis, MO: Saunders.
- Hagen-Ansert, S.L. (2006). Textbook for Diagnostic Ultrasonography (6th ed.)(Vol.1) St. Louis, MO: Mosby.
- MedImageWorld L.L.C. (2002-2005). Inferior Vena cava. Retrieved June 25, 2006, from <http://www.sonoworld.com/Chapter/ShowBookChapter.aspx?bid=4&cid=25&PageId=7>
- Tempkin, B.B.(1999). Ultrasound Scanning: Principles and Protocols (2nd ed). Philidelphia, PA: Saunders.