
MIDLANDS SURGICAL
ANATOMY TEACHING
SERIES



MSATS
HANDOUT
2021/22

High Yield | Surgical Relevance | CPD Accredited

RENAL ANATOMY

Objectives: Understand the anatomy of the kidneys, ureters, bladder, urethra and their respective neurovascular supply. Apply anatomical knowledge in context of stone disease and common urological procedures

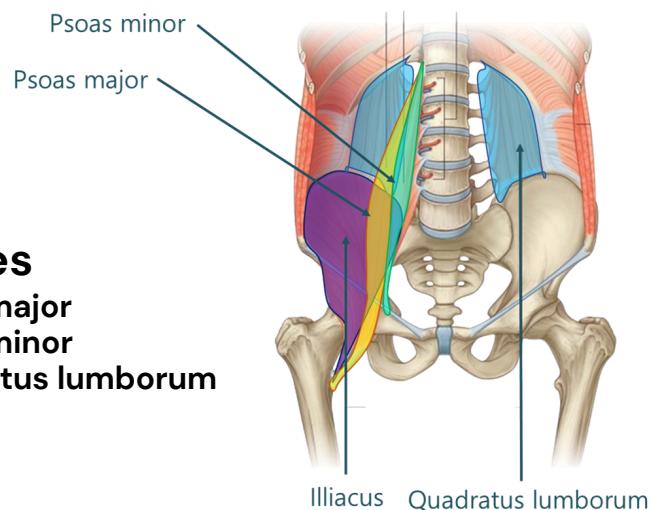
Posterior Abdominal Wall

Important Structures

- Posterior abdominal wall skeleton
- Muscles
- Lymphatics
- Vasculation:
 - Abdominal aorta
 - Inferior vena cava
- Innervation:
 - Sympathetic trunks
 - Lumbar plexus

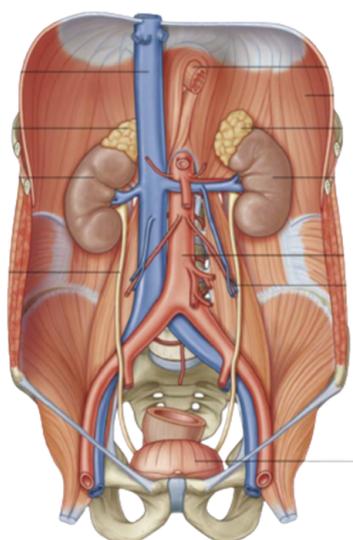
Muscles

- Psoas major
- Psoas minor
- Quadratus lumborum
- Iliacus



Muscle	Origin	Insertion
Psoas major	<ul style="list-style-type: none"> Lateral surfaces of T12, L1-L5 vertebrae & discs 	<ul style="list-style-type: none"> Lesser trochanter of femur
Psoas minor	<ul style="list-style-type: none"> Lateral surfaces of T12, L1-L5 vertebrae & discs 	<ul style="list-style-type: none"> Pelvic brim, iliopubic eminence
Quadratus lumborum	<ul style="list-style-type: none"> Transverse process of L5, iliac crest, iliolumbar ligament 	<ul style="list-style-type: none"> Transverse processes L1-L4, inferior border of rib 12
Iliacus	<ul style="list-style-type: none"> Iliac fossa, sacroiliac and iliolumbar ligaments, upper sacrum 	<ul style="list-style-type: none"> Lesser trochanter of femur

Attachments

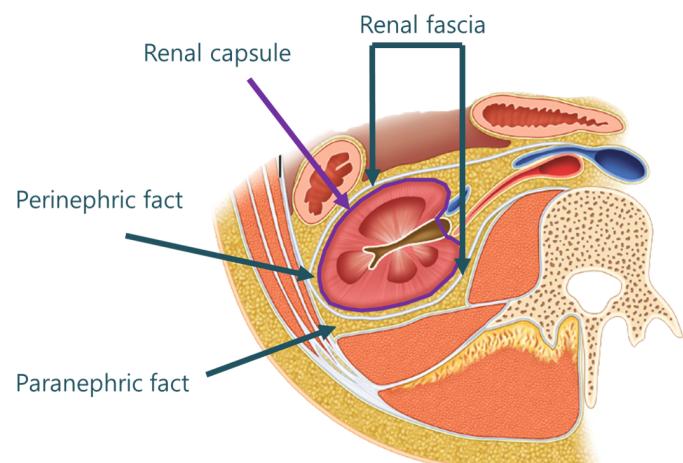


Urinary System

- Kidneys
- Ureters
- Bladder
- Urethra

The Kidneys

- Retroperitoneal
- Immediately lateral to vertebrae
- T12 – L3
- Encapsulated by renal fascia



Filters blood, removes waste and excess water

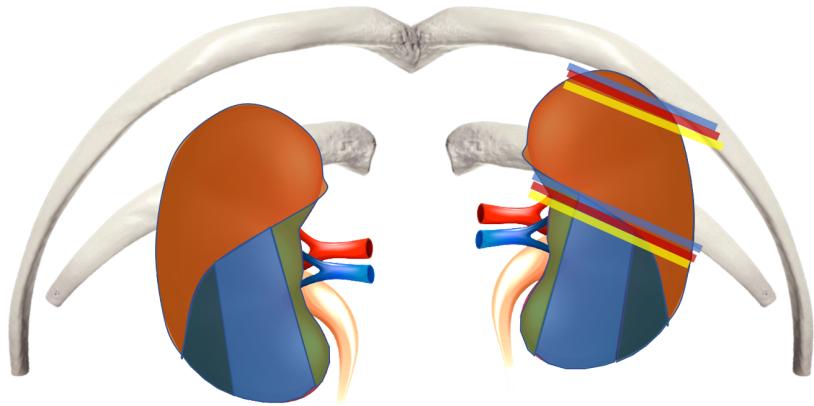
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The Kidneys

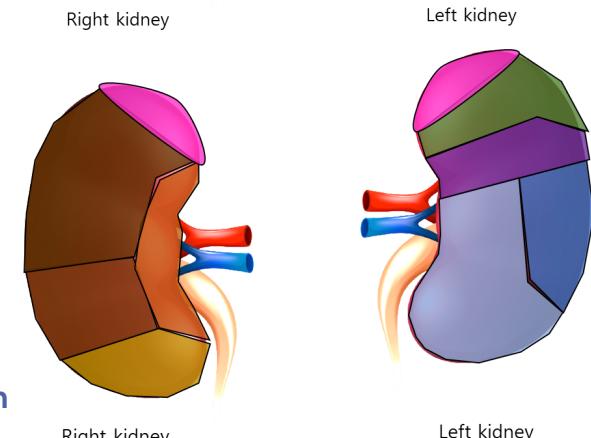
Posterior relations:

- Superior: **diaphragm**
- Medial to lateral:
 - **Psoas major**
 - **Quadratus lumborum**
 - **Transversus abdominis**
- **Ribs**
 - + **subcostal bundle**



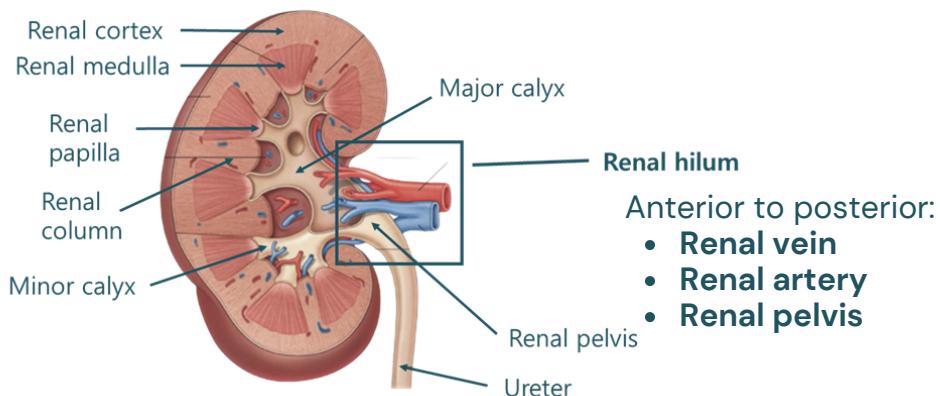
Anterior relations:

- Superior: **suprarenal glands**
- **Right kidney:**
 - **Liver**
 - **Descending duodenum**
 - **Right colic flexure**
 - **Small intestine**
- **Left kidney:**
 - **Stomach and spleen**
 - **Pancreas**
 - **Left colic flexure and descending colon**
 - **Jejunum**



Structure

- Outer **renal cortex**
- Inner **renal medulla**
- **Renal papilla**
- **Renal column**
- **Minor renal calyx**
- **Major renal calyx**
- **Renal pelvis**
- **Ureter**
- **Hilum of kidney**

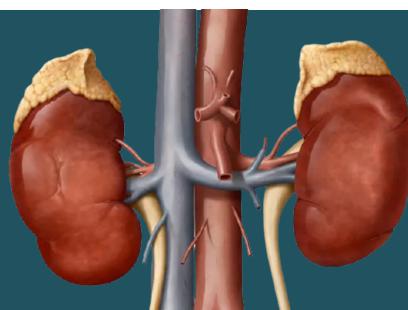


Arterial Supply

- **Renal arteries** (abdominal aorta)
 - Just inferior of SMA (between L1 & L2)
 - Right artery > left artery
 - Divides into anterior and posterior branches at hilum
 - Accessory arteries are common

Venous drainage

- **Renal veins** (IVC)
 - Anterior to renal arteries
 - Left vein > right vein
 - Anterior to aorta
 - Posterior to SMA
 - Aneurysms = nutcracker

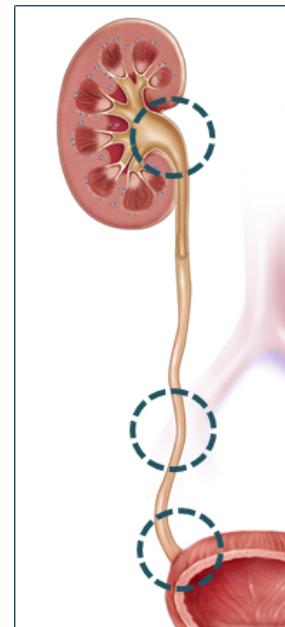
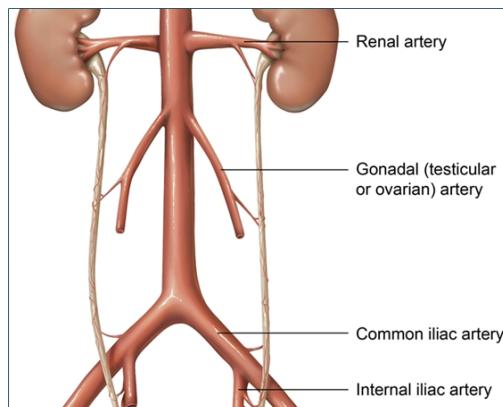


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Ureters

- **Muscular tubes transporting urine to the bladder**
 - Continuous with renal pelvis
 - 3 major points of constriction
 - Ureteropelvic junction
 - Pelvic inlet
 - Ureterovesical junction
 - **Clinical implication:** stones!
- **3 parts:**
 - Abdominal ureter
 - Pelvic ureter
 - Intravesical / intramural
- Receiving vascular supply from nearby major arteries



Minor calices → Major calices → Renal pelvis → Ureters

BLADDER

- Most anterior pelvic organ
- 3-sided pyramid
 - Apex
 - Body
 - Fundus
 - Neck
- Trigone = smooth area
 - Formed by ureteric orifices and internal urethral orifice
- Detrusor muscle – smooth muscle
- Internal urethral sphincter
 - Smooth muscle
 - Continuous with detrusor

Innervation

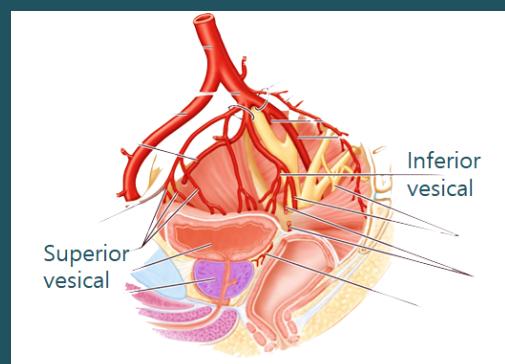
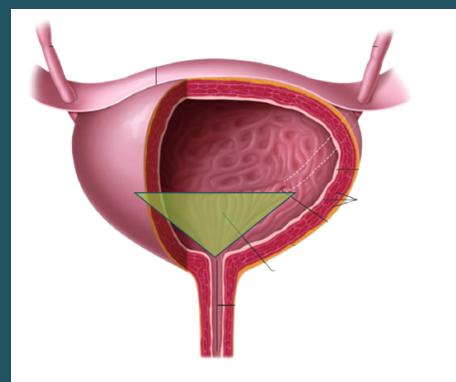
- Hypogastric nerve
 - T12-L2
 - Sympathetic
 - **Relaxes** detrusor
 - Urine retention
- Pelvic splanchnic nerve
 - S2-S4
 - Parasympathetic
 - **Contracts** detrusor
 - Micturition
- Pudendal nerve
 - Voluntary, somatic
 - **Control:** External urethral sphincter

Arterial supply

- Upper part:
 - Superior vesical branches (internal iliac)
- Lower part:
 - **Male:** inferior vesical branches
 - **Female:** vaginal arteries

Venous drainage

- Network of vesical veins
- Draining into internal iliac

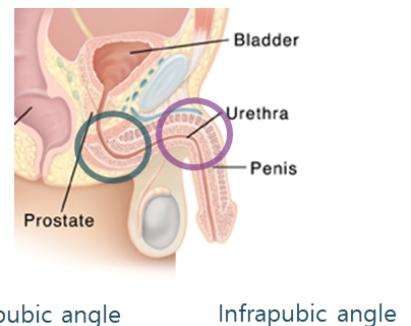


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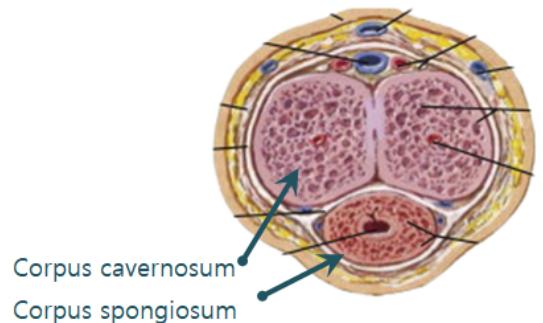
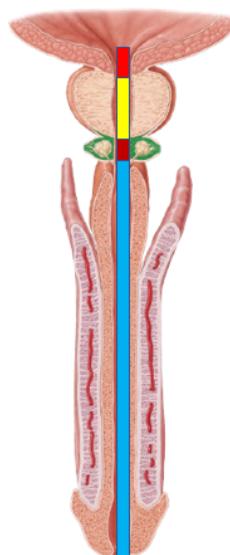
Urethra

- Begins at the base of the bladder – surrounded by internal urethral sphincter
- Ends with external urethral orifice
- Women:
 - Short (~ 4cm)
 - Anterior to vaginal opening
 - Skene's glands – lubrication
- Men:
 - Long (~ 20cm)
 - Bends twice
 - 4 parts



Parts of the male urethra

- Pre-prostatic**
 - Short (~ 4cm)
 - Anterior to vaginal opening
- Prostatic**
 - Several openings: ejaculatory ducts, prostatic ducts
- Membranous**
 - Through deep perineal pouch
 - Narrowest part
 - Passes through external urethral sphincter
- Spongy**
 - Surrounded by erectile tissue



Male Reproductive System

- Testes
- Epididymis
- Vas deferens
- Ejaculatory ducts
- Accessory glands:
 - Prostate
 - Paired seminal vesicles
 - Paired bulbo-urethral glands

Prostate

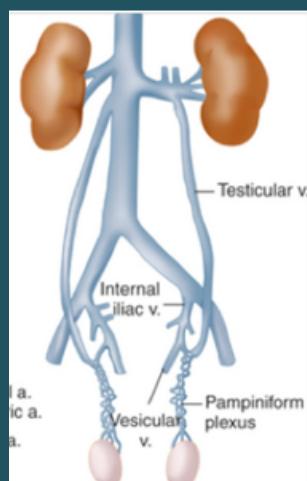
- Unpaired accessory structure
- Surrounds the prostatic urethra
- Discrete zones:
 - Transitional zone** = BPH
 - Peripheral zone** = Prostate cancer

Testes

- Develop in the abdomen
- Descends through inguinal canal
- Covered by peritoneal sac

Testes – Neurovascular supply

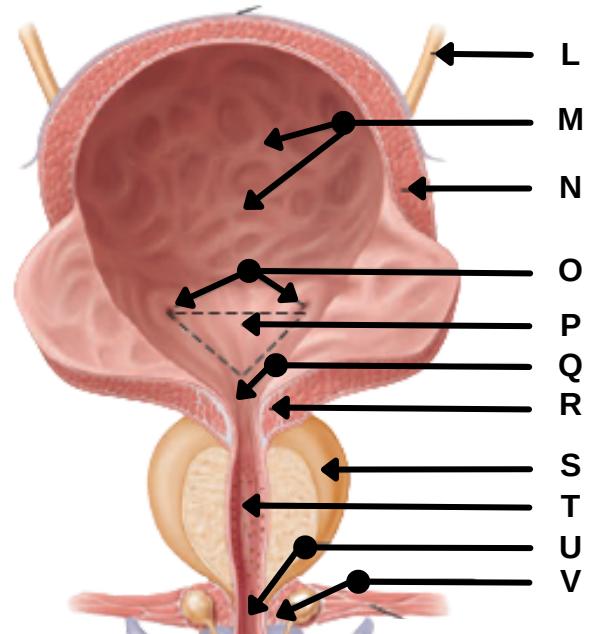
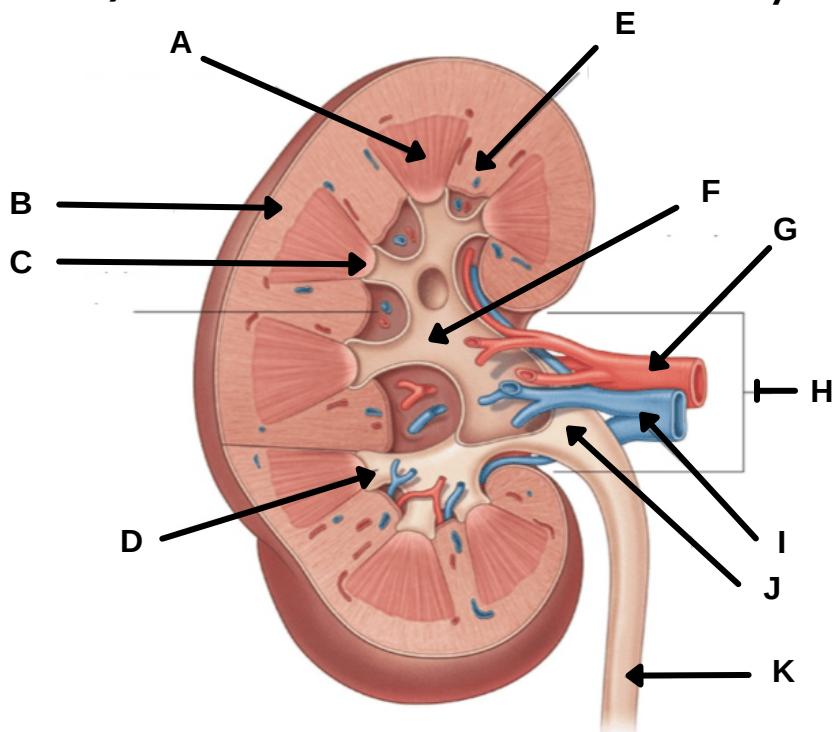
- A** – testicular arteries (abdominal aorta) + cremasteric artery + artery of vas deferens
- V** – testicular veins
- N** – testicular plexus
- L** – lumbar and para-aortic nodes



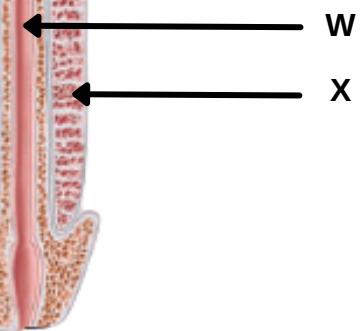
RENAL ANATOMY

Test yourself...

1) Label the structures of the kidney



2) Label the structures of the bladder and parts of the male urethra



RENAL ANATOMY

Test yourself...

MCQ 1

The kidneys are located:

- A. On either side of the lungs
- B. Inferior to the liver
- C. Within the mesentery
- D. Posterior to the quadratus lumborum
- E. Either side of spinal column, middle back

MCQ 2

What area does prostate cancer spread to most frequently

- A. Brain
- B. Lumbar spine
- C. Lung
- D. Pancreas
- E. Rectum

MCQ 3

What zone of the prostate is usually affected by BPH?

- A. Central zone
- B. Fibromuscular
- C. Transitional
- D. Peripheral
- E. Periurethral

MCQ 4

What is the structure that supplies blood to the glomerulus?

- A. Peritubular capillaries
- B. Efferent arteriole
- C. Afferent arteriole
- D. Intralobar artery
- E. Renal venules

MCQ 5

You have taken a detailed clinical history from a 64-year-old male patient during your GP surgery clinical experience visit. The patient's primary complaint is urinary incontinence, which started four weeks prior.

Later, your supervising GP asks you to name two key anatomical barriers to urinary incontinence in such a patient, and what division of the nervous system controls each barrier. Which of the following options most accurately answers this question?

- A. Internal urethral sphincter (autonomic), external urethral sphincter (somatic)
- B. Internal bladder sphincter (autonomic), external anal sphincter (autonomic)
- C. Detrusor sphincter (central), urethral sphincter (somatic)
- D. Urethral valves (autonomic), urethral sphincter (somatic)
- E. Internal urethral sphincter (somatic), external urethral sphincter (autonomic)

MCQ 6

Select the option which represents the flow of urine out of the nephron

- A. Renal papilla, minor calyx, renal pelvis, major calyx, ureter, bladder, urethra
- B. Renal column, renal papilla, minor calyx, major calyx, renal pelvis, bladder, urethra
- C. Renal pelvis, ureter, bladder, urethra
- D. Renal papilla, minor calyx, major calyx, renal pelvis, ureter, bladder, urethra
- E. Renal column, renal papilla, minor calyx, major calyx, renal pelvis, ureter, bladder, urethra

RENAL ANATOMY

Test yourself...

OSCE Station – Case Based Discussion

While on your general practice rotation you see Mr B, a 56 year old gentleman who presented to you with a history of blood in his urine. He also mentioned that he is struggling to wee. In this case, you will have to identify important aspects of the history and outline your investigations and management steps.



Q1. What specific questions would you like to ask to explore the history of the presenting complaint?

Q2. What other components of the history are important and why? What are specific social history questions to ask?

Q3. What investigations would you perform?

Q4. What are your differential diagnoses?

Q5. What is your management strategy?

1) When first noticed? When last passed urine? Any blood clots? Fever, burning sensation? Any pain (flank)? Any stones, polycystic kidneys?

2) PMH – previous stones, surgeries, recent catheterisation; DH – anticoagulants or antiplatelets; FH – cancers, stones, polycystic kidneys?

3) Urine dip for signs of infection, urine for MCs – infective causes, blood tests (FBC, URE, CRP, group save), bladder scan – if clots present

4) Mailignancy – bladder, renal or prostate cancer, Infection – UTI, prostatitis, etc; Stones; Other urological causes: trauma, BPH, surgery; non-urological = blood disorders, anticoagulants, benign urine discoloration

5) If clots, 3-way catheter, if Hb <70 = transfuse; WWW haematuria clinic (CT urogram and cystoscopy)

Labels: L = (left) ureter, M = rugae/ bladder wall, N = detrusor, O = ureteric orifices, P = trigone, Q = internal urethral orifice, R = internal urethral sphincter, W = spongy urethra, X = erectile tissue

MCQs: 1 = E, 2 = B, 3 = C, 4 = C, 5 = A, 6 = D

OSCEs:

Answers: A = renal pyramid / renal medulla, B = renal cortex, C = renal papilla, D = minor calyx, E = renal column / renal cortex, F = major calyx, G = renal hilum, H = renal hilum, I = renal vein, J = renal pelvis, K = ureter.

Labels 2: L = renal artery, H = renal hilum, I = renal vein, J = renal pelvis, K = ureter.

Labels 3: L = renal cortex, M = renal pyramid / renal medulla, N = renal hilum, O = renal pelvis, P = renal pelvis, Q = renal hilum, R = renal artery, S = renal vein, T = renal pelvis, U = renal pelvis, V = renal pelvis.

Labels 4: L = renal cortex, M = renal pyramid / renal medulla, N = renal hilum, O = renal pelvis, P = renal pelvis, Q = renal hilum, R = renal artery, S = renal vein, T = renal pelvis, U = renal pelvis, V = renal pelvis.

Labels 5: L = renal cortex, M = renal pyramid / renal medulla, N = renal hilum, O = renal pelvis, P = renal pelvis, Q = renal hilum, R = renal artery, S = renal vein, T = renal pelvis, U = renal pelvis, V = renal pelvis.