Kidneys, Ureters, Bladders, Oh My!
A Case-based Review of Genitourinary Mimics of Malignancy

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Objectives

- This case-based review will assist the radiologist at all levels of training in identifying key clinical and imaging features that help identify non-neoplastic conditions that mimic genitourinary malignancy and make appropriate recommendations to the referring clinician.
- Multimodality case-based review with discussion of pertinent clinical presentation, treatment, and differential diagnosis.

Focal pyelonephritis  Sarcoidosis  Anterior fibromuscular stroma
# Mimics of Genitourinary Malignancy

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**UCLA Health System**
Fungal Infection

Disseminated Histoplasmosis of the adrenal glands. 61 year-old female who presents with weight loss and elevated liver function tests. A and B. Grey scale and color Doppler abdominal US images demonstrate hypoechoic masses (*) in the expected location of the bilateral adrenal glands. C. Axial CT demonstrates bilateral adrenal masses (*) with adjacent inflammatory stranding. The enhancement pattern of the masses were not characteristic of adrenal adenomas. CT-guided adrenal biopsy demonstrated abundant yeasts and positive GMS stain. Cultures grew Histoplasmosis.

Background
- Extensive involvement by fungal infection may result in adrenal insufficiency
- Occurs in the setting of altered host immunity (patients with neoplasm and AIDS)
- 50% of patients with disseminated histoplasmosis ultimately develop Addison disease
- In disseminated Histoplasmosis, adrenal glands may be the only involved site of disease

Imaging features
- Bilateral enlargement of adrenal glands with central necrosis and peripheral enhancement
- Chronic: glands may atrophy and calcify

Differential diagnosis
- Metastasis
- Adenomas
- Granulomatous disease (tuberculosis)
- Hemorrhage
Large traumatic adrenal hematoma. 21 year-old male who presents with right upper quadrant pain and history of judo injury 1 month prior. A. Grey scale US image demonstrates a 13.4 cm heterogeneous right upper quadrant mass (*) containing fluid, echogenic debris, and more solid-appearing components. There was no evidence of vascularity within the mass. B and C. Coronal and axial contrast-enhanced CT demonstrate a large, well-circumscribed right adrenal mass of fluid attenuation (*). The mass underwent US-guided aspiration for symptomatic relief and 300 cc of old blood was aspirated.

**Background**
- **Etiologies:** Blunt trauma from direct compression of adrenal gland by spine and liver; orthotopic liver transplantation due to ligation and division of right adrenal vein during hepatectomy; anticoagulation; stress caused by surgery, sepsis, or hypotension
- **Complications:** adrenal insufficiency if bilateral

**Imaging features**
- **Acute:** hyperdense
- **Chronic:** calcifications may develop a few months after adrenal hemorrhage
- **Attenuation** depends on age of hematoma
- **Occurs** on the right side in up to 90% of cases in blunt trauma
- **Nontraumatic:** unilateral or bilateral
Inflammatory Pseudotumor

**Etiology**
- Benign proliferation of inflammatory cells and myofibroblastic spindle cells
- Unknown cause: low-grade fibrosarcoma with inflammatory cells, surgery/trauma, autoimmune, IgG4 disease, infection

**Background**
- Most commonly involves the lung and orbit

**Presentation**
- Constitutional symptoms due to inflammatory cytokines and mass effect

**Imaging features**
- US: anechoic to hyperechoic
- CT: hypoenhancing to hypervascular, ill-defined to discrete
- MR: variable signal intensity based on degree of inflammation and fibrosis

**Treatment**
- Complete surgical resection, steroids

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**Inflammatory pseudotumor.** A and B. Color Doppler and grey scale US images demonstrates a hypoechoic mass (*) superior to the right kidney (RK) and without significant vascularity. C. Contrast enhanced MRA demonstrates homogeneous hypoenhancing suprarenal mass (*) invading into the IVC (+), right atrium (RA), and right hepatic vein (not shown). This lesion was thought to represent renal cell carcinoma with vascular invasion. Surgical pathology revealed low grade myofibroblastic/histiocytic proliferation, consistent with inflammatory pseudotumor. No evidence of malignancy. D. For comparison, coronal contrast-enhanced MR demonstrates a heterogeneously enhancing large left renal mass (*) with enhancing tumor thrombus (T) in the IVC, biopsy proven renal cell carcinoma with invasion into the IVC.
Erdheim-Chester disease

Background
- Rare form of non-Langerhans cell histiocytosis
- Unknown cause
- Tissue infiltration by foamy histiocytosis
- Pathology: CD68 positive, CD1a and S-100 protein negative

Presentation
- Occurs after the age of 40 and with male predominance
- Bone involvement is most frequent radiologic finding: bilateral, symmetric metaphyseal and diaphyseal sclerosis; cortical thickening; increased uptake on bone scan
- Renal involvement: 29% of patients in one series, usually asymptomatic

Imaging features
- CT: Hypoattenuating homogeneous tissue infiltration with weak contrast enhancement in the renal fossa
- MRI: Isointense to muscle on T1 and T2-weighted images, slight enhancement
- Perirenal infiltration may extend to the anterior and posterior pararenal spaces
- “Hairy kidney:” symmetric and bilateral infiltration of both perirenal and posterior pararenal space
- Can cause urinary tract obstruction when the tissue extends to renal sinuses and proximal ureter

Treatment: corticosteroids, ureteral stent placement

Erdheim-Chester Disease.
A. Axial post-contrast T1-weighted MR image demonstrates mildly enhancing perirenal soft tissue (*) surrounding the bilateral kidneys and extending into the renal sinuses (not shown), resulting in severe hydronephrosis. B. For comparison, axial contrast-enhanced CT demonstrates rind of soft tissue (*) surrounding the right kidney, biopsy proven marginal zone lymphoma.

Kidneys
Focal Pyelonephritis

Renal abscess secondary to focal pyelonephritis. 66 year-old male who presents with gross hematuria. A. CT urogram showed a 4.5 cm heterogeneously enhancing mass with cystic component (*) in the superior pole of the left kidney, worrisome for renal neoplasm. MRI abdomen demonstrates this upper pole renal mass as well as additional heterogeneous areas of enhancement in the right kidney (not shown), unusual for a primary renal neoplasm. Therefore, these lesions were followed with MRI 2 months later, which demonstrated interval resolution of the heterogeneous enhancing lesions within the bilateral kidneys, consistent with focal pyelonephritis complicated by renal abscess.

Renal infarct secondary to focal pyelonephritis. B. Coronal contrast-enhanced CT demonstrates striated left nephrogram with more focal ill-defined hypoenhancing area in the superior pole (arrow). C. Follow-up axial contrast-enhanced CT demonstrates a wedge-shaped hypoenhancing area (arrow) and resolution of heterogeneous parenchymal enhancement, consistent with focal infarct in the setting of pyelonephritis.
IgG4 disease

Background
• Diffuse or focal inflammatory reaction with fibrosis and dense lymphoplasmacytic infiltrate rich in IgG4-positive plasma cells
• Autoimmune pancreatitis is most common presentation of IgG4-related disease

Presentation
• Kidneys: inflammatory pseudotumors, membranous nephropathy, chronic pyelitis
• Prostate: prostatitis
• Retroperitoneum and mesentery: retroperitoneal fibrosis, sclerosing mesenteritis

Demographics
• Most commonly occurs in middle-aged or older men for many of the abdominal manifestations of IgG4 disease

Imaging features
• Four disease patterns: 1. Round or wedge-shaped renal cortical nodules; 2. Small peripheral cortical lesions; 3. Masslike lesions; 4. Renal pelvic involvement
• Typically involves cortex
• Cortical nodules may coalesce into a perirenal rim of enhancing tissue

Differential diagnosis
• Lymphoma
• Extramedullary hematopoiesis
• Erdheim-Chester disease
• Autoimmune diseases
• Xanthogranulomatous pyelonephritis

Treatment: Glucocorticoids
Hydatid disease

Renal hydatid cyst. 62 year-old female with incidental left renal mass discovered on abdominal ultrasound. A. Color Doppler US image demonstrates a heterogeneous mass in the lower pole of the left kidney with some areas of posterior shadowing (dotted line). B. Contrast-enhanced coronal CT demonstrates a cystic mass with curvilinear calcifications (*). Surgical pathology revealed a laminated calcified cyst wall, consistent with hydatid cyst. No evidence of malignancy.

Background
- Primarily affects the liver (75% of cases)
- Secondary involvement of almost any anatomic location due to hematogenous dissemination

Pathology
- *Echinococcus granulosus and multilocularis* tapeworm
- Humans may become intermediate hosts through contact with a definitive host (usually a domesticated dog) or ingestion of contaminated water or vegetables
- Once the parasite passes through the intestines into the portal venous system, the liver acts as first line of defense and is therefore the most frequently involved organ

Imaging features
- Depends on stage of cyst: During natural evolution toward healing, dense calcification of all cyst components occurs
- US: cyst wall = double echogenic lines separated by a hypoechoic layer
- Snowstorm sign: cyst contains multiple mobile echogenic foci due to hydatid sand
- “Floating membranes” inside the cavity
- US water lily sign: complete detachment of membranes inside the cyst

Treatment: Surgery is the primary treatment, albendazole
**Xanthogranulomatous pyelonephritis.** 37 year-old female with history of recurrent urinary tract infections who presents with left flank pain and fever. A. Coronal and B. axial contrast-enhanced CT demonstrates markedly enlarged left kidney with delayed nephrogram compared to the normal right kidney. The left kidney demonstrates a multiloculated appearance due to dilatation of the calyces (*) with marked inflammatory stranding in the perinephric region (arrows) and extending along the psoas muscle (not shown). The scan was initially read as concerning for malignancy; however, CT guided drainage was performed with cultures positive for *Proteus mirabilis.*

**Background**
- Chronic granulomatous process secondary to recurrent bacterial urinary tract infections
- Most common species involved are *E. coli* and *P. mirabilis*
- Renal parenchyma is eventually replaced with lipid-laden macrophages
- Most cases occur in association with calculi in the renal pelvis

**Imaging features**
- Large staghorn calculus is found in most but not all cases
- Extensive inflammatory process characterizes xanthogranulomatous pyelonephritis
- Enlargement of the renal contour, dilated calyces, and contracted renal pelvis
- Decrease in renal function on excretory imaging

**Differential diagnosis**
- Renal tuberculosis
- Malignancy

**Treatment:** Definitive management with nephrectomy; antibiotics
Ureteritis cystica

61 year-old female who presents with hematuria. A. CT urogram demonstrates multiple lucent filling defects (arrows) in the ureter, primarily in the middle third, measuring approximately 2 mm and smooth-walled. B. Retrograde pyelogram demonstrates tiny filling defects (arrows). Surgical pathology from left nephroureterectomy revealed extensive ureteritis cystica. No evidence of malignancy.

Background
- Benign condition of the ureters representing small submucosal epithelial-lined cysts in the wall of the renal pelvis and ureter
- Typically seen in diabetics with recurrent urinary tract infection: more frequently in older patients and woman

Pathology
- Cystic degeneration of epithelial cell nests invaginating into the lamina propria
- May be associated with inflammation

Imaging features
- CT urography: Multiple, 2–3 mm, smooth filling defects in the ureter; can cause characteristic scalloping of the ureteral margins when seen in profile
- Most commonly seen in the proximal third of the ureter
- Typically scattered and discrete but can found in clusters
- Usually seen without hydronephrosis
- Typically more numerous and similar-sized filling defects than multifocal urothelial cancer

Treatment
- Treat underlying infection
- Lesions may remain stable or regress after treatment
Fungus ball

Fungal ball. 56 year-old female with history of diabetes who presents with dysuria. Coronal contrast-enhanced CT in the excretory phase demonstrates heterogeneous soft tissue attenuation filling defect containing gas in the left renal pelvis (*). Moderate hydronephrosis was also noted. Nephrostomy tube was placed, through which amphotericin B was infused. Subsequently, the fungal ball was removed with pathology demonstrating fungal yeast colonies with features suggestive of candida.

Imaging features
- US: echogenic masses within renal collecting system without acoustic shadowing; in several cases, the echogenicity is greater than adjacent renal parenchyma
- CT: Irregular filling defect of soft tissue attenuation in the collecting system

Differential Diagnosis
- Calculi
- Urothelial cancer
- Blood clots
- Papillary necrosis

Teaching Points
- Consider fungus ball when encountering renal or ureteral filling defects in an immunocompromised person

Background
- Kidneys are the most commonly involved organ in systemic candidiasis
- The kidney may be involved by hematogenous dissemination or by ascending infection in the urine
- Predisposing factors: pregnancy, debilitation, diabetes, malignancy, antibiotic, steroid, or immunosuppressive therapy
Tuberculosis

Renal tuberculosis. 50 year-old male with chronic right lower quadrant pain. A and B. Axial and coronal contrast-enhanced CT demonstrates focal caliectasis of the upper pole right kidney (black arrow) with urothelial enhancement (white arrow) and delayed nephrogram. C. There is also focal urinary wall thickening of the left lateral wall with mucosal enhancement (blue arrow). Urine cultures were positive for *Mycobacterium tuberculosis*.

**Background**
- Most common site of extrapulmonary involvement: accounts for 15-20% of infections outside of the lung, 25% of patients will have a history of prior pulmonary TB
- Hematogenous seeding of *M. tuberculosis* in the glomerular and peritubular capillary bed from pulmonary site of infection
- Genitourinary tuberculosis is a descending urinary tract infection where the infection can spread to the ureters and bladder inferiorly, unlike most infections which are ascending urinary tract infections

**Presentation**
- Frequent voiding, dysuria, hematuria, back, flank or abdominal pain
- Often long latency period between initial infection and presentation

**Imaging features**
- Renal: striated nephrogram, single or multiple parenchymal nodules (pseudotumoral type) in the cortex
- Collecting system:
  - Early: uneven caliectasis and papillary necrosis caused by varying degrees of fibrosis and obstruction (most characteristic), hydronephrosis, wall thickening, enhancement
  - Late: calcifications in chronic or treated tuberculosis, multiple thin-walled cysts, “putty kidney” - dystrophic calcifications of the kidneys, pelvoinfundibular strictures
Papillary necrosis

22 year-old male with type 1 diabetes mellitus and sickle cell anemia who presents with gross hematuria. Coronal excretory phase CT demonstrates mild bilateral hydronephrosis with filling defects (*) within the left renal collecting system secondary to sloughed necrotic papillae. The calyces are also blunted (arrow).

**Etiologies**
- Diabetes
- Analgesic abuse or overuse
- Sickle cell disease
- Pyelonephritis
- Renal vein thrombosis
- Tuberculosis
- Obstructive uropathy

**Imaging features**
- Early phases of papillary necrosis best seen in the nephrographic phase where small areas of hypoenhancement at the tip of the medullary pyramid may be detected = necrotizing papillitis
- Calyceal deformities occur in three forms:
  - Medullary: central necrosis at the tip of the pyramid
  - Papillary: Detachment of necrotic papillae starts at the calyceal fornices and can result in lobster claw sign; if necrotic papillary tip remains in the calyx → signet ring sign when calyx is filled with contrast material
  - In situ: Necrotic papilla remains attached and may become calcified
- Healing phase: papillae may epithelialize → blunting of calyces

**Background**
- Ischemic necrosis of the renal papillae
- Condition that can arise from various diseases that induce chronic tubulointerstitial nephropathy which predominantly affects the inner medulla
- Result of impaired vascular supply leading to focal or diffuse ischemic necrosis of the renal medulla and pyramids which are particularly vulnerable to ischemic necrosis
Median Lobe Hypertrophy

**Background**
- Enlarged prostate may protrude into the bladder base and simulate a mass arising from the bladder
- Enlargement of the prostate is more commonly benign

**Presentation**
- Can present with bladder outlet obstruction

**Anatomy**
- Lateral lobes: zone most commonly involved in BPH is the transition zone
- Median lobe: deep glands of the periurethral zone

**Imaging features**
- US/CT: most important feature to identify is the site of origin
- MR: round nodules of varying size and high T2 signal intensity and variable amounts of low T2 signal intensity depending on the degree of glandular and stromal tissue

**Median lobe hypertrophy.** A and B. Axial and coronal contrast-enhanced CT in the excretory phase demonstrates a heterogeneously enhancing mass (*) contiguous with the prostate but also appears to possibly arise from the urinary bladder wall. Transurethral resection was performed and demonstrated no evidence of malignancy. C and D. Axial and longitudinal grey scale images of the urinary bladder demonstrates a polypoid mass (*) protruding into the urinary bladder and contiguous with the prostate due to median lobe hypertrophy.
**Cystitis**

**Hemorrhagic cystitis.** 69 year-old female with a history of cervical cancer status post chemoradiation who presents with hematuria. A. and B. Noncontrast and excretory phase CT demonstrates intrinsically hyperdense material layering in the posterior aspect of the urinary bladder (arrow). Cystoscopy demonstrated multiple varicosities, some that were actively bleeding, as well as abnormal thickened epithelium along the posterior wall. In the acute phase of hemorrhagic cystitis, there is denudation of the urothelium with abnormal focal or diffuse bladder wall thickening. Hypervascularity and bleeding vessels are commonly seen. In the chronic phase, fibrotic changes result in a small, thick-walled urinary bladder.

**Granulomatous cystitis.** 46 year-old male who presents with hematuria. C. Non-contrast CT demonstrates diffuse bladder wall thickening and intrinsic high density material within the urinary bladder (*). Foley catheter is also noted. Full thickness biopsy demonstrated granulomatous cystitis. No evidence of malignancy.

**Urothelial carcinoma.** Axial excretory CT urogram image demonstrates an ill-defined lobulated soft tissue mass in the posterior wall (dotted line) and a thick-walled bladder diverticulum (*) containing high density material surrounded by inflammatory stranding. Cystoscopy revealed a large sessile mass, biopsy proven urothelial carcinoma, with a large diverticulum full of organized, lamellated clot.
Cystic lymphangioleiomyomatosis

Background
- Benign proliferation of smooth muscle (lymphangioleiomyomatosis cells)
- Can lead to gradual obstruction of lymphatics
- Most often seen in premenopausal women
- Seen in 21% of cases of patients with lymphangioleiomyomatosis (LAM)

Presentation
- When large, can compress adjacent organs and cause back pain, abdominal pain, urinary frequency, with worsening symptoms over the course of the day

Imaging features
- Locations: retroperitoneum near the abdominal aorta, the mesentery, and the renal arteries
- Diurnal variation in size: increases during the day and shrinks during the night; theorized to be secondary to increased lymph flow during the day due to increase in chyle production after meals, increase in lymphatic return from the lower extremities during the day from activity, and gravitational effect from increased intraluminal pressure when the patient is upright rather than supine; distinguishing feature from malignancy
- US: Change in echotexture between morning and afternoon
- CT: Complex cystic retroperitoneal masses along the lymphatic system
- Associations: pulmonary thin-walled cysts, pleural effusion, pneumothorax, renal angiomyolipomas, lymphadenopathy, chylous ascites
- Demonstrates delayed enhancement, unlikely necrotic lymphadenopathy

Differential Diagnosis: Lymphoma, retroperitoneal sarcoma, ovarian malignancy, tuberculous adenopathy
Retroperitoneal fibrosis

**Background**
- Most cases are idiopathic, remainder of cases are associated with inflammation, malignancy, medications
- Spectrum of diseases characterized by fibroinflammatory tissue surrounding the abdominal aorta and iliac vessels

**Presentation**
- When large, can cause symptoms related to mass effect (back pain, abdominal pain)
- Men are 2-3x more likely to develop the disease
- In the majority of cases, the fibrosis involves the ureters and results in obstructive uropathy → present with decreased urinary excretion

**Treatment**
- Surgical relief of urinary obstruction, steroids

**Imaging Features**
- Locations: retroperitoneum near the abdominal aorta from the renal arteries to the iliac vessels and often progresses to encase the ureters and IVC, lies anterior and lateral to the aorta, does not cause aortic displacement
- Similar attenuation to skeletal muscle, enhancement depends on stage of disease

**Teaching Points**
- Features that favor RPF over lymphoma: pelvic extension, medial ureteral bowing
- Features that favor lymphoma over RPF: predominantly suprarenal location, perirenal extension, anterior aortic displacement, lymphadenopathy, larger size, heterogeneity on T2-weighted and post-contrast images, lower ADC
Anterior Fibromuscular Stroma

Background
- Fibromuscular tissue anterior to the transition zone, contiguous with the bladder smooth muscle and the skeletal muscle of the sphincter
- Contains no glandular tissue
- Becomes less prominent with age when enlargement of the transition zone due to benign prostatic hyperplasia compresses this area

Imaging features
- Markedly low T2 signal intensity and low ADC due to its compact muscle and fibrous composition
- Often hypovascular, possibly due to its fibrous nature

Teaching Points
- The anterior fibromuscular stroma becomes less prominent in men with increased age and gland size, likely due to the compressive effect of benign prostatic hyperplasia
- When bulky, the anterior fibromuscular stroma may mimic anterior tumor in its lentiform morphology, low T2 signal intensity, and low ADC
- The distinguishing feature of normal anterior fibromuscular stroma is its midline and symmetric position

Anterior fibromuscular stroma. A. Bulky T2 hypointense region (arrow) in the anterior midline with associated restricted diffusion (arrow) on B. DWI and C. ADC map images, which may mimic features of prostate cancer. However, its characteristic location hints that this is a normal anatomical structure.
Central Zone

Background
- Central zone is the tissue that surrounds the ejaculatory ducts between the peripheral and transition zones from the posterior base of the prostate superiorly to the verumontanum inferiorly
- Volume of central zone decreases with age
- Tumor in the central zone is rare, 0.5-2.5% of prostate cancer and associated with more aggressive tumors
- Enlargement of the transition zone can lead to compression of the central zone and increased displacement to the base

Imaging features
- Homogeneously hypointense on T2-weighted images and dark on ADC maps
- Typically the symmetric appearance of the central zone on either side of the midline and its expected location near the base helps to differentiate it from prostate cancer; however, in 20% of cases, the central zone is asymmetric
- Coronal images: Triangular shape with the prominent portion at the base and the apex at the verumontanum
- Axial images: Single confluent structure or two dumbbell-shaped lobes

Central zone. A. T2-weighted MR image and B. ADC map demonstrate a focal area of T2 hypointensity at the left posterolateral aspect of the prostate gland near the base with associated low ADC (white arrow). The area is adjacent to and surrounding the ejaculatory ducts (black arrows). Identification of this characteristic location is key to recognizing that this represents the central zone, a normal anatomical structure of the prostate.
Granulomatous Prostatitis

Granulomatous prostatitis. 63 year-old male with a history of bladder cancer status post intravesical BCG therapy, who presents with an elevated PSA. A. T2-weighted MR image, B. diffusion-weighted image, C. ADC map, and D. post-contrast T1-weighted image demonstrate a T2 hypointense right posterolateral peripheral mid gland lesion with marked restricted diffusion and rim-enhancement, consistent with PI-RADS 5/5 suspicion level (arrows). Targeted MR-US fusion biopsy showed benign prostatic stroma with extensive necrosis and chronic inflammation. The presence of necrosis and chronic inflammation composed of mostly lymphocytes and plasma cells was likely related to prior BCG therapy.

**Background**
- Presents with firm nodule on digital rectal examination and elevated PSA
- Causes: idiopathic, intravesical bacille Calmette-Guérin (BCG) therapy for bladder cancer, tuberculosis prostatitis, and previous intervention such as transurethral resection of the prostate

**Imaging Features**
- Discrete mass with decreased T2 signal intensity and ADC
- Inflammation may spread into the periprostatic fat and mimic extraprostatic extension of tumor
- Areas of non-enhancement within the lesion corresponds to caseous abscess on pathology
Prostate Postbiopsy Hemorrhage

A. T2-weighted MR image of the prostate demonstrate wedge-shaped areas of T2 hypointensity in the right lateral and left posterolateral peripheral gland, which may be mistaken for tumor (arrows). B. T1-weighted MR image demonstrates that these regions correspond to intrinsic T1 hyperintense signal secondary to blood products from recent biopsy (arrows). In addition, the wedge-shaped features of these areas is more supportive of a non-neoplastic etiology.

Etiology
- The prostate produces citrate which helps to preserve semen and acts as an anticoagulant
- The alterations in signal intensity produced by hemorrhage from prostate biopsy may mimic or obscure an underlying suspicious lesion
- In general, it is recommended to delay prostate MRI after biopsy to allow for the hemorrhage to resolve with many institutions advocating a delay of 6 to 8 weeks after biopsy
- Hemorrhage is more commonly seen in the peripheral zone than transition zone

Imaging features
- Hemorrhage: T1 hyperintense, T2 hypointense, can show restricted diffusion depending on the age of hemorrhage
- In general, prostate cancer has lower ADC than hemorrhage in benign peripheral zone
- MRI hemorrhage exclusion sign: As tumor has a lower amount of citrate compared to normal tissue, tumor will bleed less than normal prostate. Therefore, post-biopsy hemorrhage within normal tissue can be helpful in outlining the margins of the tumor

Teaching Points
- In the setting of hemorrhage, DWI and dynamic contrast enhanced MRI is helpful in localizing tumor
Stromal Benign Prostatic Hyperplasia

**Background**
- 30% of prostate cancer arises from the transition zone
- Benign prostatic hyperplasia (BPH): enlargement of the transition zone due to hyperplasia of the prostatic stromal and epithelial cells
- Two histologic subtypes of BPH: glandular and stromal
- Overlap in imaging appearance between stromal BPH nodules and transition zone tumors
- BPH nodules can be extruded into the peripheral zone and mimic peripheral zone tumor, but in general, their well-defined, rounded appearance and heterogeneous T2 signal point towards BPH rather than prostate cancer

**Imaging features**
- T2 signal intensity ranges from hyperintense to hypointense depending on the ratio of glandular to stromal tissue
- Glandular BPH: T2 hyperintense due to fluid content, does not mimic prostate cancer
- Stromal BPH: T2 hypointense similar to tumor, restricted diffusion and early enhancement, well-defined, round encapsulated appearance
- Transition zone cancer: homogeneous low signal intensity with ill-defined margins (erased charcoal sign), lack of capsule, lenticular shape, invasion of anterior fibromuscular stroma

Stromal BPH. A. T2-weighted MR image, B. ADC map, and C. DWI image demonstrate a focal area of decreased T2 signal in the left transition zone with associated restricted diffusion (arrows). Although its low ADC signal is prominent, its well-encapsulated margins suggest that this is a stromal BPH nodule, which was later confirmed on biopsy.
Epididymo-orchitis

Background
- About 20-40% of patients with epididymitis progresses to epididymo-orchitis
- In men who are sexually active and younger than 35 years, *Neisseria gonorrhoeae* and *Chlamydia trachomatis* are the most common pathogens
- In children and men who are older than 35 years, *E.coli* is the most common

Presentation
- Scrotal swelling, erythema, fever, dysuria

Complications
- Testicular ischemia/infarction: testicular edema may compromise testicular venous outflow → In cases of severe epididymo-orchitis, relatively avascular areas within a hyperemic testis or epididymis suggests focal infarction
- Intratesticular and scrotal abscess formation: Central region of liquefaction appears as a more hypoechoic focus with a lack of flow centrally
- Diffuse heterogeneous echotexture of the testis can mimic infiltrating tumor

Teaching points
- Areas of infection often have increased color flow relative to that of the normal testis, similar to neoplasms. However, patients with focal orchitis usually present with acute pain and may have a fever and elevated WBC.
- Follow-up imaging in 2–4 weeks can help clarify the diagnosis because areas of focal orchitis would be expected to improve with antibiotic therapy.
**Sarcoidosis**

**Background**
- Most common finding is epididymitis, with bilateral involvement in 1/3 of cases
- Isolated involvement of the testis is very rare

**Teaching Points**
- Consider sarcoidosis in cases of multiple intratesticular and epididymal masses in an African American patient
- In a patient with systemic sarcoidosis, consider inguinal approach open biopsy over orchiectomy

**Imaging features**
- US: enlarged epididymides; multiple bilateral hypoechoic intratesticular nodules
- MR: low signal on T2 and enhancement

**Sarcoidosis.** Grey scale US images demonstrate multiple bilateral hypoechoic intratesticular masses with enlarged epididymides replaced with hypoechoic masses. Internal vascularity was noted within the masses (not shown). This patient was a 48 year-old African American male with biopsy proved thoracic sarcoidosis. Tumor markers for testicular neoplasm were unremarkable. Follow-up US demonstrated stability of these findings.

**Treatment**
- Steroid treatment is recommended only for systemic sarcoidosis unless patient has bilateral involvement
- Clinical response to steroids has been reported

**Differential Diagnosis**
- Germ cell tumors
- Sex cord stromal tumors
- Leukemia
- Lymphoma
- Metastases
- Granulomatous disease (sarcoidosis and tuberculosis)
- Adrenal rests
- Leydig cell hyperplasia
Leydig Cell Hyperplasia

Leydig cell hyperplasia. 43 year-old male presents for infertility work-up. Grey scale US image demonstrates a 4 mm oblong hypoechoic mass in the periphery of the upper pole of the right testis (arrow). Surgical biopsy was performed and demonstrated a Leydig cell nodule and no evidence of malignancy.

Background
- Usually asymptomatic in adults, but the childhood form may lead to precocious puberty from hormone secretion
- In contrast to Leydig cell hyperplasia, Leydig cell tumors are often symptomatic, being frequently hormonally active
- Typically not palpable

Pathogenesis
- Faulty hypothalamic–pituitary–testicular axis with resultant chronic Leydig cell stimulation
- Increased number of Leydig cells

Imaging features
- Nodules often occur bilaterally and range in size from 1 to 6 mm
- US: hypoechoic or hyperechoic, variable vascularity
- MR: multiple, bilateral solid lesions that are hypointense on T2-weighted images relative to normal testicular parenchyma, mild to avid contrast enhancement

Teaching Points
- Consider Leydig cell hyperplasia in the differential diagnosis of small subcentimeter multifocal testicular lesions
Mimics of Testicular Malignancy

A. **Epidermoid cyst.** Hypoechoic intratesticular mass with “onion ring” appearance of concentric hyperechoic and hypoechoic layers, no internal vascular flow, and a well-defined rim. This recognition alerts the urologist to the possibility of an epidermoid cyst, which may result in testis-sparing surgery, rather than orchiectomy.

B. **Testicular adrenal rests in a patient with congenital adrenal hyperplasia.** Peripherally located hypoechoic mass with a similar lesion in the contralateral testis. Increased corticotropin in congenital adrenal hyperplasia can prevent involution and cause these adrenal rest cells which become trapped in the gonad during testicular development, to become adrenal rest tumors.

C. **Testicular cavernous hemangioma.** Partially cystic mass in a spongy pattern with both arterial and venous waveforms on color Doppler imaging. The diagnosis of testicular cavernous hemangioma was confirmed on surgical pathology.

D. **Testicular lipomatosis.** Multiple hyperechoic foci throughout the bilateral testes in a random distribution and without posterior acoustic shadowing, increased vascularity, or distortion of the testicular contour. Testicular lipomatosis is a non-neoplastic condition in which multiple fat-containing hamartomas are seen in the bilateral testes. This entity has been described in patients with Cowden disease, a rare autosomal dominant condition characterized by hamartomas and neoplasms in several organ systems.
• Malignancy in the genitourinary system is one of the top differential diagnoses, presenting with a variety of focal or diffuse imaging manifestations. However, many non-neoplastic diseases can present with similar patterns on imaging.
• An understanding of normal variants and alternate diagnoses can reduce the frequency of malignancy misdiagnoses.
• As radiologists play a central role in diagnosis and management, consideration of these non-neoplastic pathologies can help avoid unnecessary surgical intervention.