

Male Reproductive System

ANATOMY OF THE MALE REPRODUCTIVE SYSTEM

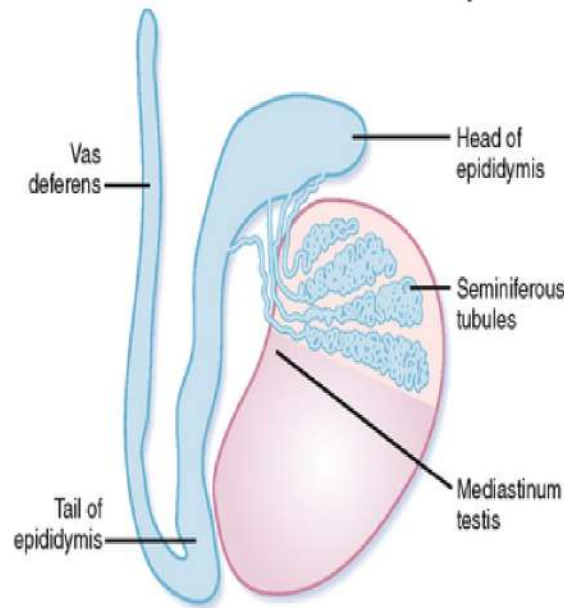
Testis and Epididymis

The testes develop in the retroperitoneum during early fetal development. Each testis is attached to the inferior scrotal wall by the *gubernaculum testis*, which does not grow significantly in length as the rest of the fetus develops. As a result, the testes are tethered to the scrotum. As the torso grows, the spermatic cord stretches in length, maintaining the vascular supply in the form of the testicular artery and vein, and maintaining the reproductive pathway through the vas deferens. Thus, although this process is often described as the testes “descending” into the scrotum during the second month of gestation, it may be more accurate to say the fetal abdomen grows away from the testis. In adulthood, the gubernaculum remains as a part of the mesentery-like structure that maintains appropriate orientation of the testis within the scrotum. Redundancy of this mesorchium results in the “*bell-clapper*” deformity that increases the risk for testicular torsion. If there is more complete failure of scrotal attachment, the result is an “undescended testis,” which is more appropriately termed *cryptorchidism*.

A portion of the peritoneal space is trapped by the testis and gubernaculum. This pocket of peritoneum is called the *processus vaginalis* and typically obliterates late in development. Persistent communication of the processus vaginalis with the peritoneal space provides a pathway for peritoneal fluid and disease to descend into the scrotum. Discontinuous areas that fail to obliterate result in noncommunicating hydrocele

Each testis receives arterial supply from a testicular artery that arises from the abdominal aorta. The *pampiniform plexus* is a network of veins that provide venous outflow along the spermatic cord, ultimately uniting to form a single testicular vein on each side. The left testicular vein courses along the retroperitoneum from the inguinal canal to the left renal vein. The right testicular vein usually joins the inferior vena cava at the level of the inferior pole of the right kidney, although it does occasionally join the right renal vein.

Testicular parenchyma consists primarily of *seminiferous tubules* where spermatogenesis takes place. These are soft, convoluted tubular structures that resemble strands of spaghetti several microns in diameter. The tubules are compacted together and are encapsulated within the tunica albuginea, giving the testis its ovoid shape ([Fig. 20-1](#)). A small incision or laceration in the tunica allows the seminiferous parenchyma to spill out like spaghetti from a plastic bag. The mediastinum testis is a septum that runs within the testicular parenchyma, providing a lattice for the vascular structures and efferent ductules that carry sperm from the seminiferous tubules to the epididymis



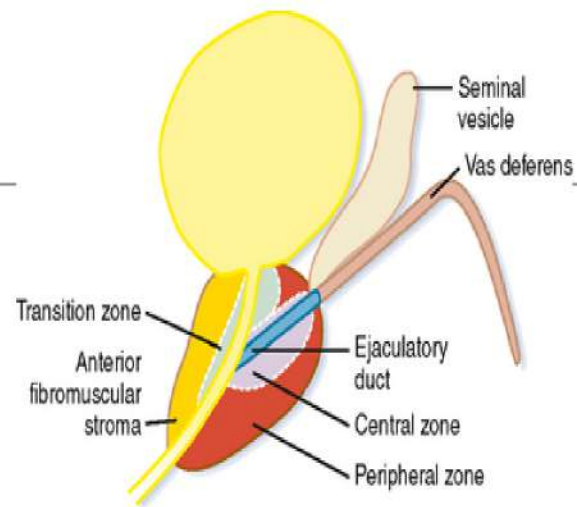
Schematic illustration of anatomy of the testis and epididymis

Sperm travels through the mediastinum testis to the head of the epididymis, which also consists of multiple tubular structures. These tubules begin to coalesce into more organized, straightened tubules in the epididymal tail until they finally channel into a single tube, the *vas deferens*. The vas deferens courses along the spermatic cord to the internal inguinal ring. Once inside the pelvis, it deviates away from the gonadal vessels, and travels inferior and medial to insert into the ejaculatory ducts near the ostium of the ipsilateral seminal vesicle.

Prostate and Seminal Vesicles

The prostate has an inverted cone shape. As such, the base of the prostate is cranial and the apex is caudal. The bladder sits atop the prostatic base, with the seminal vesicles situated between the posteroinferior bladder wall and rectum. The urogenital diaphragm delineates the caudal-most border of the prostatic apex. The prostate gland is separated from the rectum posteriorly by *Denonvilliers (rectovesical) fascia*. Santorini's plexus of veins (a venous plexus that surrounds the ventral and lateral prostate gland) and the pubic symphysis border the prostate anteriorly. The levator ani complex borders the lateral walls of the prostate caudally; the obturator internis muscles abut the lateral margin more cranially.

The prostate gland can be divided into one-third nonglandular and two-thirds glandular elements. The nonglandular components of the gland consist primarily of the anterior *fibromuscular stroma* and *prostatic urethra*. The fibromuscular stroma is located directly anterior to the urethra and includes the majority of the anterior lobe of the prostate ([Fig. 20-2](#))



Schematic illustration of prostatic anatomy in the sagittal plane.

The bladder neck enters the base of the prostate centrally to join the proximal prostatic urethra. The ejaculatory ducts enter the prostatic urethra at a posterior mound called the *verumontanum*, defining the beginning of the distal prostatic urethra.

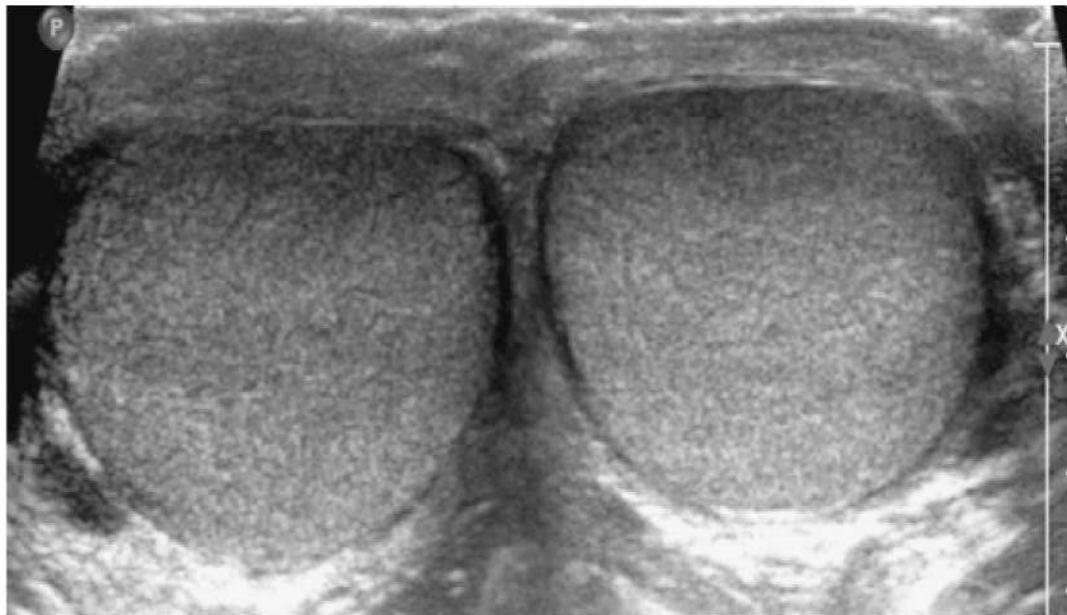
The glandular components of the prostate consist of the *peripheral zone*, *central zone*, *transitional zone*, and *periurethral glandular tissues*. The peripheral zone is localized around the posterior periphery of the gland and extends anterolaterally toward the anterior fibromuscular stroma but does not surround it. It contains and surrounds the entire posterolateral aspect of the gland, similar to a baseball mitt holding a baseball. In young men, the peripheral zone comprises approximately 70% of the prostate and envelops the entire central gland, which consists of the transitional zone, central zone, and periurethral glandular tissue. The transitional and central zones comprise approximately 5% and 25% of the gland, respectively, in the young male individual. As men age, this ratio inverts with the transitional zone taking up the majority of the central glandular tissue as it undergoes significant proliferative changes resulting in benign prostatic hyperplasia (BPH). Hyperplastic changes in the transitional zone and periurethral glandular tissues compress the central zone against the surrounding peripheral zone into a thin rim resulting in the surgical pseudocapsule. This pseudocapsule is separate and different from the true fibrous capsule, which is a 2- to 3-mm fibromuscular layer that encapsulates the external surface of the prostate. The surgical pseudocapsule serves as the surgical plane for transurethral prostatectomy often used for treatment of BPH.

NORMAL IMAGING APPEARANCE OF THE MALE REPRODUCTIVE SYSTEM

Scrotal Contents

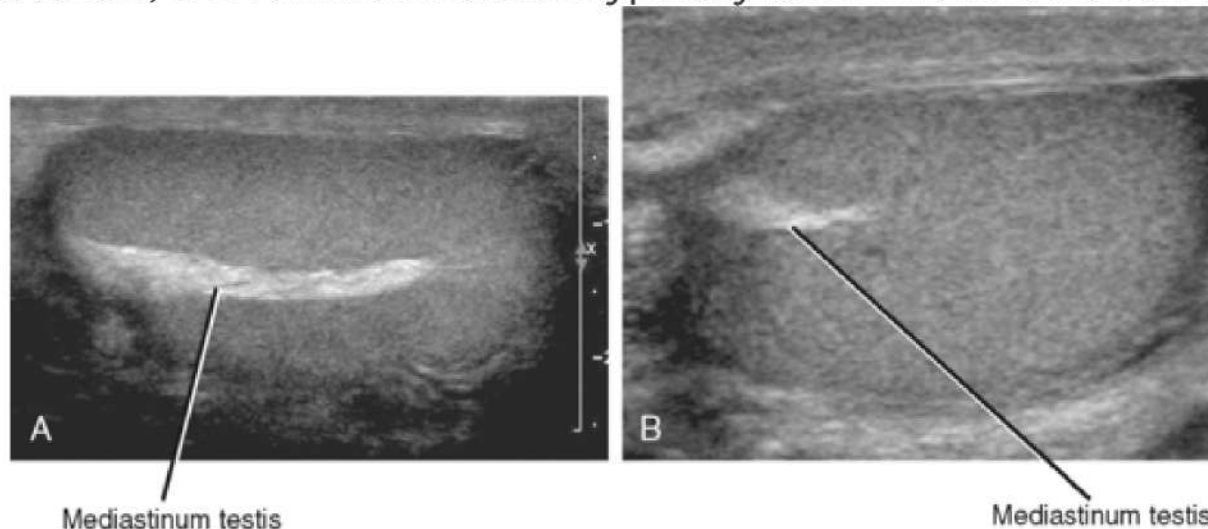
Not only does the design of the scrotum provide a climate conducive to spermatogenesis, but it also places the testes and paratesticular tissues in a location convenient to physical inspection and evaluation by ultrasound (US). Because of wide availability of high-resolution transducers with excellent near-field resolution and color, spectral, and power Doppler, nearly all scrotal imaging is performed by sonography. Because no ionizing radiation is involved, serial examinations can be performed to evaluate disease progression or regression without concern for patient safety

By US, each testis is an ovoid structure that is homogenous and mildly hypoechoic compared with the sparse adjacent soft tissues ([Fig. 20-3](#)). Because it is not possible to compare the echogenicity of the testes with other organs, it may be difficult to identify diffuse bilateral abnormalities of echogenicity. Fortunately, most testicular disease processes result in focal, multifocal, or diffuse unilateral abnormalities.

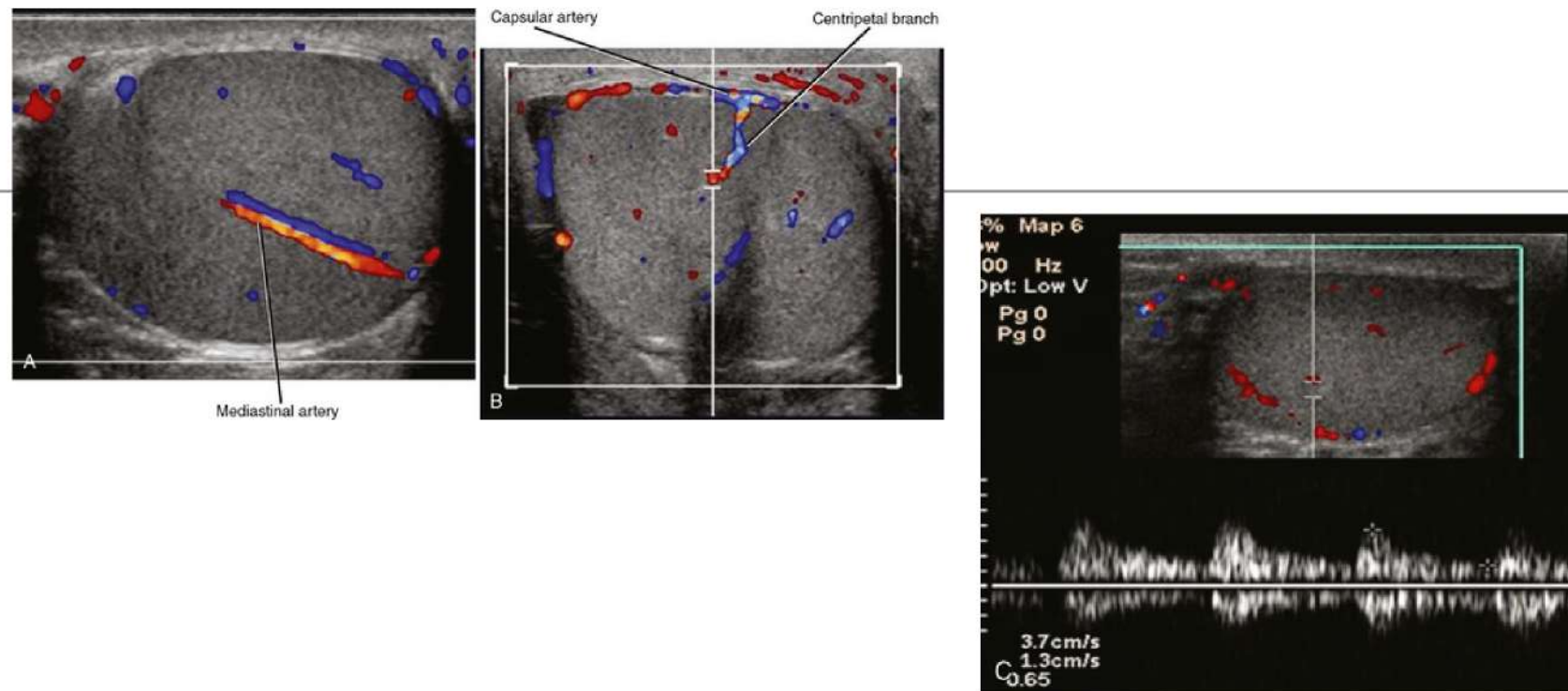


Normal “buddy shot.” Transverse ultrasound image includes both testes, allowing comparison of echogenicity between the two.

An echogenic line (the *mediastinum testis*) can usually be identified with US, bisecting the testis along its long axis asymmetrically ([Fig. 20-4](#)). A mediastinal artery is visible about 50% of the time and can mimic a small cyst or mass when viewed in cross section. Elongating the vessel and use of color Doppler imaging confirm the vascular nature of this finding ([Fig. 20-5](#)). Capsular arteries underlie the tunica albuginea and give rise to centripetal branches that radiate inward. Spectral Doppler demonstrates a low-resistance arterial waveform, with resistive indices typically between 0.50 and 0.75

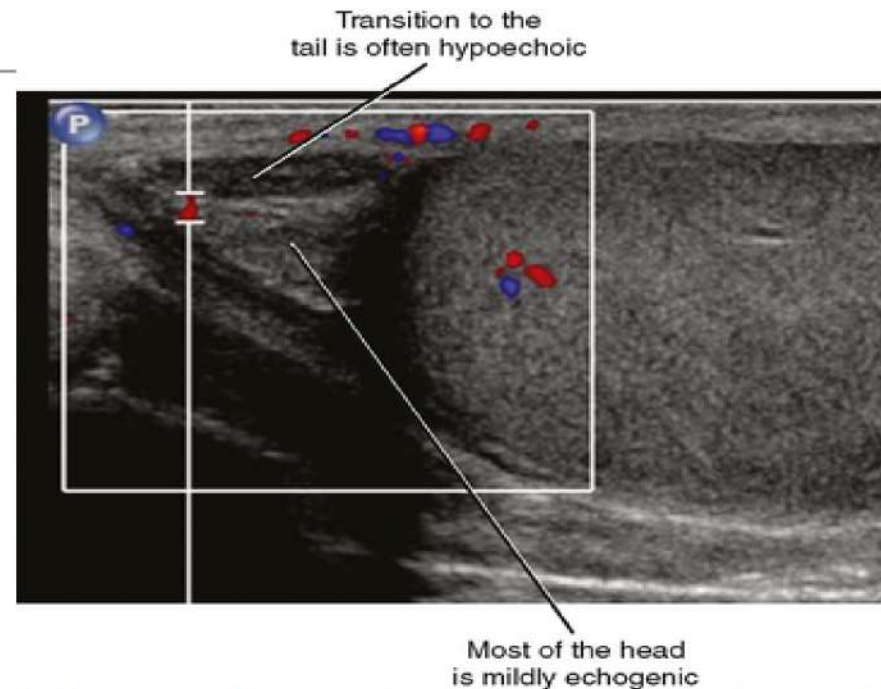


Mediastinum testis. **A**, Sagittal ultrasound image of the testis demonstrates an echogenic line representing the fibrofatty tissue of the mediastinum testis. **B**, Transverse image demonstrates a typical eccentric location. This example is slightly more pronounced than typical but is not abnormal



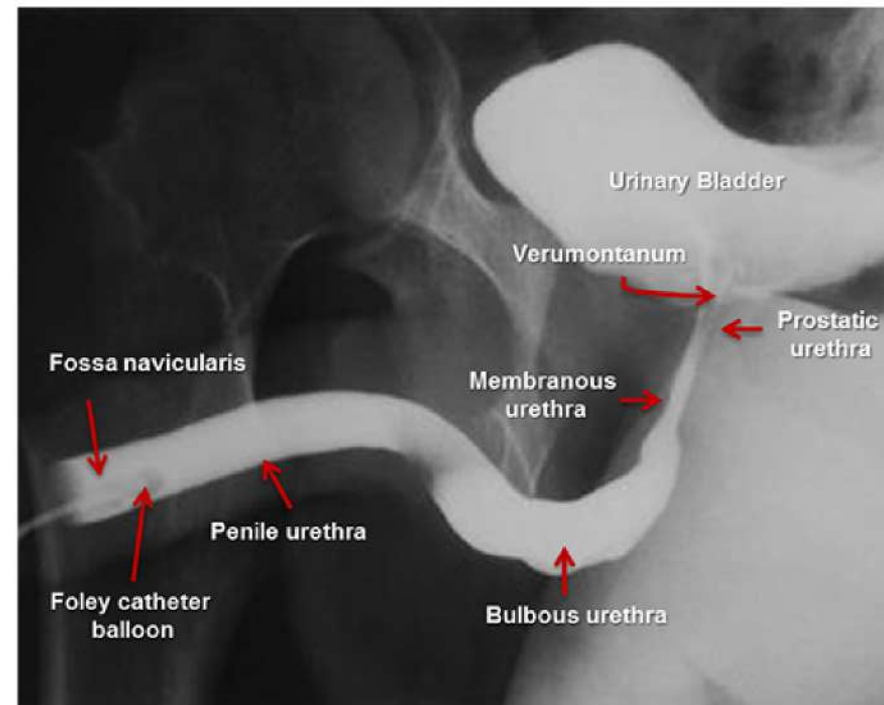
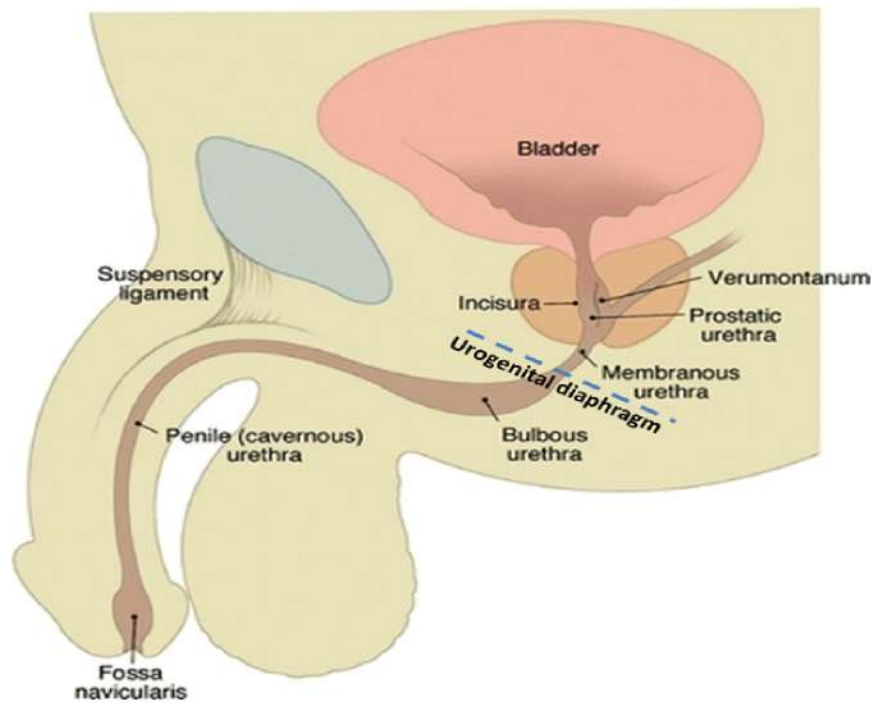
Ultrasound evaluation of arterial flow in the testis. **A**, Transverse ultrasound image with color Doppler imaging demonstrates mediastinal artery and vein. **B**, Color Doppler imaging demonstrates capsular artery and centripetal branch. **C**, Spectral Doppler imaging demonstrates a normal low-resistance waveform

The head of the *epididymis* is seen on sagittal US images as a triangular, solid structure adjacent to the superior pole of the testis. Although the epididymal head is usually mildly echogenic compared with the testis, the tubules become more organized in the tail, which can render the tail hypoechoic. This can result in a “two-toned” appearance at the junction of the epididymal head and body ([Fig. 20-6](#)).



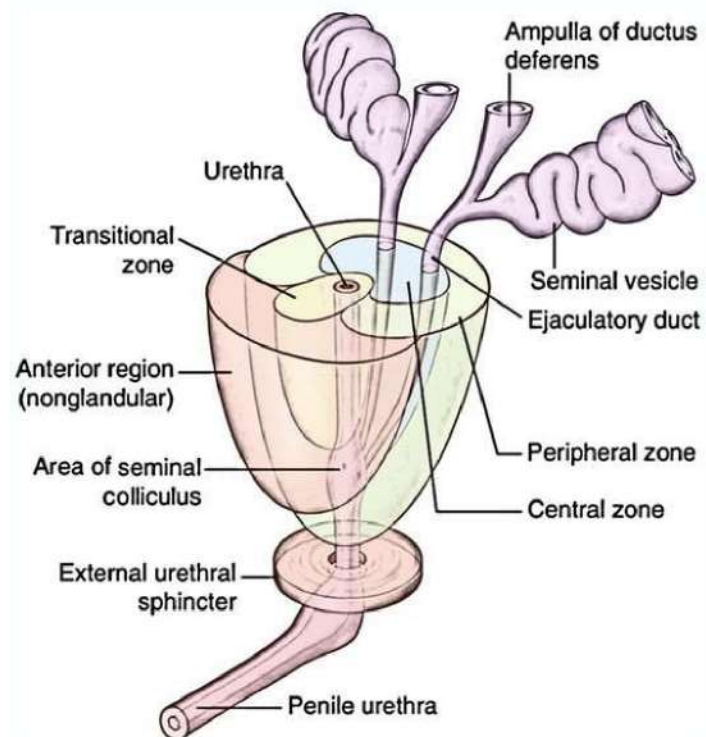
Sagittal ultrasound image demonstrates the head of the epididymis. This “two-toned” appearance from a mildly echogenic head to a hypoechoic tail is a normal finding and should not be mistaken for a mass.

Retrograde urethrography (RUG)



PROSTATE





Anatomy

Zonal anatomy

Scroll through the images to see the zones in which the prostate is divided:

- **Transition zone** surrounds the prostatic urethra. This zone enlarges in aging men resulting in benign prostatic hyperplasia.
- **Central zone** lies in the base of the prostate behind the transition zone and surrounds the left and the right ejaculatory duct.
- **Anterior fibromuscular stroma** is a small area of tissue that is situated on the anterior side of the prostate.
- **Peripheral zone** is situated on the posterior and lateral side of the prostate.

70-75% of all prostate cancers originate in the peripheral zone (PZ). The posterior aspect of this zone can be examined with digital rectal exam.

25% of prostate cancers originate in the transition zone (TZ).

Very few prostate cancers manifest in the central zone or in the anterior fibromuscular stroma.

Plain Radiograph

- Cannot be used to demonstrate localized disease in the prostate
- They are generally only needed in the first line evaluation of metastatic disease. (most skeletal metastases from prostate cancer – about 85% are osteoblastic and are visible as an area of abnormal radionuclide bone scan).
- Imaging with skeletal radiographs can help distinguish metastatic areas from degenerative disease.



X ray of the pelvis shows prostatic calcification with areas of sclerosis in the pelvis and proximal femur on both sides

CT Scan

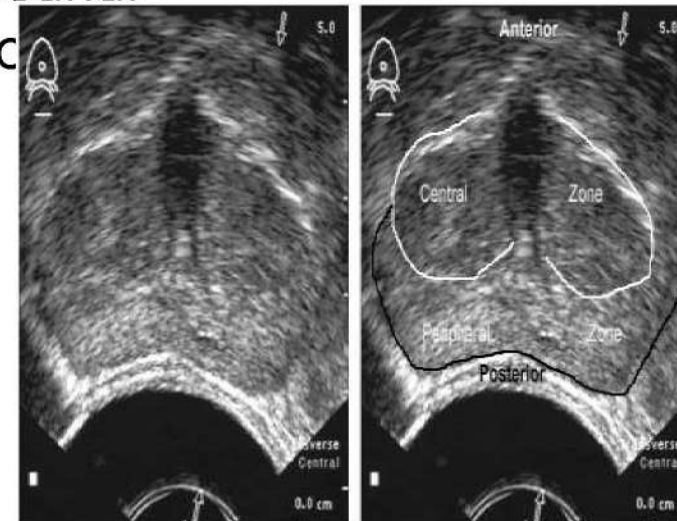
- Has **little value** in demonstrating **intraprostatic pathology** and in local staging
- However it may be **helpful** in detecting **metastatic disease** (such as **LN involvement** or **bone metastases**)
- It also **helpful** in detecting **invasive progression** of prostate carcinoma
- Nodal staging is indicated in
 - pt with a PSA value of 20 ng/ml or higher
 - Clinical stage T2b or higher
 - Gleason score of 7 or higher



Prostate cancer with rectal invasion

Ultrasound Prostate

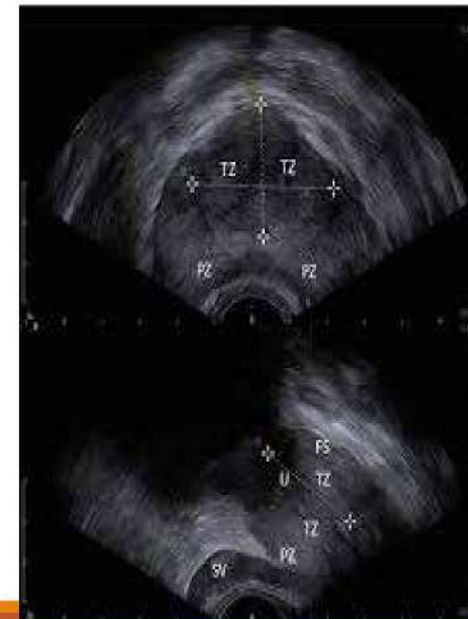
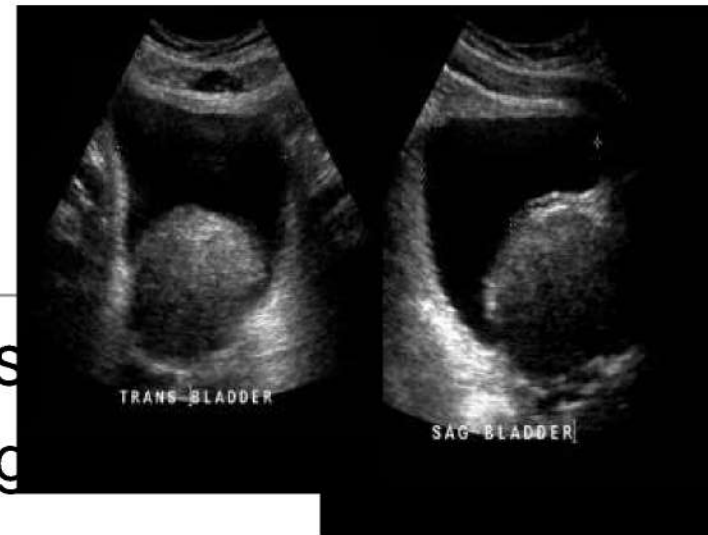
- Approach of ultrasound can be divided into :
 - TRUS (Transrectal Ultrasound)
 - TRAS (Transabdominal Ultrasound)
- Objective of Prostate Ultrasound
 - Size of gland
 - Overall echotexture
 - Focal lesion
 - Seminal vesicles
 - Vasa deferentia
 - Ejaculator ducts
 - Periprostatic fat

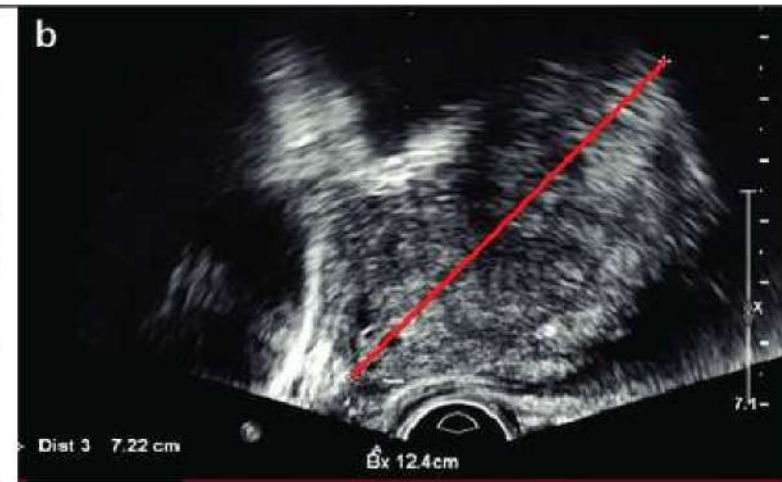
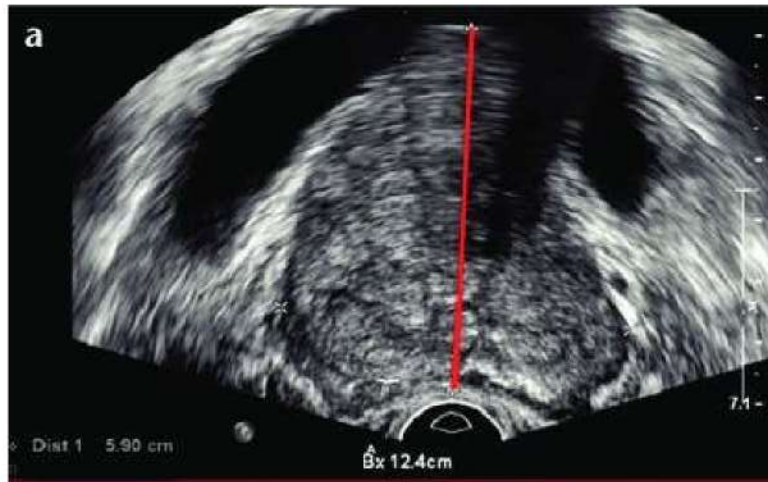


Normal TRUS: transverse scan

1) Prostate Volume

- Size of glands
 - Sagittal image
 - Transverse image
- $V : (0.52) \times L \times W \times H$
- Weight = Volume
- Normal : 7-16 grams
- Volume < 30 ml
(NORMAL)





Formula=
length×width×height×0.52

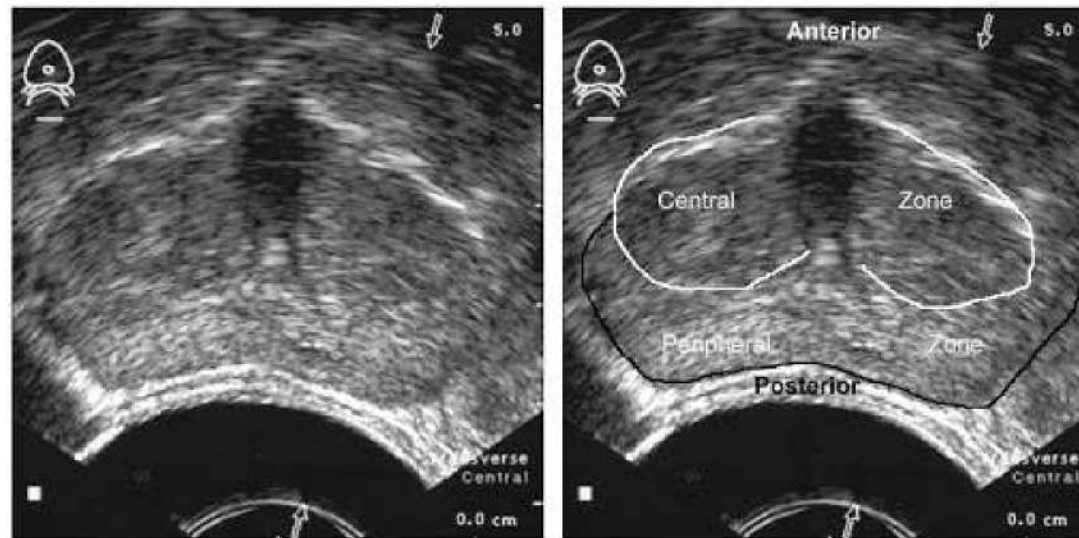
Estimated volume=
 $5.90 \times 5.65 \times 7.22 \times 0.52 = 125 \text{ mL}$

2) Echotexture of prostate

- Outer gland :
 - Iso-hyper echoic
- Inner gland :
 - Hypoechoic

Hyperechoic : (white on screen)
Hypoechoic : (gray on screen)
Anechoic : (black on screen)
Isoechoic : (same relatively)





Normal TRUS: transverse scan

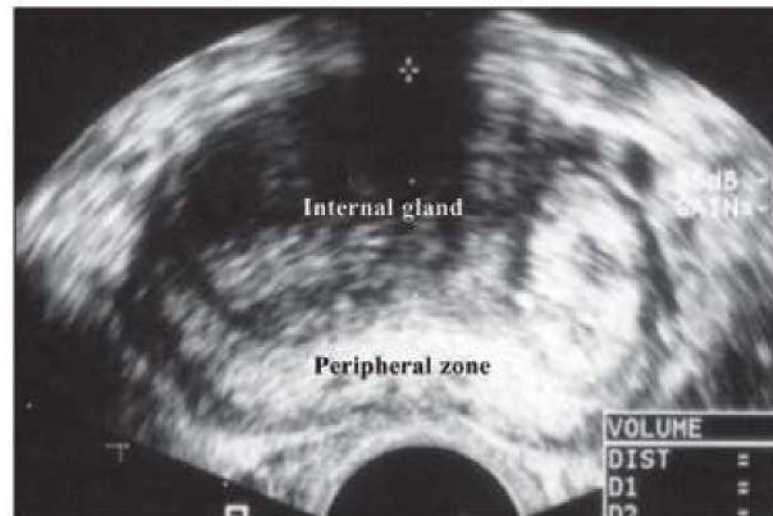
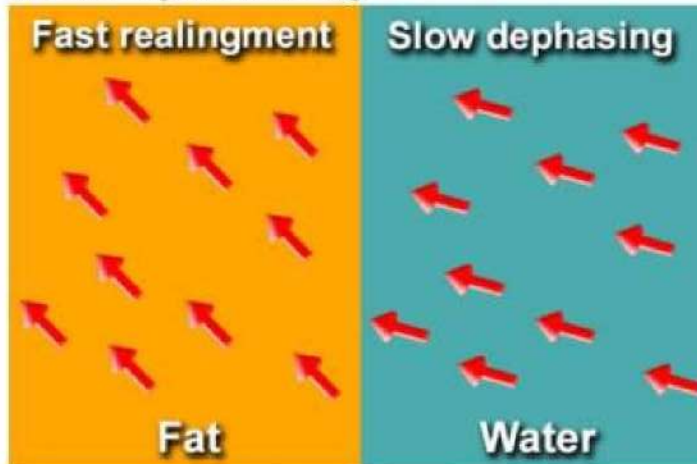


Figure 1. Normal aspect of the prostatic gland at ultrasound. Observe the homogeneous and more echogenic peripheral zone in relation to the central gland.

Tissue differentiation - Fat v water

Hover on/off image to show/hide findings



Click image to align with top of page

Tissue differentiation - Fat v water

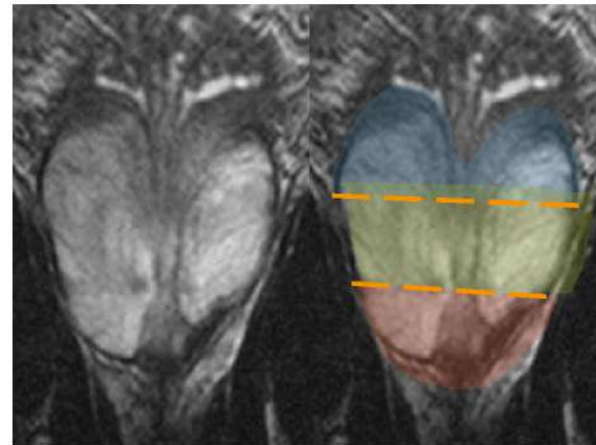
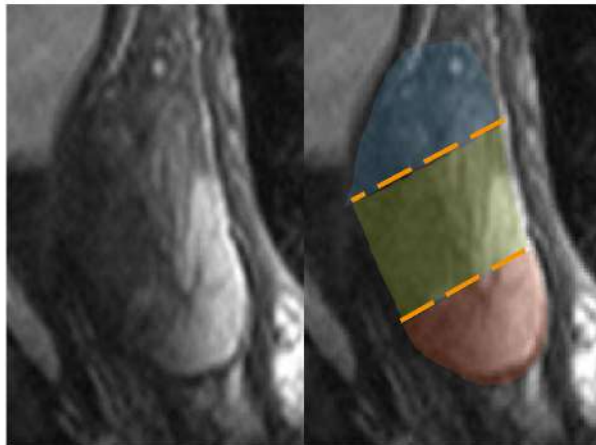
- ◆ Protons in the body realign and dephase with varying rapidity depending on the tissue type
- ◆ Detecting the signal after different time intervals allows different tissue types to be highlighted
- ◆ Protons in fat realign quickly with high energy and produce high T1 signal – this phenomenon is exploited to produce 'T1-weighted' images which highlight fat in tissues of the body
- ◆ Protons in water dephase slowly – this phenomenon is exploited to produce 'T2-weighted' images which highlight water in tissues of the body

Key points

- ◆ On **T1** images **FAT** is white
- ◆ On **T2** images both **FAT** and **WATER** are white

prostate

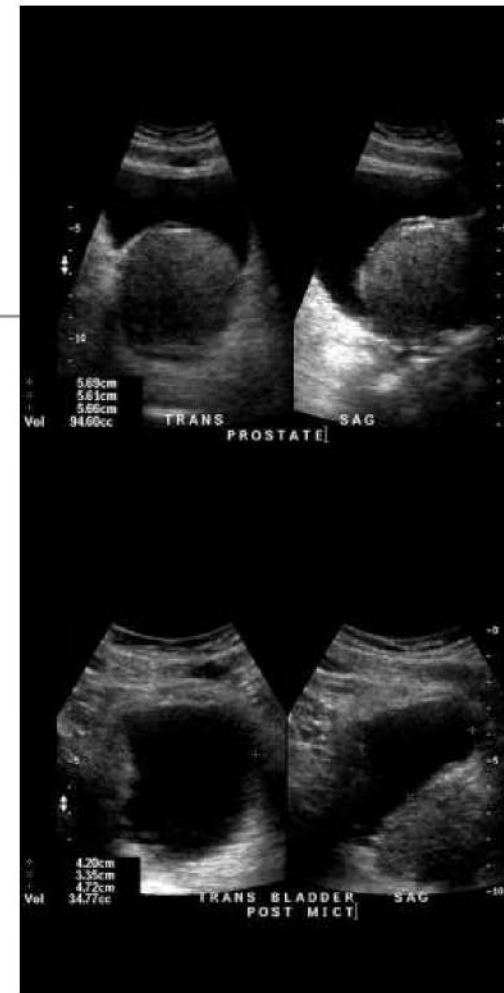
- The best anatomic detail is on T2WI.
- Below an example of a prostate with minimal BPH (<30 mL entire gland).
- From superior to inferior, the gland is commonly divided into 3 levels (approximate thirds)
 - Base (includes parts of peripheral zone, central zone and transition zone)
 - Mid Gland (includes mostly peripheral and transition zones)
 - Apex (includes mostly peripheral zone, some transition zone)



BP
H

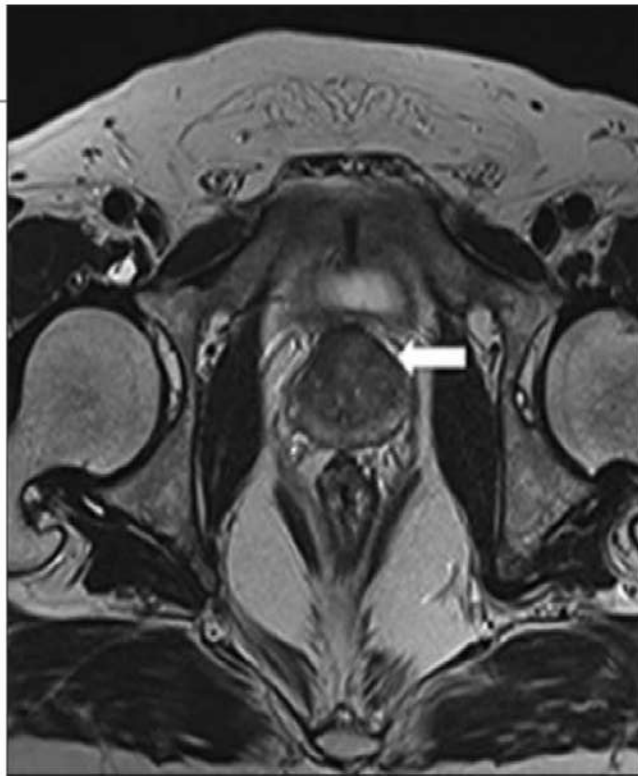
Ultrasound in BPH

- Ultrasound has become the standard **first line investigation** after the urologist's finger.
 - there is an increase in volume of the prostate with a calculated volume **exceeding 30 mL** (width x height x length x 0.52)
 - the central gland is enlarged, and is hypoechoic or of mixed echogenicity
 - calcification may be seen both within the enlarged gland as well as in the **pseudocapsule** (representing compressed peripheral zone)
 - **post-micturition residual volume** is typically **elevated**
 - associated bladder wall hyper trophy and

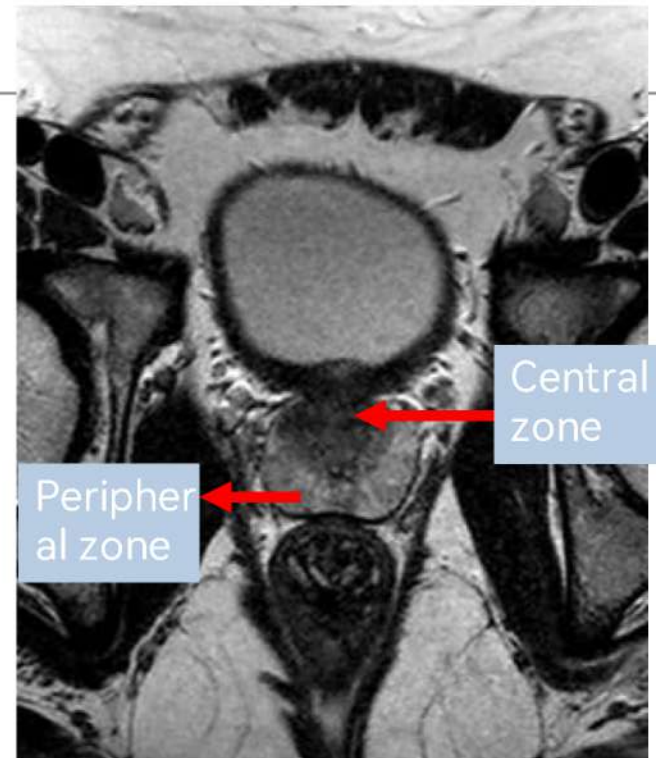


Ultrasound of the bladder and prostate demonstrates an enlarged prostate (consistent with benign prostatic hyper trophy) resulting in a high post micturition volume

MRI of Prostate (BPH)



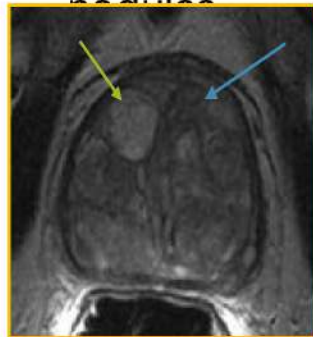
Magnetic resonance imaging T2- weighted axial image of the prostate, showing normal prostate anatomy.



Coronal image of a normal prostate. Note the hyperintensity of the CZ compared to the PZ.

Hyperplasia

- Benign prostate hyperplasia (BPH) typically arises in the transition zone, distorts zonal anatomy, and can get very large (over 200 mL).
- BPH has glandular components (T2 light) as well as stromal components (T2 dark), usually with multiple encapsulated appearing nodules.

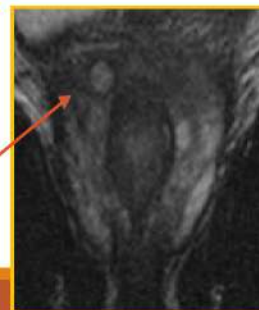


BPH less commonly occurs outside of the transition zone.

- Small BPH nodule at R base at the central/peripheral zone border



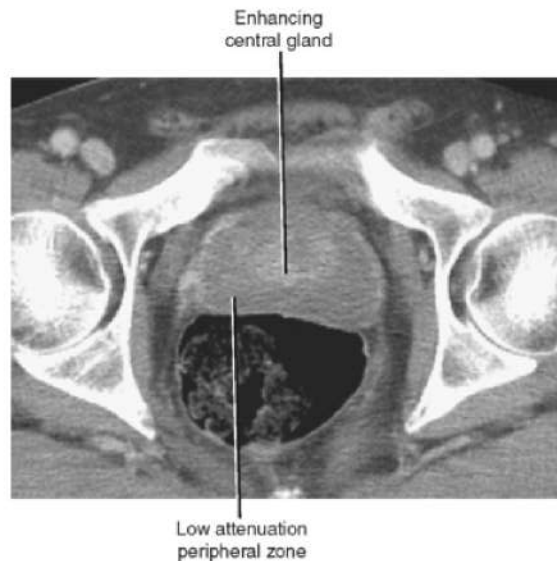
BPH commonly extends into the urinary bladder (UB), frequently referred to as the “median lobe,” worth mentioning as there can be treatment

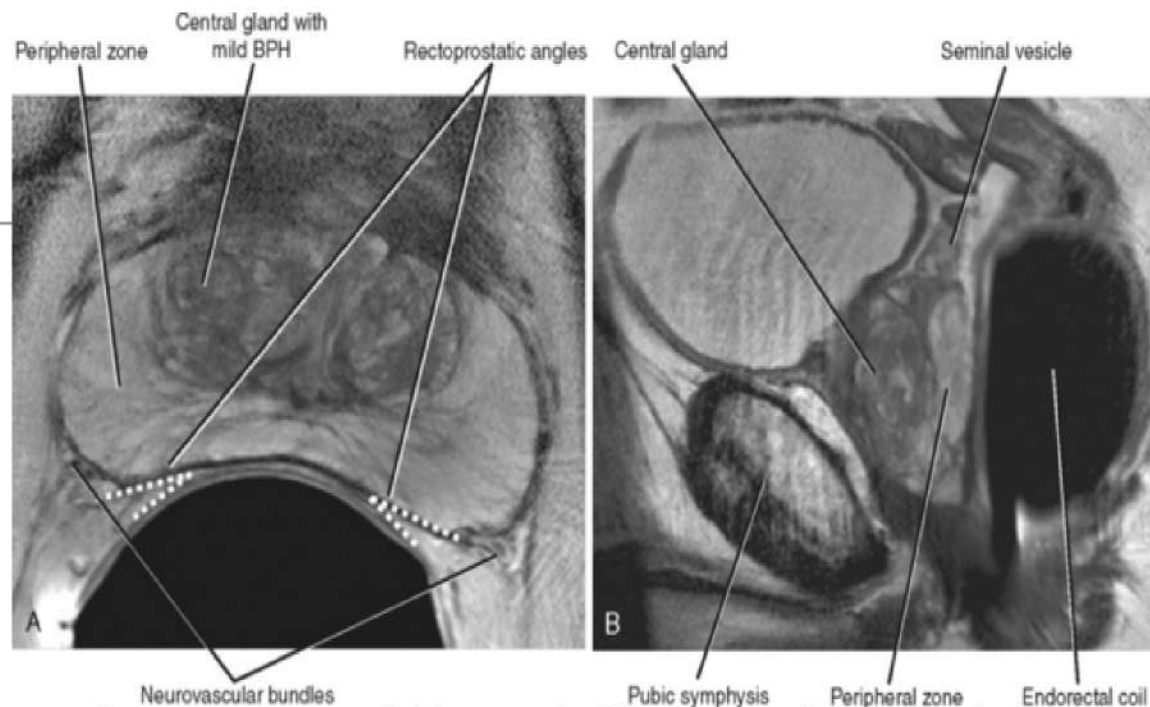


Prostate and Seminal Vesicles

Typical appearance of the prostate on CT is an ovular soft-tissue density, often difficult to separate from the surrounding fascia and musculature. Large BPH nodules and global prostatic enlargement are sometimes evident as irregular soft-tissue nodules seen encroaching into the bladder base, often with associated bladder wall thickening. Crude zonal anatomy can be appreciated on contrast-enhanced images in patients with BPH, as the central gland enhances heterogeneously, delineating it from the surrounding hypovascular peripheral zone. Calcification within the prostate gland is common and usually asymptomatic, although it is more common in men with recurrent prostatitis, BPH, and a variety of metabolic disorders. Calcification of the seminal vesicles and vas deferens are also common and are associated with diabetes mellitus.

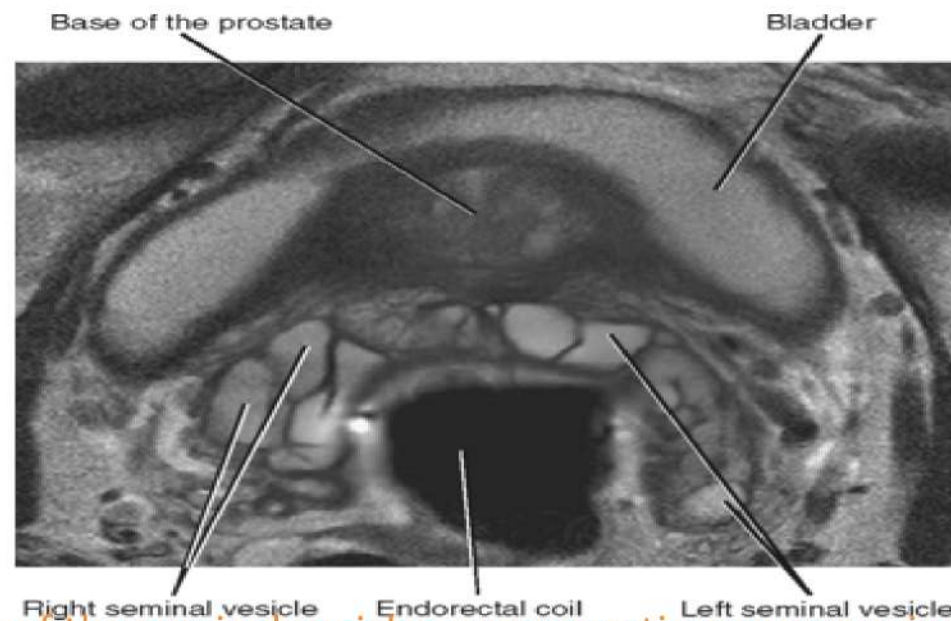
Enhanced axial computed tomography in a 42-year-old man demonstrates some limited zonal anatomy





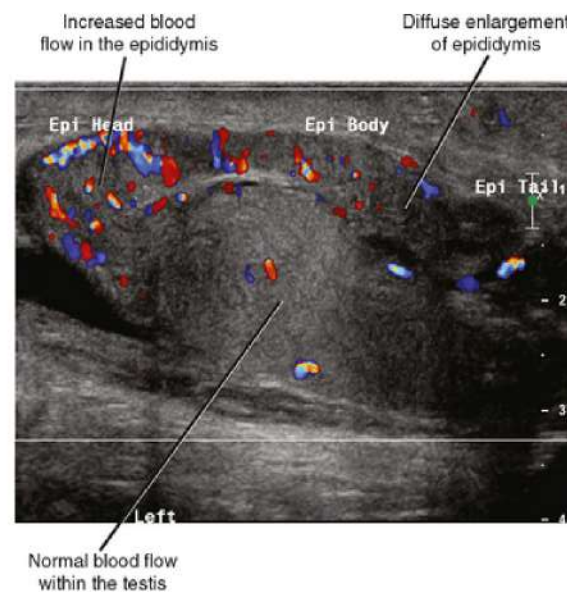
Normal zonal anatomy of the adult prostate on high-resolution T2-weighted magnetic resonance images obtained with an endorectal coil in the **(A)** axial and **(B)** sagittal planes. Images were obtained on a 3-Tesla magnet. On magnetic resonance images, the transitional zone and central zone are considered together as one region called the *central gland*. *BPH*, Benign prostatic hyperplasia

The seminal vesicles can be best visualized on coronal and axial images as clusters of high-T2 signal intensity tubules just cranial to the posterior prostatic base ([Fig. 20-9](#)). The course of the urethra through the prostate is best depicted on sagittal images. The *neurovascular bundles* can be appreciated on T1- and T2-weighted axial images as small clustered foci of low signal in the rectoprostatic angles, which are the two acute angles formed by the outer rim of the posterior peripheral zone and anterior rectal wall. The site where each neurovascular bundle penetrates the true prostatic capsule provides an avenue for extracapsular spread of prostate cancer; thus, familiarity with this region is critical to MR staging. The true prostatic capsule appears as a region of low signal intensity 1 to 2 mm thick surrounding the exterior surface of the gland on T2-weighted images



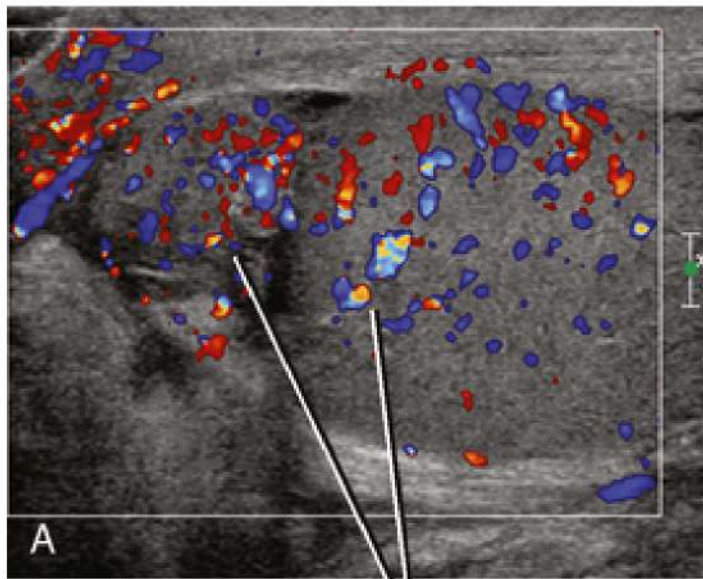
Normal appearance of the seminal vesicles on magnetic resonance imaging. Axial T2-weighted image at the level of the prostate base demonstrates the midportion of both seminal vesicles

Ultrasound findings of epididymitis. Sagittal ultrasound image with color Doppler demonstrates diffuse enlargement and increased vascularity of the epididymis.

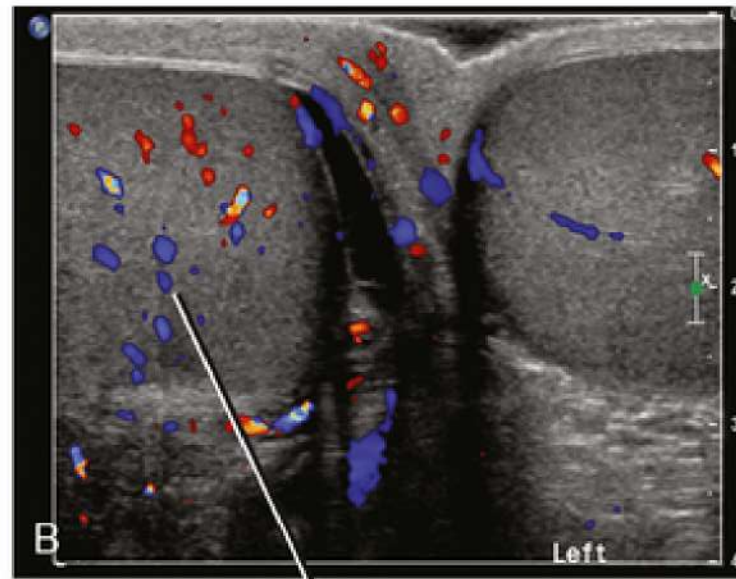


cases

Epididymoorchitis on ultrasound. **A**, Color Doppler image demonstrates enlargement of the epididymis with increased blood flow to both the epididymis and testis. **B**, Transverse midline color Doppler image of both testes allows direct comparison of vascularity, increased on the patient's right side in this case

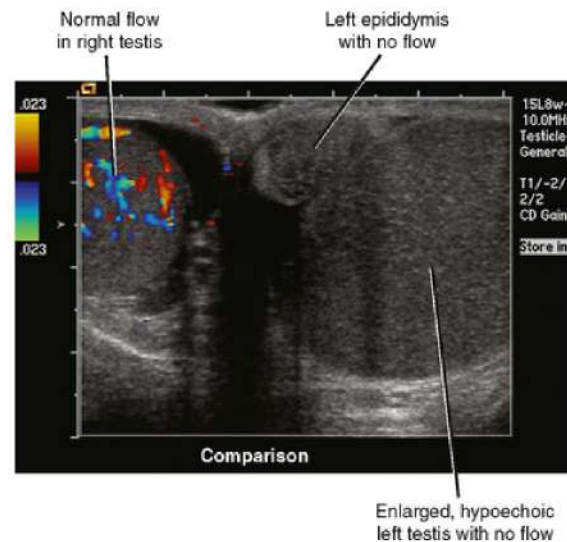


Increased blood flow
in epididymis and testis

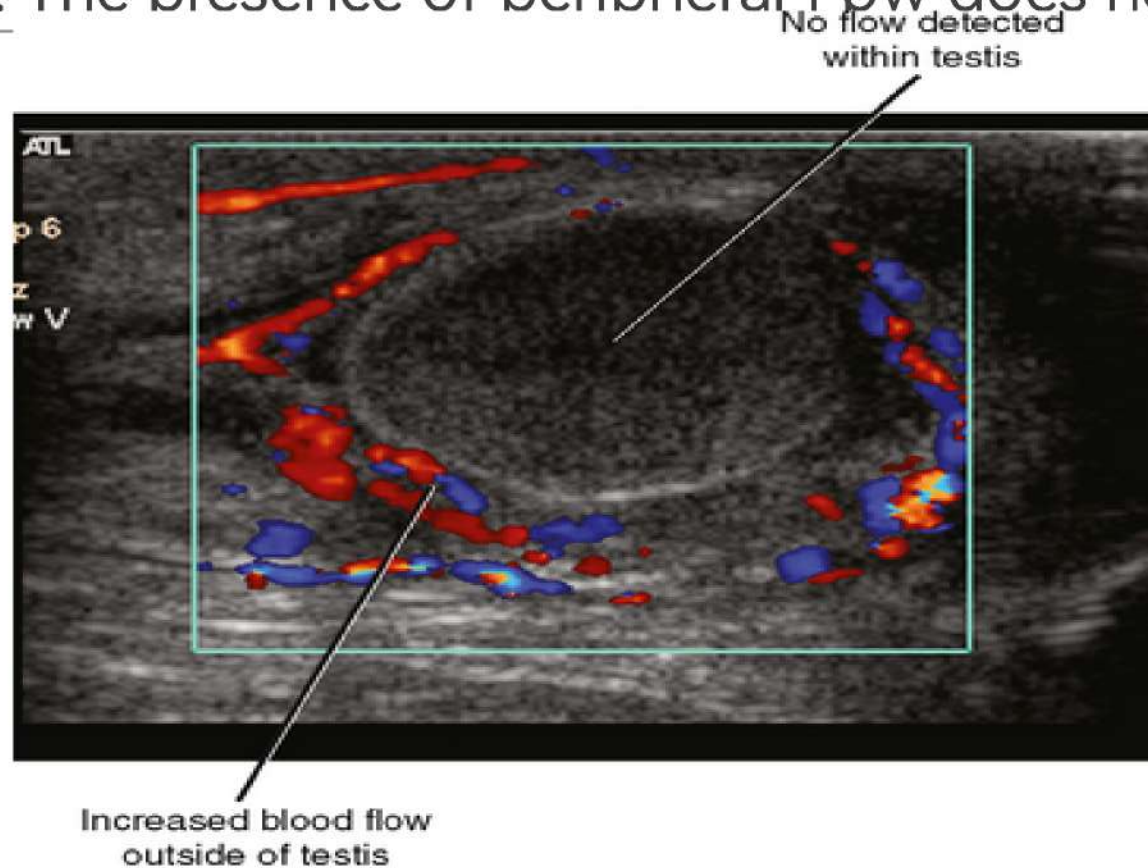


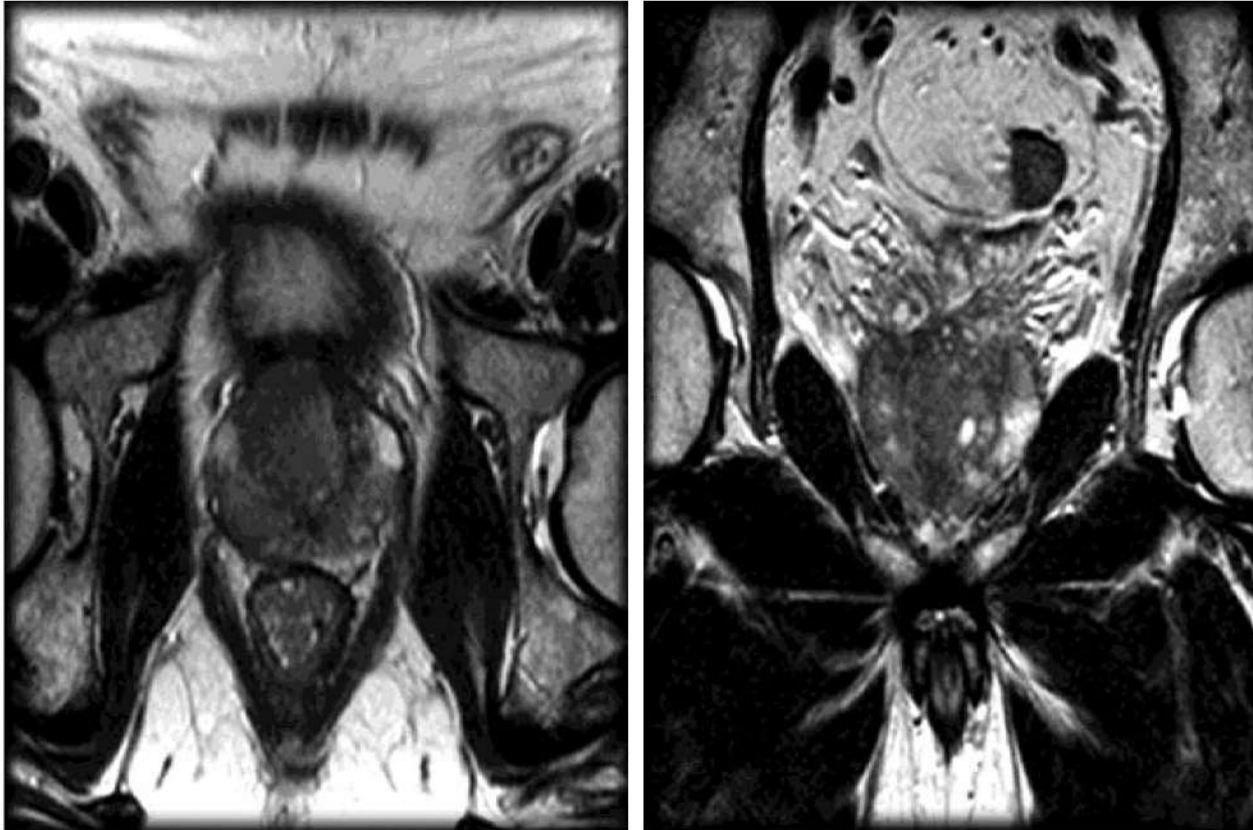
Increased blood flow
in right testis

Ultrasound findings in testicular torsion. Transverse midline color Doppler ultrasound image in a patient with severe left scrotal pain demonstrates enlargement of the left testis and epididymis compared with the right side. No flow is detected within the left testis, whereas normal flow is demonstrated on the right side.

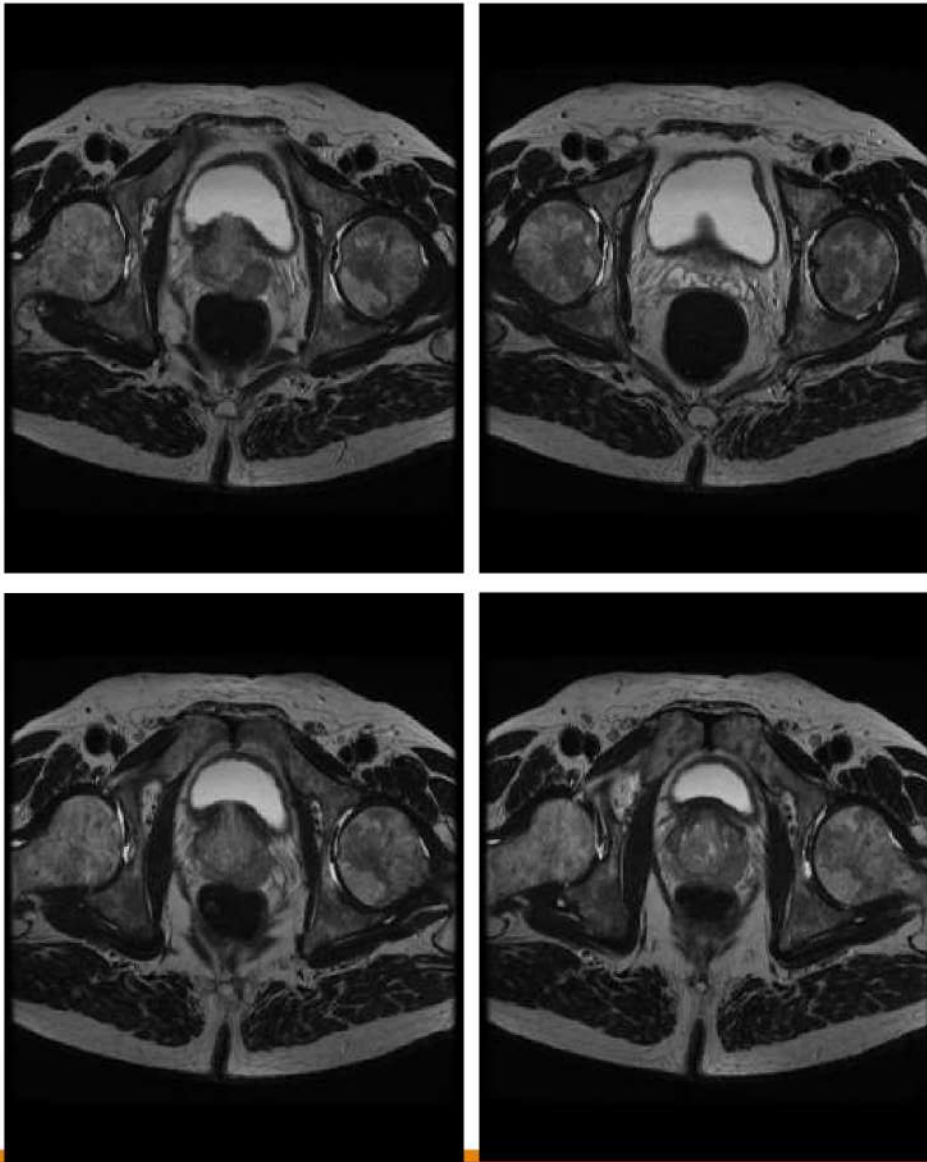


Peripheral hyperemia in testicular torsion. Color Doppler ultrasound image demonstrates increased blood flow surrounding an infarcted testis, but no flow within the testis itself. The presence of peripheral flow does not exclude torsion.





Ill-defined hypointense lesions in the peripheral zone of the prostate gland. This appearance is suggestive of prostate carcinoma.

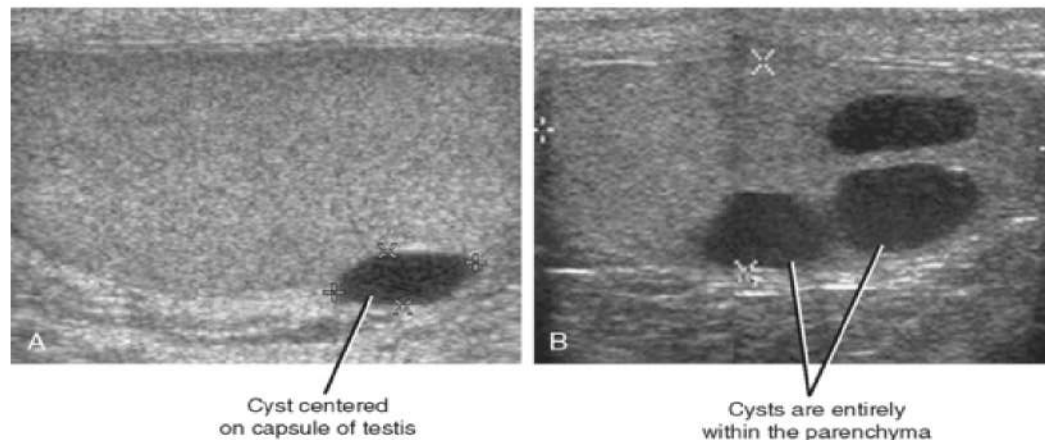


T2 hypointense nodule at the base of the left prostate side lobe extending beyond the capsule. Involvement of left seminal bladder can't be excluded. Disseminated osteoblastic skeletal metastases.

<https://radiopaedia.org/cases/t3-prostate-cancer-on-mri>

testicular Cysts

Cysts of the tunica albuginea are usually found in men older than 40 years. They are located at the periphery of the testis, usually at the upper anterior or lateral margins. At grayscale US, they are usually biconvex or lentiform in shape and meet all the criteria of a simple cyst. The cysts are typically unilocular but can be multilocular. Simple intratesticular cysts are similar in appearance to those of the tunica but can be located anywhere in the testis and can be solitary or multiple.



Benign testicular cysts. **A**, Sagittal ultrasound image demonstrates an oval-shaped simple cyst centered on the tunica albuginea. Note that it results in a slight bulge in contour, making it palpable. **B**, Sagittal image of multiple intratesticular cysts. Although some are adjacent to the tunica, not all of them are. These were not palpable. Germ cell tumors that undergo necrosis and teratomas with cystic components also can have a cystic appearance. However, cystic malignant lesions have a complex appearance with solid components or thick septations, or both, that distinguish them from simple cysts