18 Urologic Ultrasound Protocols

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Introduction

This chapter describes a urologist's view of what a complete ultrasound evaluation of the primary organs of interest for the urologist (i.e., kidney, bladder, prostate, testis, perineum, and phallus) should include. As a urologist, I find myself striving to improve diagnostic accuracy and the management of the patient's pathology. Ultrasound, being an accurate, safe, non-invasive, and low-cost modality, has become the primary modality of diagnosing as well as guiding the treatment of urologic diseases. However, having taught many urologists how to perform the ultrasound exam, the question kept being asked, "What images do I need for a complete ultrasound examination." Although I was tempted to answer "as many as it takes to document the presence or absence of disease," I knew that the student of ultrasound was in need of a protocol they could start with and change as their proficiency increased. In addition, quality involves consistency which in the context of ultrasound is the need to assure that all required images are documented. This is especially important in large practices and institutions in which the multiple of sonographers employed different levels of training and experience. Being responsible for ultrasound quality in a large urology practice, I find it essential to assure that each exam contains specified images with consistent labeling and that images are acquired in a specific order. This has helped to ensure that a quality study has been performed and that reviewers of these images know exactly where to locate the images of interest. It also helps with assuring that all required images are documented.

I am also a stickler for detail. Not only do I require of my studies for the images to be in a specified order but also the quality of each and every image must be "ready for publication," as I often refer to my obsession for image quality. The seven user-adjustable settings of gain, time-gain compensation, frequency, focal zone, depth, and field of view must be optimized. Labeling should be of either upper or lower case and neatly organized on the image.

I was therefore motivated to include this chapter which describes a precise protocol for performing and documenting the Urologic ultrasound examination. My expectation is that as the urologist becomes an expert sonographer, changes to the protocol will occur. I have incorporated the requirements of the American Institute of Ultrasound in Medicine (AIUM) to assure those interested in AIUM Urology Practice Accreditation, as well as meeting the ever-escalating requirements of third-party payers, that use of these protocols will meet their require-

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ments. This chapter can serve as a training tool for new and seasoned sonographers. It is my hope that the use of these protocols will add to the quality of patient care that we provide.

Documentation

Documentation of ultrasound images and the written report is essential for ensuring high-quality patient care. Proper documentation includes the production of a permanent record of the ultrasound examination and the interpretation of the examination [1]. In addition, documentation should be easily retrievable and storage and access to this documentation should comply with local, state, and federal requirements.

Components of Proper Documentation

Written Report

The report should include specific identifiers including the patient identification, the date of the examination, and the measurement parameters as well as a description of the atypical findings of the examination. Ideally, the report should also include specifics on how the evaluation was performed including details on the transducer used and machine settings employed. Most of the important machine settings are often already included on the recorded image. The report must be signed by the physician who ordered and interpreted the ultrasound examination. The final report must be signed by the interpreting physician within 24 hours. If the ordering physician is not the interpreting physician, then the ordering physician must sign the report within 48 hours. Prominently displayed at the top of the report should be the indications for performing the examination. *Appendix A* contains a set of templates that offer a structure for the report. These templates were designed for direct entry into an electronic database; however, they can be easily formatted by the user for a printable report.

Report Essentials

1. Indication for Procedure: This should be the first and foremost on any report. The diagnosis code is often included with the description of the indication to document medical necessity.
2. Transducer: Frequency and type of transducer (e.g., linear array, curved array, endorectal, biplane, etc.). If possible, specify the size of the footprint.
3. Report signed and dated by Physician. This should be done within 24 hours of the time of the exam.
4. Report includes facility contact information. This is essential information for anyone reviewing the report and needing additional information.
5. Report is appropriate for the examination.

Please note: If all components of the exam are not seen, then the report should document that component was "Not Seen" and the reason why.

Images

Images should include patient identification, the date and time of each image, clear image orientation, measurements clearly identified and labeling of anatomy and any abnormalities. If appropriately documented, the image should be able to be viewed by any trained sonographer. The image should provide a clear, unimpeded ultrasound representation of the anatomy of interest. Gain, acoustic output, time-gain compensation, transducer frequency, focal zone, depth size, image contrast, image brightness, and field of view must be set to be of "publishable" quality. No images should be stored in which the settings are not optimized. Images should always be attached to the report or be easily accessible from the report. Images must also be technically adequate to provide diagnostic information.

Image quality must be of "publishable" quality and should have (Fig. 18.1):

1. Sufficient and uniform brightness.
2. Sharp and in focus.

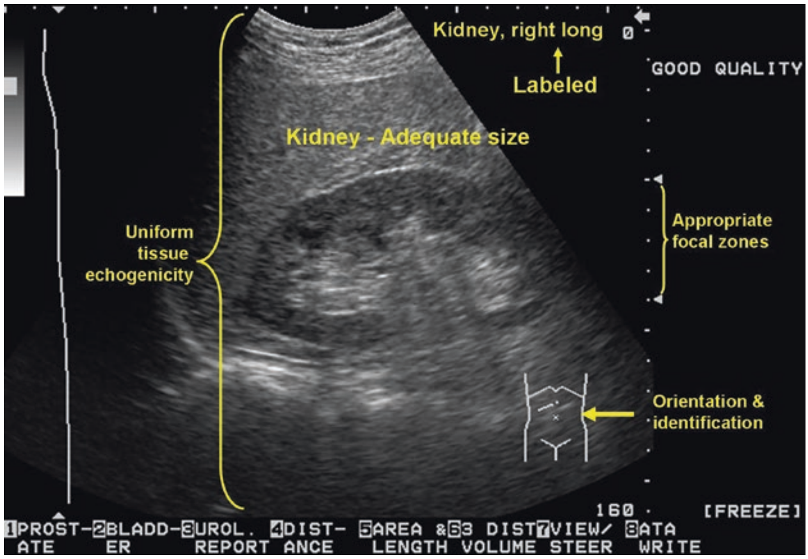


Fig. 18.1 The image should provide a clear, unimpeded ultrasound representation of the anatomy of interest. Gain, acoustic output, time-gain compensation, transducer frequency, focal zone, depth size, image contrast, image brightness, and field of view must be set to be of "publishable" quality

3. Adequate size.
4. Proper image orientation.
5. Proper labeling which should be of uniform case and aesthetically positioned.

The use of electronic medical records has made the documentation of ultrasound examinations somewhat easier. However, it has also created challenges in managing the archives of images and assuring the accessibility of these records to only authorized personnel. Regulatory requirements for documentation have been promulgated by the American College of Radiology (ACR) and the American Institute of Ultrasound in Medicine (AIUM). In addition, federal and state regulations governing electronic data storage of patient information also apply and need to be adhered to.

The AIUM Practice Guidelines and in particular for Ultrasound in the Practice of Urology [2].

These guidelines discuss the qualifications and responsibilities of personnel as well as specifications for individual examinations.

Considerations regarding the documentation and storage of ultrasound studies include the following:

- Providing a mechanism for the retrieval and storage of images and reports of all studies performed.
- Storing ultrasound images and the report on a secure recording media.
- The report and the information included on the images should meet or exceed the standards promulgated by accreditation organizations such as the AIUM.
- Ultrasound images and a report from the interpreting physician must be maintained in a readily accessible fashion for comparison and consultation.
- Recording media must have a shelf life compatible with the minimum number of years, required by law, for the maintenance of patient records. In most states, this will be for at least 7 years after the patient's last examination was performed; however, these requirements vary from state to state. For pediatric patients, the recommended period is until the patient reaches the age of 21.
- Images and the reports pertaining to them are considered protected health information and are subject to the regulations of the Health Insurance Portability and Accountability Act of 1996. *Federal and State Regulatory Requirements for Document Storage*.

Federal and State regulatory requirements must be implemented for the storage of patient studies. These include the Health Insurance Portability and Accountability Act of 1996

(HIPAA) [3], HiTech Act of 2009 [4], possibly FDA regulations Title 21 CFR Part 1270 if human tissue is also being stored as part of the procedure, Subpart C [5], plus State regulations usually written and enforced by the State's Department of Health.

Specific Ultrasound Protocols

To assist the urologic sonographer to develop a systematic way to scan a particular organ system I present the following set of ultrasound protocols. There is no "correct" way to perform a scan. Many alternative approaches exist. However, I strongly believe that having an organized approach will allow the sonographer to perform a comprehensive and expeditious exam that will provide optimum patient care. What follows represents a urologist's approach and should be used as a guideline for the novice and as a point of reference for the more experienced sonographer. Protocols for quick reference and templates for data entry are provided (Appendix A). Many practices incorporate the templates as part of their electronic medical record.

Color and Spectral Doppler

The use of color Doppler imaging should be considered an integral part of all ultrasound exams. Many inflammatory, neoplastic, and benign conditions have characteristic flow patterns that can assist in diagnosis. Each examination requires images that document the blood flow in that organ and if a paired organ system is present, then a comparison of blood flow between the organs interrogated is required.

Spectral Doppler is evolving as an invaluable component of several urologic ultrasound exams. There is an expanding literature suggesting that these modalities might be a non-invasive indicator of testicular function. Biagiotti et al. [6] provided data suggesting that resistive index (RI) and peak systolic velocity (PSV) were better predictors of dyspermia than FSH and testicular volume. In a companion study, they demonstrated

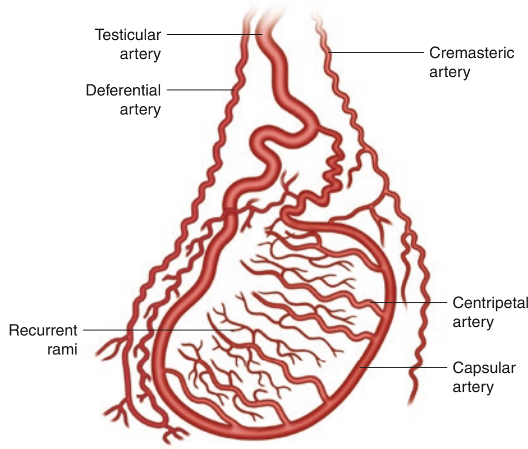


Fig. 18.2 Intratesticular arterial circulation consists of the centripetal and recurrent rami arteries which are branches of the capsular artery which is formed, in turn, from anastomosis of the testicular, deferential, and cremasteric arteries

that RI and PSV can differentiate obstructive azoospermia from (OAS) from non-obstructive azoospermia (NOS).

It is often difficult to interrogate intratesticular vessels when the intratesticular microcirculation is impaired. Unsal et al. [7] provided data supporting interrogation of the capsular vessel and capsular branches in lieu of the intratesticular vessels (Fig. 18.2).

They found that RI of both capsular vessels and capsular branches could serve as indicators of impaired testicular microcirculation. Pinggera et al. [8] examined semen quality and the RI of intratesticular arteries in 160 men. Of interest, their study indicated that 80 with a normal sperm count had an RI of 0.54 + 0.05 while the 80 with impaired sperm counts had a statistically higher RI of 0.68 + 0.06. In addition, Balci et al. [9] demonstrated that a decrease in RI, suggestive of an improved testicular microcirculation, was found after varicocele repair in patients with improvements in semen quality. More recently we found (Hillelsohn et al. [10]) that an RI greater than 0.6 was associated with dyspermia and as well as correlating with impaired spermatogenesis on testicular biopsy [11].

In the kidney, an RI of approximately 0.7 is considered normal. An elevated RI is found in acute renal failure [12] and several other types of renal dysfunction including obstruction [13].

It is therefore our protocol to include Spectral Doppler measurements when examining the testis and kidney with ultrasound. Spectral Doppler is a standard part of the evaluation of the phallus.

Sonoelastography

The ability to access pathology by palpation has long been a key part of the Physician's physical examination. Hard lesions are often a sign of pathology. Sonoelastographraphy (tissue elasticity imaging) is an evolving ultrasound modality which adds the ability to evaluate the elasticity of biological tissues. Essentially, it gives a representation, using color, of the softness or hardness of the tissue of interest.

But how do we use ultrasound to "palpate" an organ? To do so requires a mechanical wave to be produced in the tissue of interest. There are two ways to produce this mechanical wave.

1. A Compression Wave travels travel quickly in tissue (1500 m/s). The echoes produced by these waves successively compressing tissue layers produce scatter which is then received and processed by the ultrasound equipment. Since the Stress produced by the compression wave cannot be measured, only a relative elasticity can be determined.
2. A Shear Wave travels much slower (1 to 10 m/s) and propagates by creating a tangential "sliding" force between tissue layers. The elasticity (E), density of the tissue (p, kg/m^2) and shear wave propagation speed (c) are directly related through the eq. $E = 3pc^2$. Therefore, by measuring the shear wave propagation speed the elasticity of the tissue can be directly determined.

Several approaches for elastography have been introduced. All of them have three common steps:

1. Generate a low-frequency vibration in tissue to induce shear stress
2. Image the tissue with the goal of analyzing the resulting stress
3. Define a parameter related to tissue stiffness

The principle of elastography is based on the concept that a given force applied to softer tissue results in a larger displacement than the same force applied to harder tissue. By measuring the tissue displacement induced by compression, it is possible to estimate the tissue hardness and to differentiate benign (soft) from malignant (hard) lesions. This relationship between stress (s) and strain (e) is given by Young's Modulus or Elasticity (E),

$$E = s / e$$

E is larger in hard tissues and lower in soft tissues.

Visually, the elasticity of a tissue is represented by color spectrum. Be aware that the color given to hard lesions is determined by the manufacturer of the equipment as well as being able to be set by the user. Therefore, just as in using color Doppler, the user needs to look at the color bar (see Figs. 18.4 and 18.5) to know what color represents a "hard" and "soft" lesion.

The three methods commonly used for sonoelastography are as follows:

1. Quasi-Static Ultrasound or Real-Time Elastography (RTE): Fig. 18.3 in which the deformation is induced by manually pressing on the anatomy with the transducer, and measured using ultrasound. RTE is a qualitative technique. Due to the requirement of manual displacement, RTE is not able to measure absolute tissue stiffness as currently employed. Its major benefits are that it has a high spatial resolution, is a real-time measurement, and does not require any modifications to conventional ultrasound hardware.
2. Dynamic Elastography: A continuous Low-frequency vibration induces stationary waves which are evaluated to determine elasticity. This approach is used more often with MR since they require manipulation of two devices simultaneously.
3. Shear wave elastography (Fig. 18.4) relies on the observation of the propagation of a transient pulsed (shear) wave to determine the viscoelastic properties of the tissues. This method allows rapid scanning of the organ of interest. A limitation of the generated shear

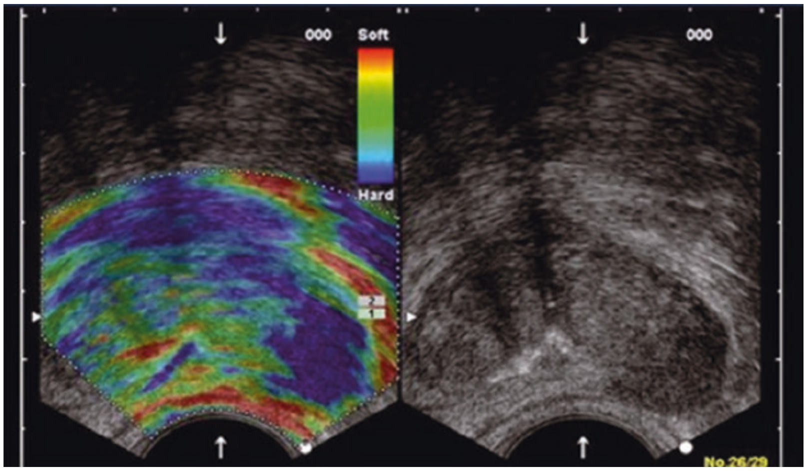


Fig. 18.3 Real-time elastography of prostate (left image) and gray-scale image on the right. In this set of images, the harder/firmer tissue is blue while the softer tissue is red

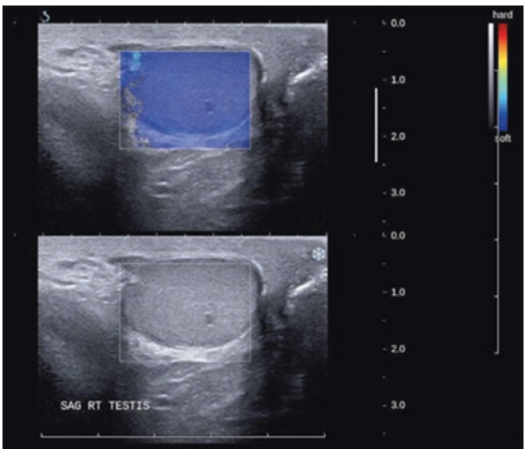


Fig. 18.4 Shear wave elastography of the testis (top image) with B-mode (gray scale) image on the bottom. In this set of images, the softer tissue is blue

waves is that they are very weak resulting in only a few millimeters of propagation. To compensate for this, various electronic innovations have been developed to limit the ultrasound power and overheating that would occur with larger perturbations. Supersonic Imagine is the primary company using this technology.

Two recent studies have used real-time elastography to differentiate benign from malignant testicular lesions, as it is postulated that malignant lesions have an increased stiffness due to a higher concentration of vessels and cells compared to surrounding tissues. Goddi et al. assessed 88 testes with 144 lesions and found a 93% positive predictive value, 96% negative predictive value, and 96% accuracy, and similarly Algner et al. assessed 50 lesions and found a 92% positive predictive value, 100% negative predictive value, and 94% accuracy in differentiating malignant from benign lesions. Additionally, Li et al. have found that men with non-obstructive azoospermia had a significantly different elasticity compared to patients with obstructive azoospermia and healthy controls with a normal semen analysis. Real-time tissue elastography is an exciting new innovation in assessing abnormalities on scrotal examination; however, more data is necessary prior to avoiding surgical intervention based on the findings.

In the kidney, renal masses [14, 15] as well as the viability of renal transplants [16] have been assessed.

When compared with fusion MRI, sonoelastography of the Prostate has similar sensitivity and specificity [17] . The use of various ultrasound modalities, including sonoelastography, has been described as multiparametric ultrasound and appears to significantly improve the diagnostic accuracy of ultrasound [18] .

If your equipment is sonoelastography-enabled, I would encourage you to use this modality on all abnormal lesions detected in any organ system interrogated by ultrasound.

Specific Protocol for Scrotal Ultrasound

Specifics to be Documented on Report:

- *Indication for Procedure*: For example, testicular pain, palpable mass, thickened skin/contracted scrotum making physical exam difficult. Diagnosis code can also be included to document medical necessity.
- *Transducer*: 12–18 MHz linear array transducer with a footprint that is greater than the testicular length.

Please note: if all components of the exam are not seen, then the report should document that component was "Not Seen" and why.

Scanning Technique

The patient is examined in the supine position. There are several different techniques to support the scrotum. The easiest is to use the patient's legs for support. Other approaches use towels placed across the patient's thighs or under the scrotum. The phallus is positioned up on the pubis held by the patient and/or covered by a towel.

Transducer Selection

A high-frequency (12–18 MHz) linear array transducers are most often used for scrotal scanning. Broad bandwidth transducers allow for multiple focal zones, eliminating the need for adjustment during the examination. Multiple frequency transducers allow the transducer to be set at one of several distinct frequencies. A linear array probe with a "footprint" able to measure the longitudinal length of the testis is ideal. A curved array probe can be used when there is a thickened scrotal wall or in the presence of scrotal edema or for large testis. The curved array transducer is also useful to compare the echogenicity of the testes. However, the frequency is usually lower, resulting in a less detailed image. Color and spectral Doppler are becoming essential elements of scrotal ultrasound because they provide documentation of normal testicular blood flow and paratesticular findings.

Survey Scan

Evaluation of the scrotal contents begins with a longitudinal survey scan, progressing medial to lateral to get an overall impression of the testis and paratesticular structures. The standard orientation of the image should be with the superior pole to the left and the inferior pole to the right on the monitor screen (Fig. 18.5, Top). If the testis is larger than the footprint of the transducer, it is difficult to visualize the entire mid-sagittal testis in a single image. It separately documents views of the superior and inferior portions of the testis including the epididymis in these regions. At least one image should visualize both testes to document the presence of two testes. In addition, a lateral and medial view of each testis should be documented.

The transverse view is obtained by rotating the transducer 90^0 counterclockwise. The standard orientation for the right testis is to have the lateral aspect to the left and the medial aspect to the right. Conversely, for the left testis, the lateral aspect should be to the right and the medial aspect to the left (Fig. 18.5).

Using the mid-testis as a starting point of the survey scan, proceed first toward the superior pole and then back to the mid-testis before scanning to the inferior pole. Measurements of width and AP dimensions are taken and documented at the mid-testis. A measurement should also be made of the long axis at the mid-testis together with the mid-transverse AP measurement. Testicular volume is then calculated from these measurements. If the equipment being used has split-screen capabilities, comparative views of echogenicity and blood flow can easily be made and documented.

Scrotal Imaging Protocol

1. Image showing both testes (single screen) is the first image obtained. This is important to

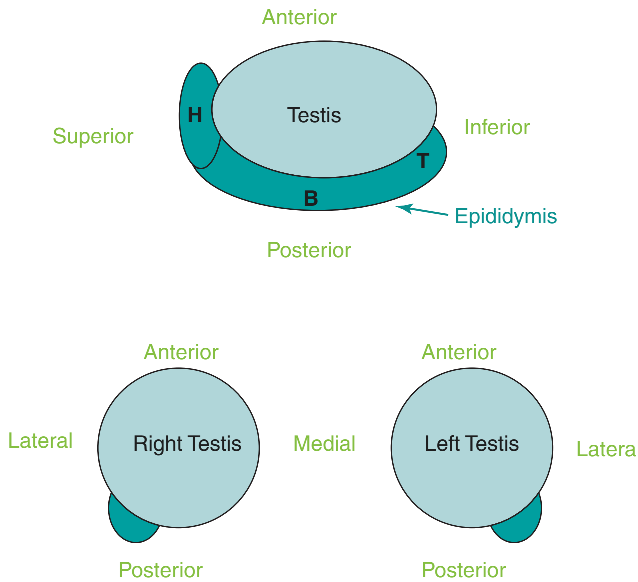


Fig. 18.5 The standard orientation for the right testis is to have the lateral aspect to the left and the medial aspect to the right. Conversely, for the left testis, the lateral aspect should be to the right and the medial aspect to the left. With a view demonstrating both testes, the right testis is on the left side of the screen and the left testis is on the right

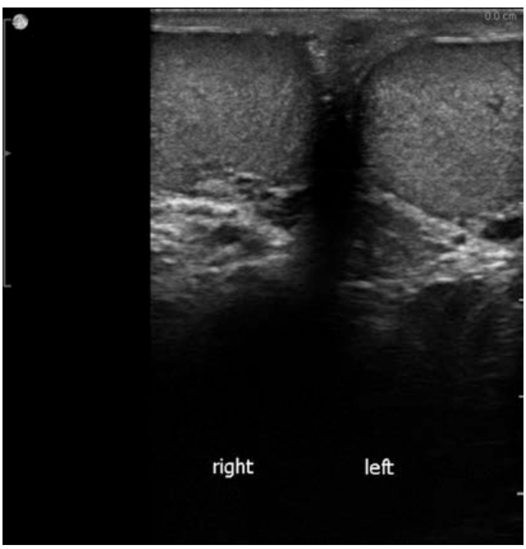


Fig. 18.6 Image showing both testes (single screen image)

document the presence of both testes and to compare echogenicity between the testes. If a testis is absent or a prosthetic is in place, this should be labeled on the image and documented in the report. Comparative scrotal skin thickness can also be measured on this image, Fig. 18.6.

2. Video clip of survey scan of the left testicle (longitudinal and transverse). The presence of intratesticular and/or extratesticular masses and fluid collections (e.g., hydrocele fluid) is observed for later documentation.
3. Left testicular measurements with the split screen: longitudinal view on the left and transverse view on the right, Fig. 18.7.
4. Video clip of survey scan of the right testicle (longitudinal and transverse).
5. Right testicular measurements with the split screen: longitudinal view on the left and transverse view on the right of the screen, Fig. 18.8.
6. Scrotal skin thickness measured (especially important if abnormal).

Split Screen (Laterality Is When Looking at Screen)

7. Epididymis #1: Epididymal caput (head), right and left sides, split screen: right testis on the left of the screen and left testis on the right of the screen, Fig. 18.9.
8. Epididymis #2: Epididymal corpus (body), right and left sides, split screen: right epididymal body on the left of the screen and

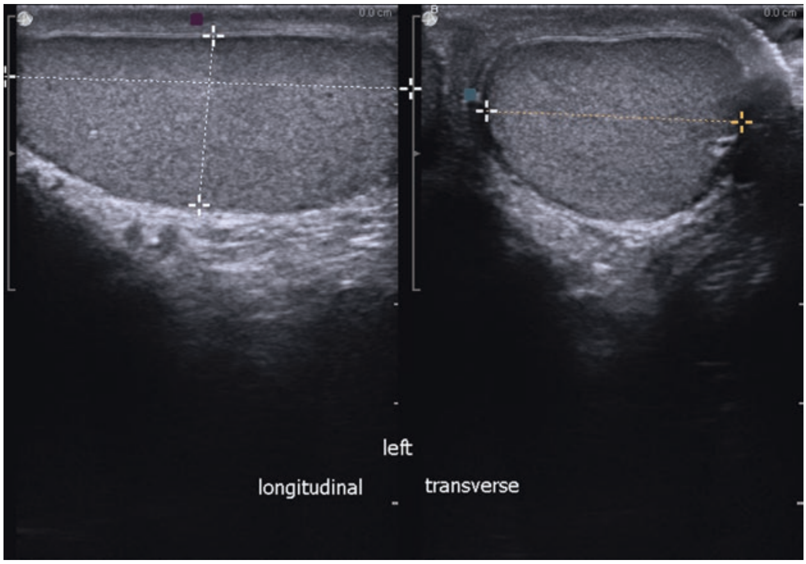


Fig. 18.7 Left testicular measurements (split screen images)

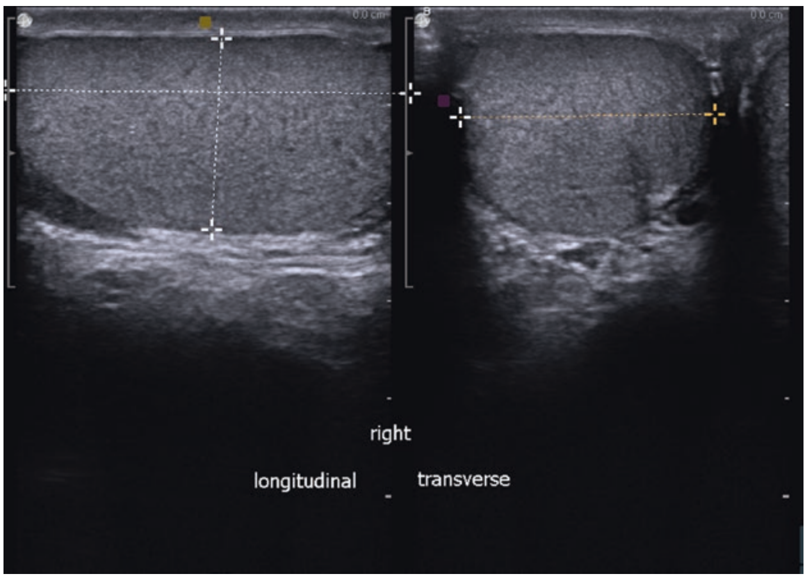


Fig. 18.8 Left testicular measurements (split screen images)

left epididymal body on the right of the screen, Fig. 18.10.

9. Epididymis #3: Epididymal cauda (tail), right and left sides, split screen: right epididymal body on the left of the screen and left epididymal body on the right of the screen, Fig. 18.11.
10. Lateral longitudinal view of the left and right testes: right testis on the left of the screen and left testis on the right of the screen, Fig. 18.12.
11. Medial longitudinal view of the left and right testes: right testis on the left of the screen and left testis on the right of the screen. Fig. 18.13.
12. Upper (superior pole) transverse view of the left and right testes: right testis on the left of the screen and left testis on the right of the screen, Fig. 18.14.

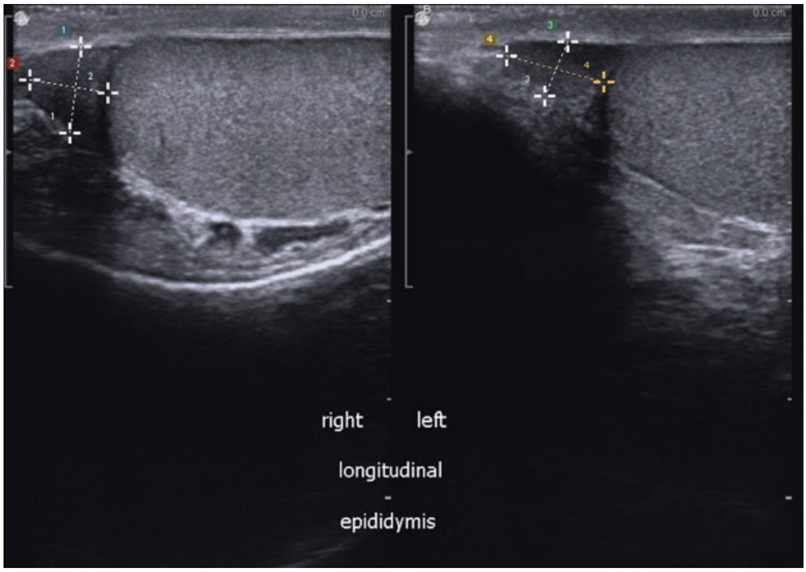


Fig. 18.9 Caput (head) of right and left epididymis (split screen images)

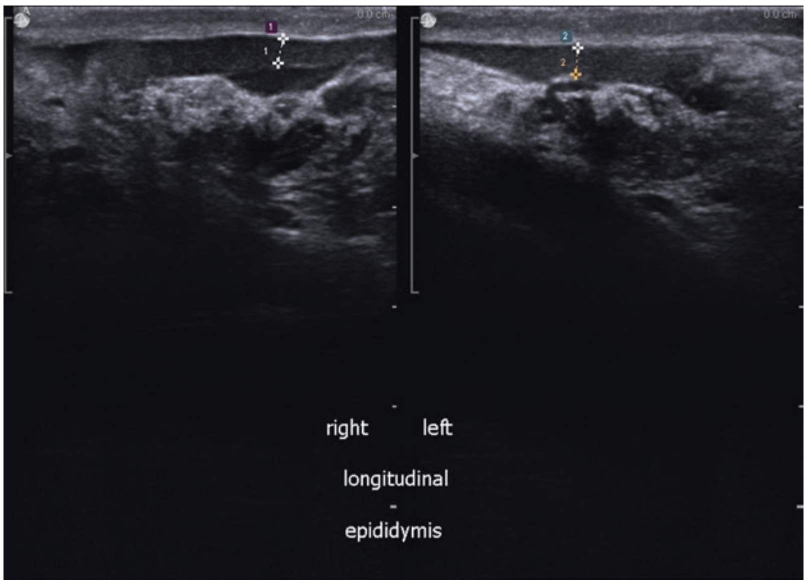


Fig. 18.10 Body of right and left epididymis (split screen images)

13. Lower (inferior pole) transverse view of the left and right testes: right testis on the left of the screen and left testis on the right of the screen, Fig. 18.15.

Color Doppler

14. *Intratesticular blood flow pattern*. Split screen of longitudinal view of both testes with the right testis on the left of the screen and the left testis on the right of the screen. If a difference in flow pattern is noted this should be documented by obtaining an image and noting in the report, Fig. 18.16.
15. A single-screen transverse view of both testes for comparative intratesticular blood flow, Fig. 18.17.
16. *Varicocele evaluation #1*. Longitudinal split screen of spermatochord superior to the testis with the right spermatochord on left of screen and left spermatochord on right of screen. Measurement of inner diameter of largest vein and width of the entire complex, Fig. 18.18.

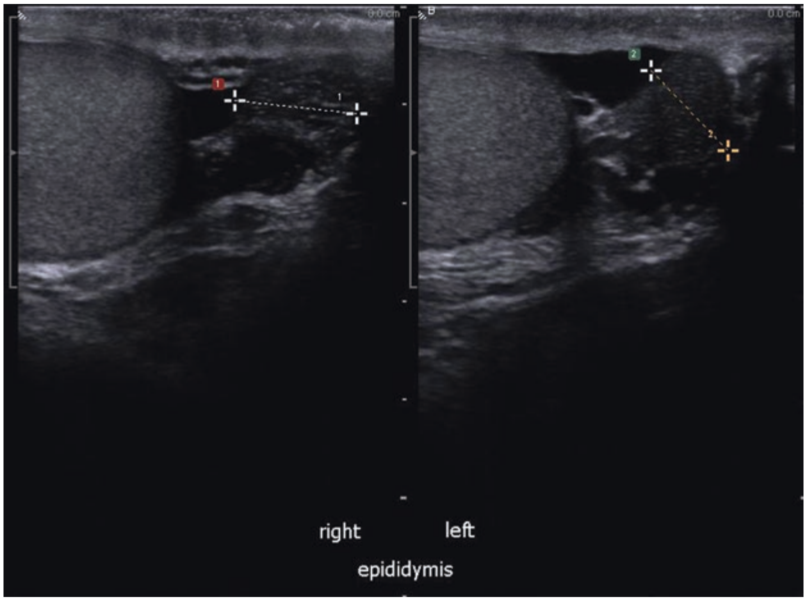


Fig. 18.11 Cauda (tail) of right and left epididymis (split screen images)

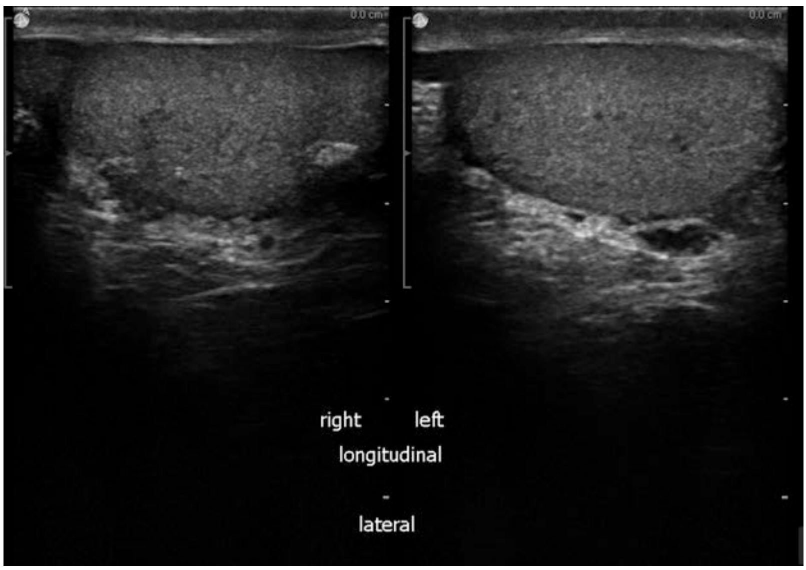


Fig. 18.12 Lateral longitudinal view of the left and right testis (split screen images)

17. *Varicocele evaluation #2*. Longitudinal split screen of spermatochord posterior to the testis with the right spermatochord on the left of the screen and left spermatochord on the right of the screen. Measurement of the inner diameter of the largest vein and width of the entire complex, Fig. 18.19.
18. *Optional: Varicocele evaluation #3*. Transverse split screen of spermatochord posterior to the testis with the right spermatochord on the left of the screen and left spermatochord on the right of the screen. Measurement of the inner diameter of the largest vein and width of the entire complex, Fig. 18.20.

Spectral Doppler

19. Evaluate a left intratesticular artery with PSA, EDV, RI, and AT (acceleration time) at the upper, upper, middle, and lower pole of the testis, Fig. 18.21.

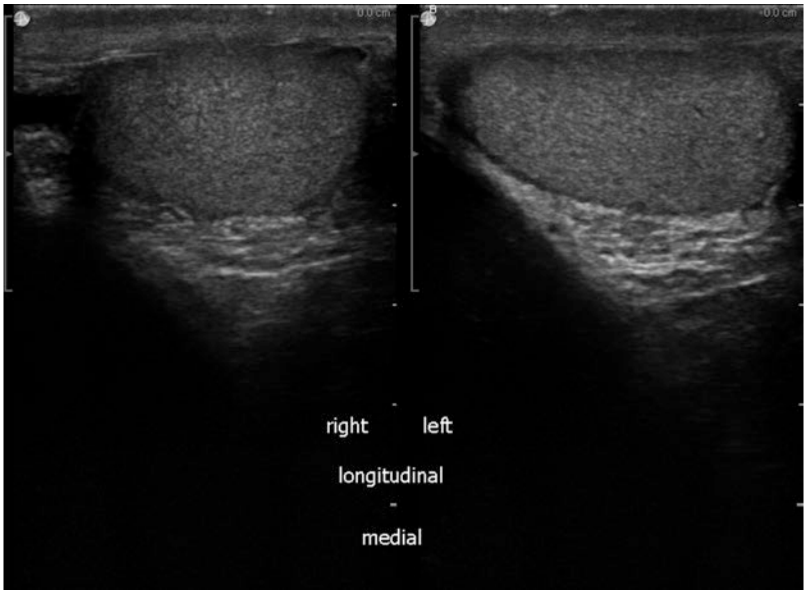


Fig. 18.13 Medial longitudinal view of the left and right testis (split screen images)

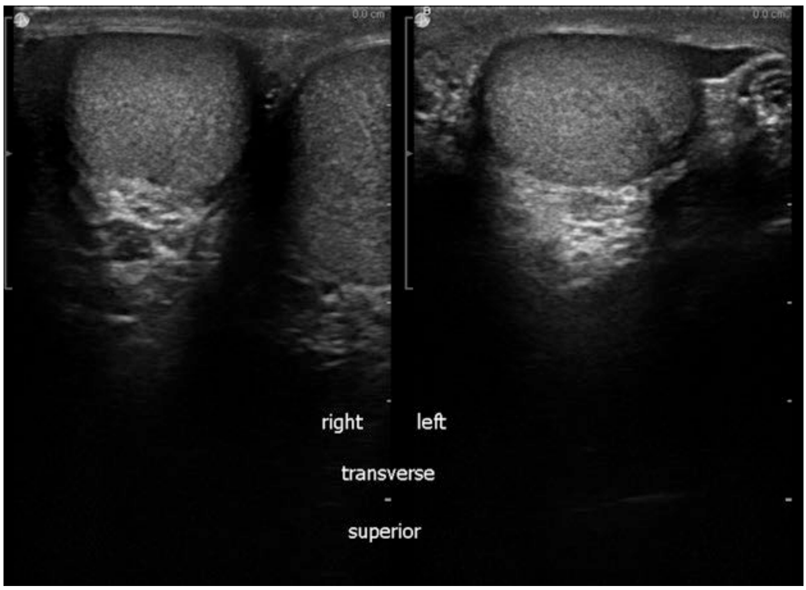


Fig. 18.14 Upper (superior) pole transverse view of the left and right testis (split screen images)

20. Evaluate a right intratesticular artery with PSA, EDV, RI, and AT (acceleration time) at the upper, upper, middle, and lower pole of the testis, Figs. 18.22 a–c.

Additional Images

Cine loops (video) of kidneys can be extremely helpful when evaluating the testes. This is particularly important in the following situations to rule out upper tract dilation (hydronephrosis) and/or upper tract masses: (1) varicoceles do not decrease in size in the supine position or no change with Valsalva, (2) solitary right varicocele, (3) large varicocele, (4) recurrent varicoceles, and (5) bilateral varicoceles.

Also, if intratesticular or other abnormalities are noted they should be imaged and documented in the report. The image should identify the size, preferably in 3 dimensions.

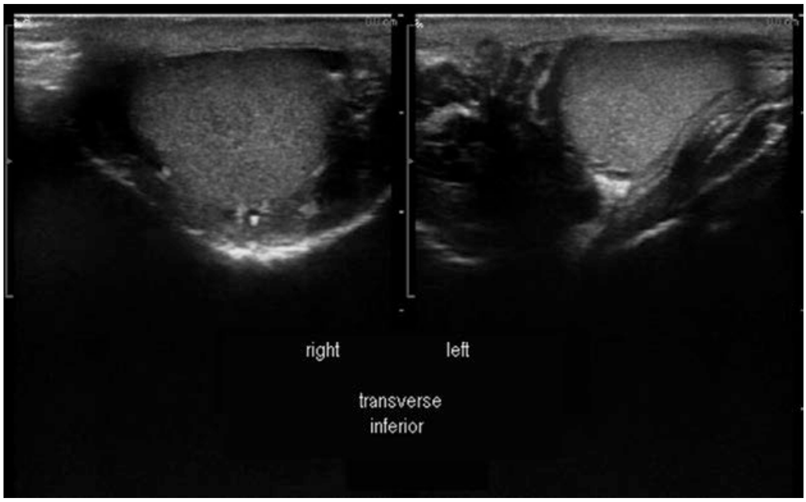


Fig. 18.15 Lower (inferior) pole transverse view of the left and right testis

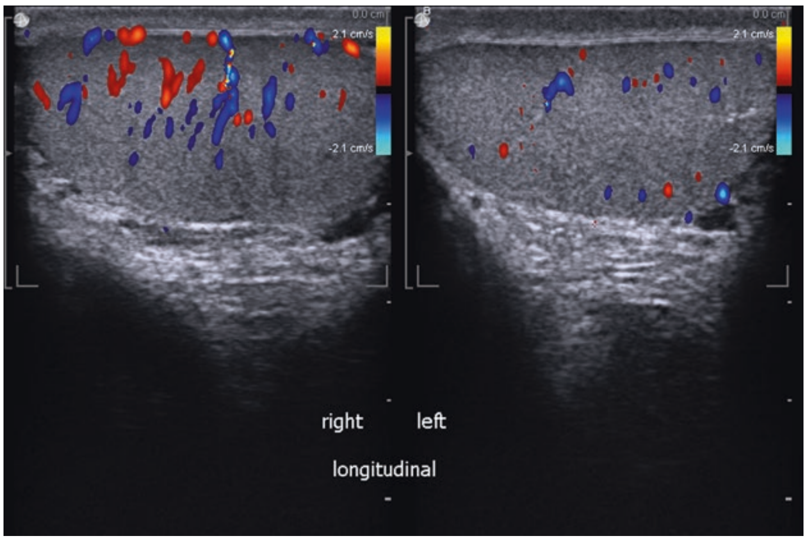


Fig. 18.16 Longitudinal view of intratesticular blood flow pattern (split screen images)

If sonoelastography is available, it should be used for the evaluation of intratesticular lesions and potentially for the evaluation of spermatogenesis.

Penile Ultrasound

Patient Preparation

The patient should lay comfortably on the examination table in a supine position with legs together providing support for the external genitalia. An alternative position is dorsal lithotomy with the penis lying on the anterior abdominal wall. Regardless of patient position preferred, the area of interest should remain undraped for the duration of the examination, but care should be taken to cover the remainder of the patient as completely as possible including the abdomen, torso, and lower extremities. Ample amounts of ultrasonographic acoustic gel should be used between the transducer probe and the surface of the penis to allow for high-quality images without acoustic interruption.

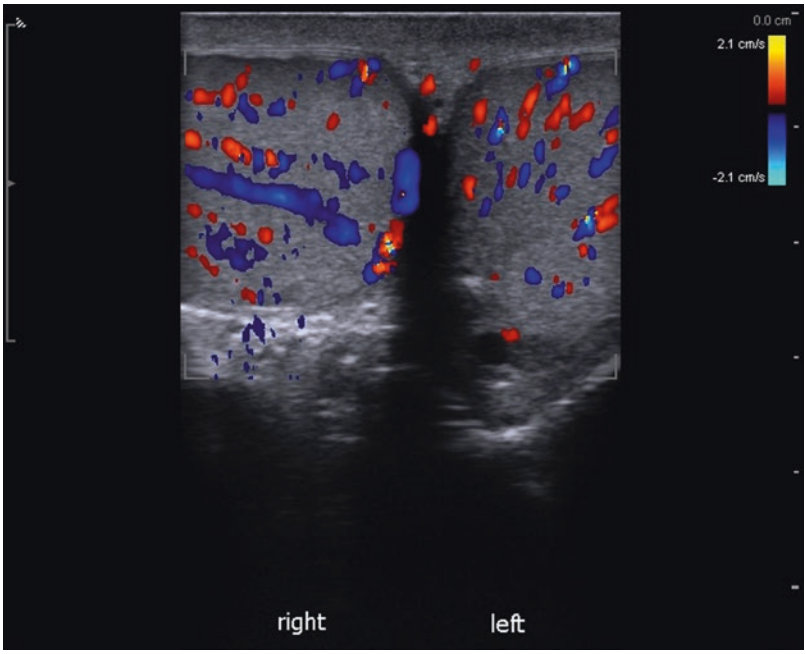


Fig. 18.17 Transverse view of intratesticular blood flow pattern (split screen images)

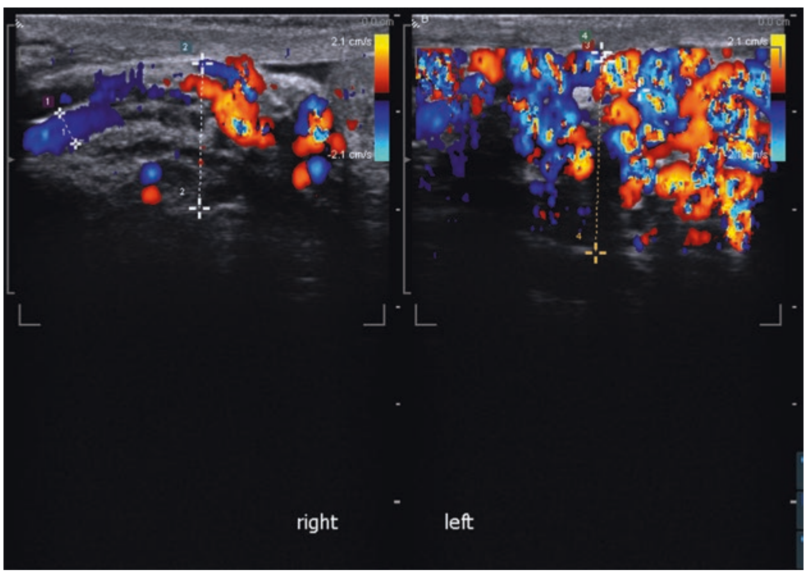


Fig. 18.18 Longitudinal view of spermatic cord for varicocele evaluation (split screen images)

Routine Survey Scan

As with other ultrasound exams, penile ultrasound uses specific scanning techniques and images targeting the clinical indication prompting the study. Irrespective of the indication for penile ultrasound, routine scanning during penile ultrasound should obtain both transverse and longitudinal views of the penis by placing the transducer probe on the dorsal or ventral aspect of the penis. We will present the technique using a dorsal approach which we find easier for the flaccid phallus. However, the ventral approach is often better with a fully erect phallus. The goal is to visualize the cross-sectional view of the two corpora cavernosa dorsally and the corpus spon-

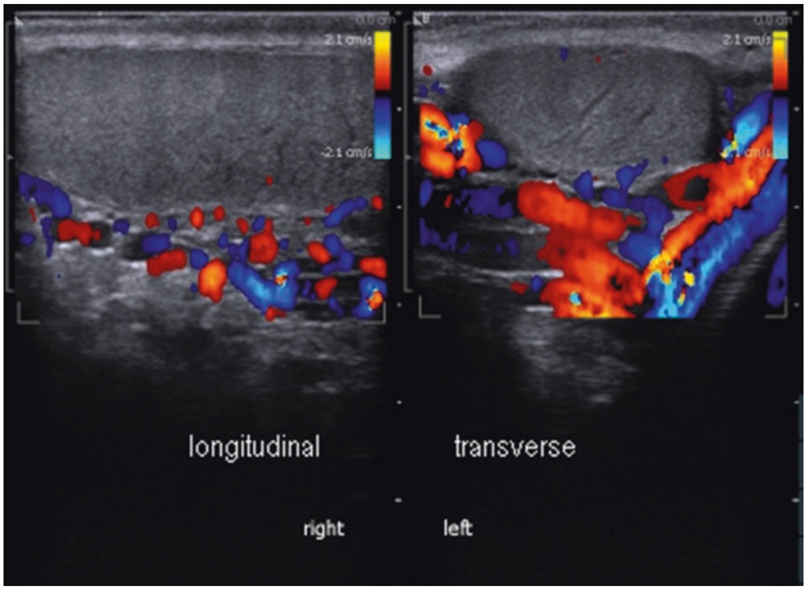


Fig. 18.19 Transverse view of spermatic cord for varicocele evaluation (split screen images)

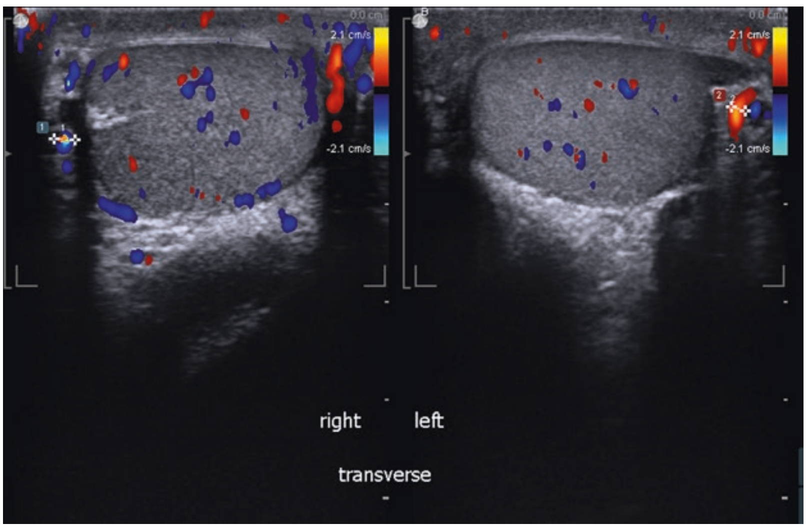


Fig. 18.20 Transverse view of intratesticular blood flow pattern (split screen images)

giosum ventrally at different points along the length of the penis from the base of the penile shaft scanning distally toward the glans penis.

The corpora cavernosa appears dorsally, as two homogeneously hypoechoic circular structures, each surrounded by a thin (usually less than 2 mm) hyperechoic layer representing the tunica albuginea that envelops the corpora. The tunica albuginea is a fibroelastic tissue that can become more echogenic and thicker with increased fibrosis. This is often seen in men with Peyronie's disease and erectile dysfunction related to the inability of the emissary veins to be compressed against the inside of the tunica albuginea resulting in a venous leak. The corpus spongiosum is a ventrally located circular structure with homogeneous echotexture, usually more echogenic than the corpora cavernosa. It is well visualized by placing the ultrasound transducer probe on either the dorsal or ventral aspect of the penis; however, it is easily compressible, so minimal pressure should be

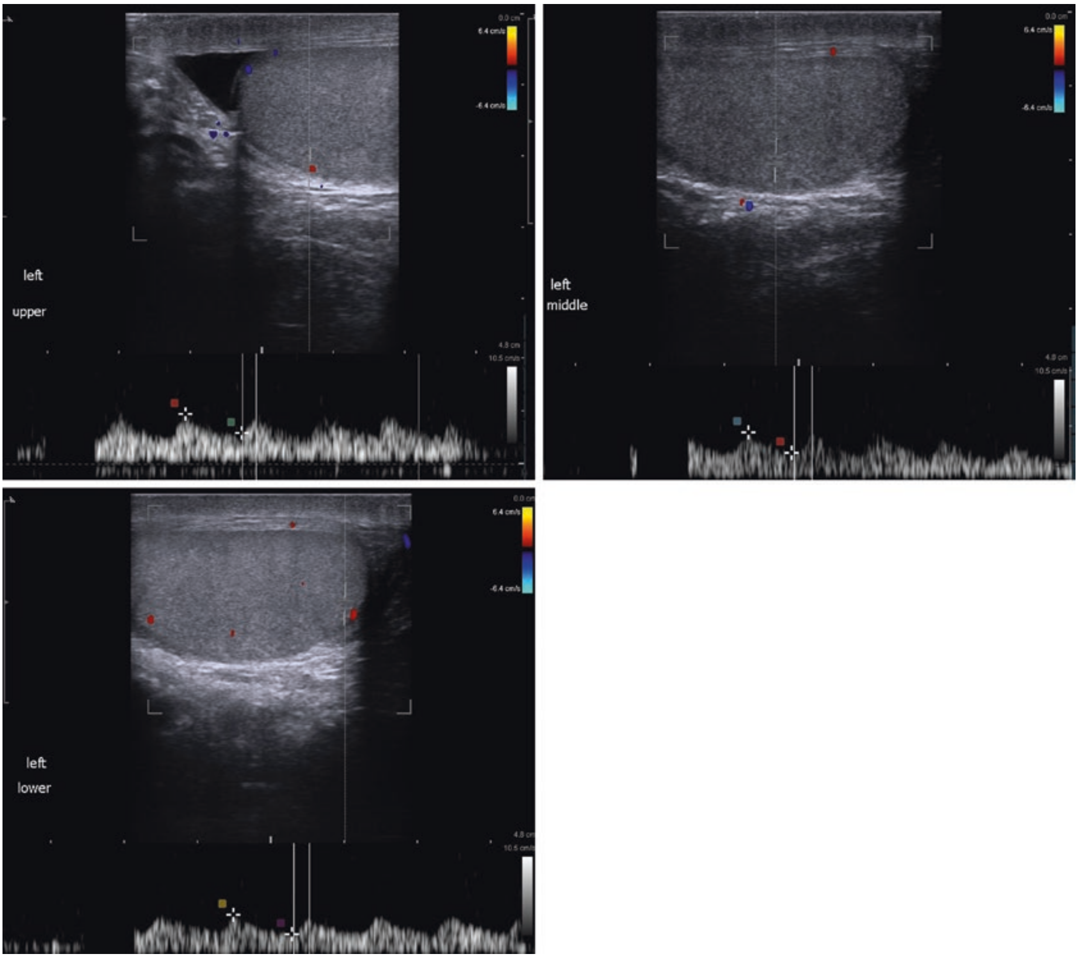


Fig. 18.21 Spectral Doppler of left intratesticular arteries in the upper, upper-middle, and lower pole of the testis (single image view)

maintained while scanning. For routine anatomic scanning of the penis with ultrasound, all three corpora can be sufficiently viewed from a single dorsal aspect obtained image of the penile shaft. A survey scan is first performed prior to obtaining static images at the proximal (base), mid-portion, and distal (tip) of the corpora cavernosal bodies for documentation. The value of the survey scan cannot be overstated. It often provides the perspective that is necessary to assure the absence of coexisting pathology. In addition, a careful survey scan of the phallus will identify abnormalities of the cavernosal vessels, calcified plaques as well as abnormalities of the spongiosa tissue. All abnormalities should be documented with appropriate measurements, if applicable, in static images.

Static images recommended as representative views of this initial surveying scan are the transverse view at the base of the penile shaft, at the mid-shaft, and at the distal shaft just proximal to the corona of the glans penis. Each image shows transverse sections of all three corporal bodies. Orientation, by convention, is for the right corporal body to be on the left side of the display while the left corporal body is located on the right side of the display. Our preference when viewing a longitudinal projection is to use a split-screen view to compare the right and left corporal bodies with measurements of the cavernosal artery diameter taken in this view. We keep the orientation constant, with the projection of the right corporal body on the left side of the display while the left corporal body is located on the

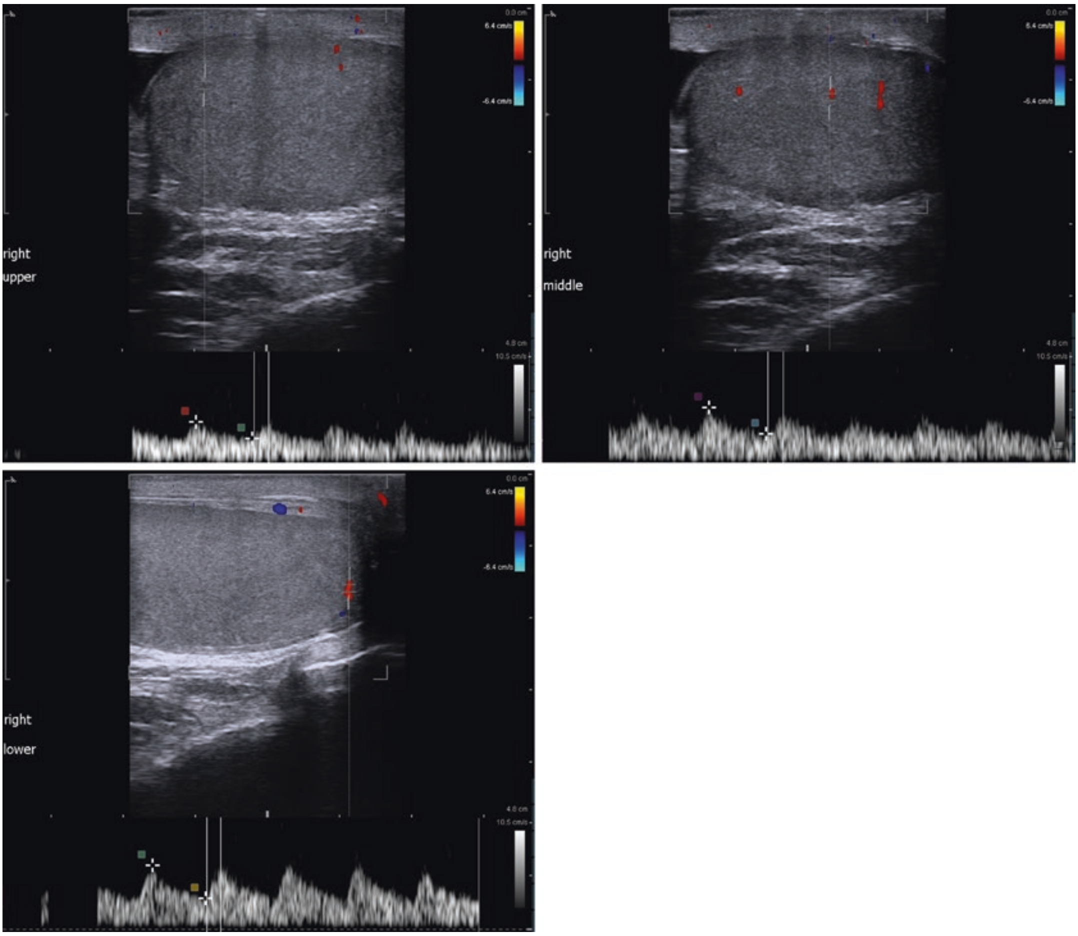


Fig. 18.22 Spectral Doppler of left intratesticular arteries in the upper, upper-middle, and lower pole of the testis (single image view)

right side of the display. Either a dorsal or ventral approach can be used as preferred by the sonographer. A flaccid phallus is often best visualized by the dorsal approach while an erect phallus by the ventral approach.

Penile Ultrasound Protocol

Specifics to be Documented on Report

- Indication for Procedure: For example, evaluation of penile curvature, evaluation of erectile dysfunction, and evaluation of urethral blood supply. Diagnosis codes can also be included to document medical necessity.
- Transducer: 12–18 MHz linear array transducer with a small footprint.

Please note: if all components of the exam are not seen, then the report should document that component was "Not Seen" and why.

Baseline Study

- Longitudinal and transverse survey scan of the phallus including the corporal bodies and urethra with video clips. This should include views of both corpora cavernosa and corpora spongiosum. Any abnormalities seen should be specifically interrogated and

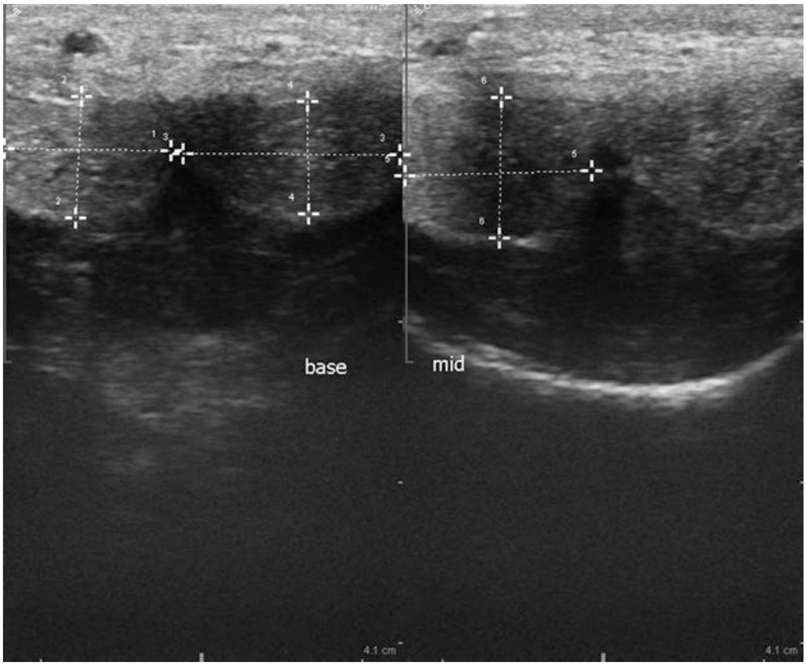


Fig. 18.23 Split screen base (proximal), mid and distal view of phallus in transverse plane with height and width measurements

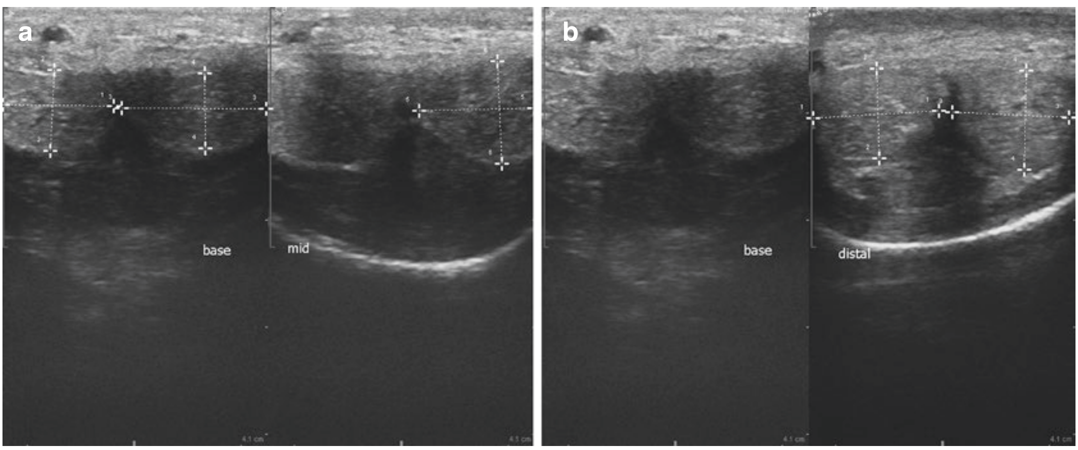


Fig. 18.24 (**a**) Split screen base (proximal), mid and distal view of phallus in transverse plane with height and width measurements. (**b**) Split screen base (proximal), mid and distal view of phallus in transverse plane with height and width measurements

documented. These cine loops will allow for the comparative echogenicity of both corpora. If a cine loop is not obtained, then a split-screen view documenting comparative echogenicity should be obtained.

- Split-screen base (proximal), mid and distal views of the phallus in the transverse plane. This should include views of both corpora cavernosa and corpora spongiosum, Figs. 18.23 and 18.24a, b.
- Measure height and width of the mid phallus of each corpora in transverse projection, Fig. 18.23 and 18.24a, b.
- Split-screen longitudinal views of both corpora cavernosa and corpora spongiosum. This should include views of the left and right cor-

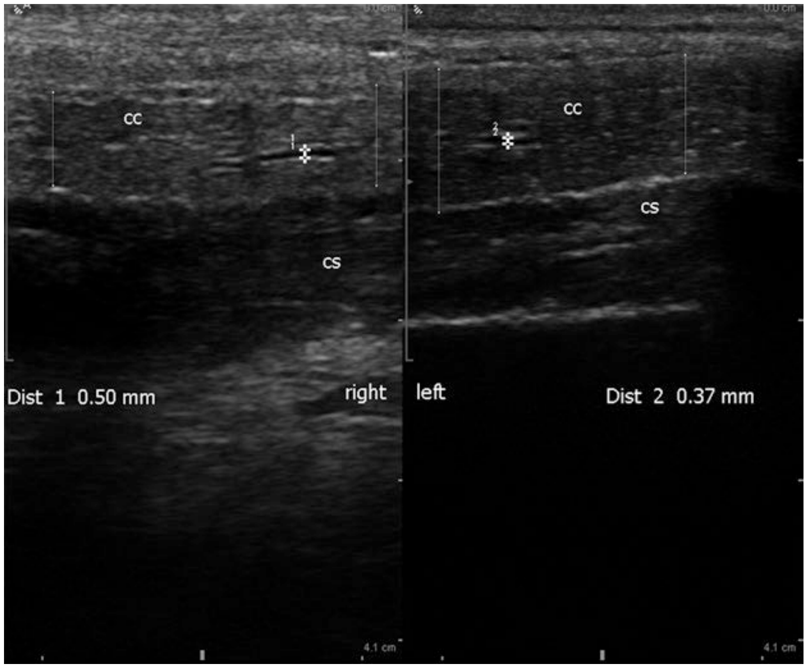


Fig. 18.25 Split screen longitudinal views of both corpora cavernosa (cc) and corpora spongiosum(cs) with measurement of the cavernosal arteries and corpora cavernosa width measurements (double head arrows)

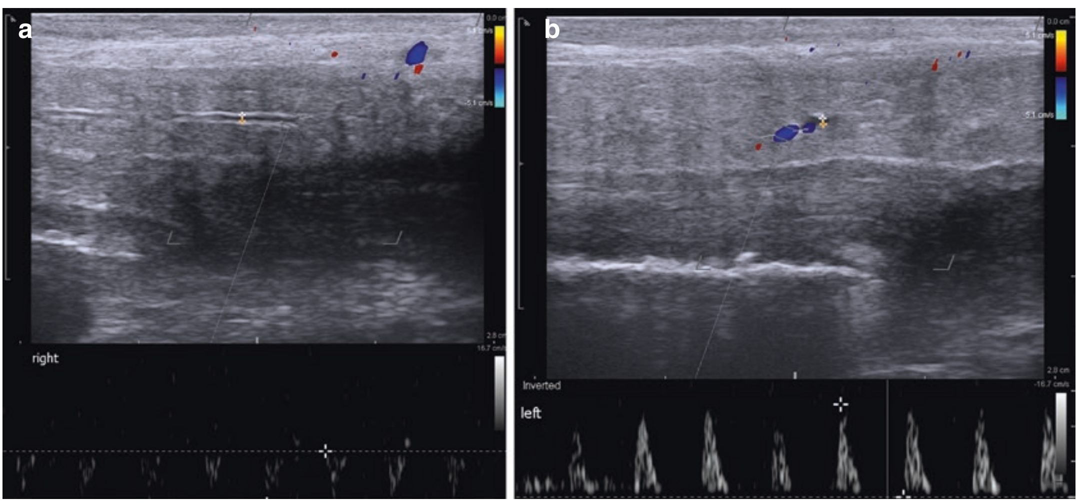


Fig. 18.26 (**a**) Baseline spectral Doppler waveform of right cavernosal artery. (**b**) Baseline spectral Doppler waveform of left cavernosal artery

pora cavernosal arteries, Fig. 18.25. Measure the height of the proximal, mid, and distal phallus of each corpora in the longitudinal projection.

- Baseline spectral Doppler waveform (with PSV, EDV, RI, and optional measurements (e.g., acceleration time and pulsatility index) and inner diameter measurements of longitudinal views of both left and right cavernosal arteries, Fig. 18.26a, b.
- Document abnormalities (e.g., altered echogenicity, plaques, calcifications, and corpora tears) in both transverse and longitudinal projections with measurements, Fig. 18.27a–c.
- Baseline spectral Doppler waveform (with PSV, EDV, RI, and optional measurements)

including inner diameter measurements of Left and Right Cavernosal Artery.
- Sonoelastography (if available) of the phallus in both transverse and longitudinal projections, P5d.
  – Transverse images of base phallus, mid phallus, and distal phallus with additional images of areas of interest (e.g., dense tissue, calcifications, etc.).

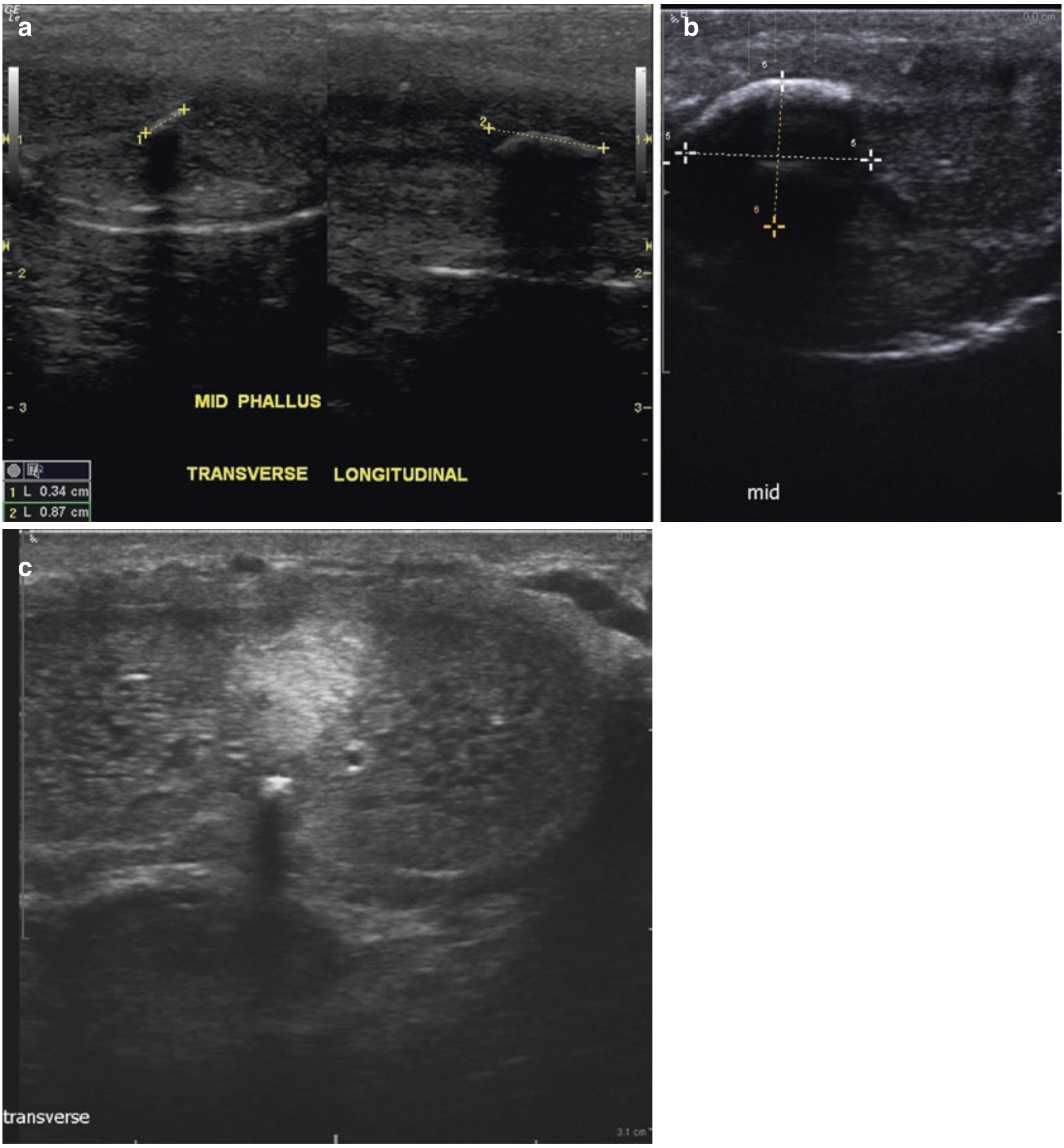


Fig. 18.27 (**a**) Transverse and longitudinal measurements of calcification in penile plaque (split screen images). (**b**) Transverse projection of phallus demonstrating a calcified plaque in the anterior tunica albuginea in the mid phallus on the right (arrows). (**c**) Transverse projection of phallus demonstrating a non-calcified dense (echogenic) plaque between the two corpora cavernosa and a small (punctate) calcification inferior to this with posterior shadowing. (**d**) A series of sonoelastography images of the phallus in both transverse and longitudinal projections demonstrating areas of increased firmness (red) in the left corpora as compared to the softer (blue) right corpora cavernosa

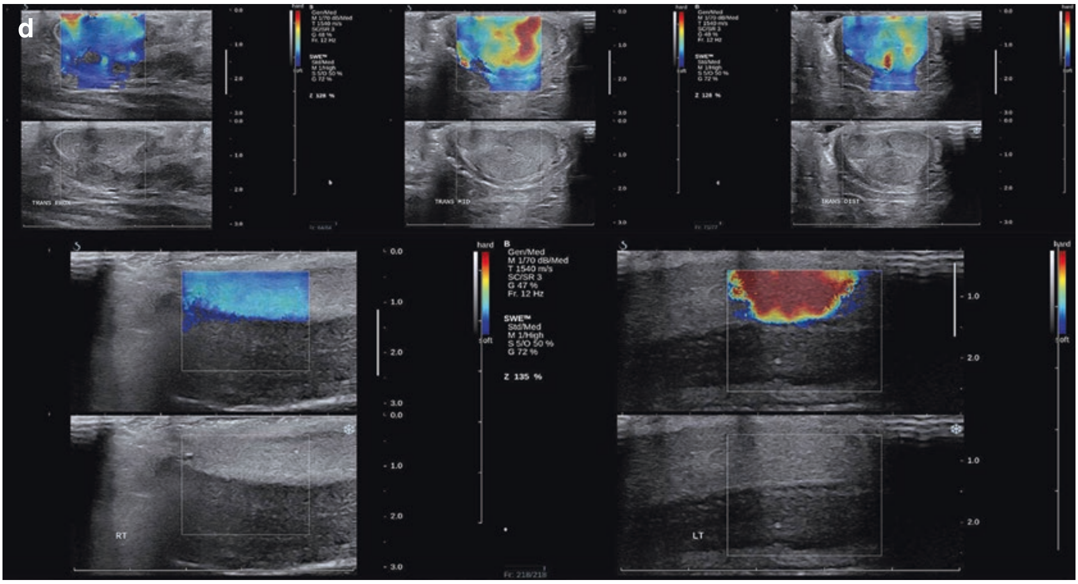


Fig. 18.27 (continued)

– The longitudinal (sagittal) projection should be of the left and right corpora cavernosa centered on the cavernosal artery on the left and right cavernosal artery. The mid-sagittal projection should also be imaged as should additional images of areas of interest (e.g., dense tissue, calcifications, etc.).

Penile Study for Vascular Integrity

Technical Pointers for Spectra Doppler:

1. Make sure that the angle of incidence is less than 60°.
2. PSV and EDV measured with at least 3 waveforms of equal size present.

Post-injection spectral Doppler analysis of the left and right cavernosal artery (performed every 5 minutes giving an additional medication injection every 10 minutes, if indicated), Fig. 18.28a, b.

- Spectral Doppler waveform (with PSV, EDV, RI, and optional measurements).
- Inner diameter measurements of Left and Right Cavernosal Artery.
- Subjective assessment of tumescence and rigidity.
- Split-screen base (proximal), mid and distal views of the phallus in the transverse plane with height and width measurements at maximal tumescence (Fig. 18.29).

In addition, we perform sonoelastography at baseline and when maximum corporal dimensions (i.e., maximal tumescence) are achieved and include

- Sonoelastography of the phallus in both transverse and longitudinal projections.
  – Transverse images of base phallus, mid phallus, and distal phallus with additional images of areas of interest (e.g., dense tissue and calcifications).
  – The longitudinal (sagittal) projection should be of the left and right corpora. Cavernosa centered on the cavernosal artery on the left and right cavernosal artery. The mid digital projection should also be imaged as should additional images of areas of interest (e.g., dense tissue and calcifications).

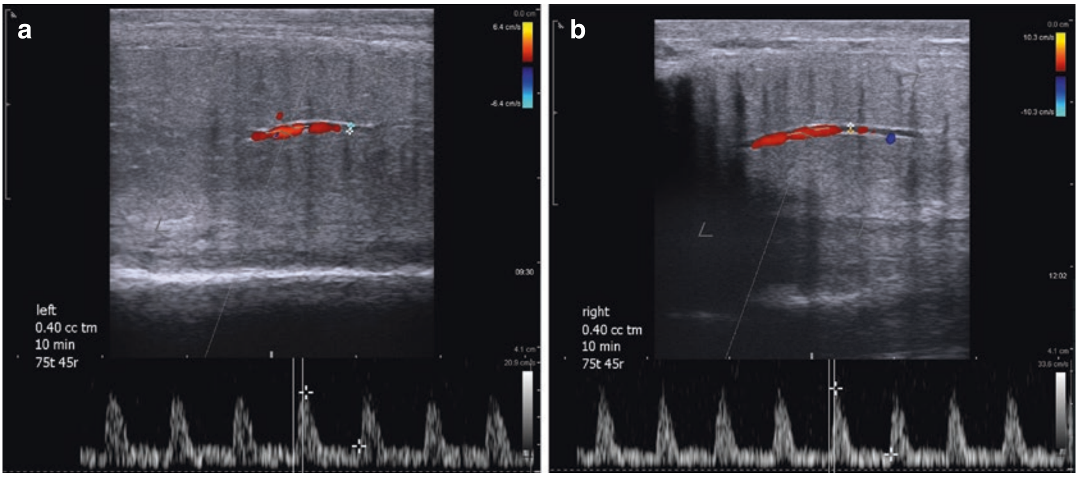


Fig. 18.28 (**a**) 10 minute post-injection spectral Doppler analysis of the left cavernosal artery. (**b**) 10 minute post-injection spectral Doppler analysis of the right cavernosal artery

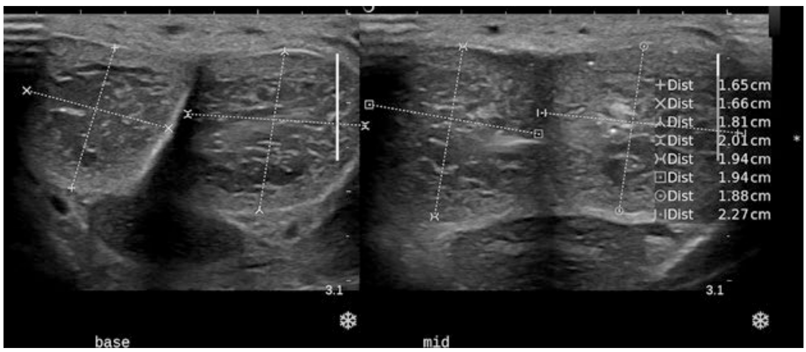


Fig. 18.29 Split screen transverse view of the base (proximal), mid view of the phallus 10 minutes after injection with measurements

We end our study when any of the following conditions occur:

- RI is equal to or greater than 1.0 or
- The maximal PSV is reached (i.e., subsequent measurements demonstrate decreasing PSV) or.
- Our maximal concentration/volume of pharmacologic agent is used.

Perineal (Bulbocavernosal Muscle aka Bulbospongiosus Muscle)

Measurement of the Bulbocavernosal Muscle (BCM) aka Bulbospongiosus Muscle is a novel way of assessing the androgenic effects of testosterone in men. Dabaja et al. [19] (Asian Journal of Andrology 2014, 16, 1–5) have provided compelling evidence that the BCM area correlates with androgenic activity. They also have data (personal communications) suggesting that BCM area less than 0.75 cm^2 correlates with hypogonadism and that testosterone supplementation results in an increased BCM. This is important since, at present, we have no way, other than assessing serum testosterone and DEXA, to evaluate the efficacy of testosterone replacement therapy. In addition, since the BCM is integral in the ejaculatory process this might provide insight into the etiology of this common malady. We have therefore implemented their protocol in patients presenting with complaints of hypogonadism and/or ejaculatory dysfunction as an additional marker of low testosterone prior to the institution of therapy. We will also follow this measurement after therapy is initiated.

To begin the examination, the patient should be supine with the legs in a "frog leg" position to enable the sonographer to gain access to the perineum. The area of interest is the anogenital line as indicated in Fig. 18.30.

1. Survey scan of the urethra and cavernosal bodies from distal to proximal in the transverse plane with video clips. The area in red in Fig. 18.31 is the bulbocavernosus muscle draped over the urethra. Imaging of this muscle will use both translational motion and non-translation techniques termed painting and fanning respectively.

   In the transverse plane, obtain a transverse view in which the urethra cross-section is seen as round (Fig. 18.32). Measure the width of the right (RT BCM) and left (LT BCM) aspects of the bulbocavernosus muscle as well as along the tendinous raphe (AP BCM). Also, measure the AP dimension of the urethra (urethra). You should obtain the best transverse image of the bulbocavernosus muscle. This should be where the urethra is seen as round. This orientation will prevent obtaining an oblique view, which might overestimate the dimensions of the bulbocavernosus muscle. You will then measure the Right and left BCM width as described above. In this same projection, you should measure the area of the bulbocavernosus muscle (Fig. 18.33). The BCM area is most often obtained by freehand drawing using the trackball on the ultrasound unit. Repeat these measurements on a second image. Report each set of measurements separately as well as reporting the average of the two readings (see BCM template).
2. You will then turn the transducer and perform a survey scan in the longitudinal direction to interrogate the urethra. Perform a longitudinal survey scan of the urethra identifying the area

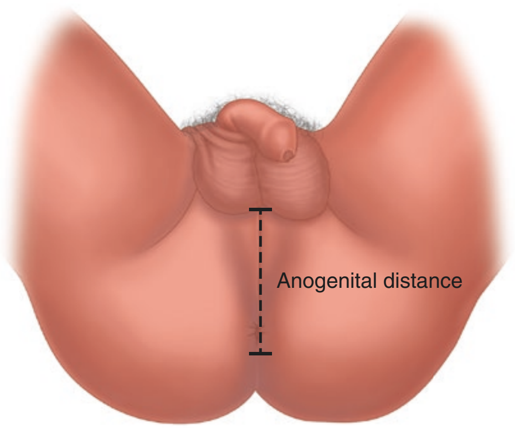


Fig. 18.30 Anogenital line

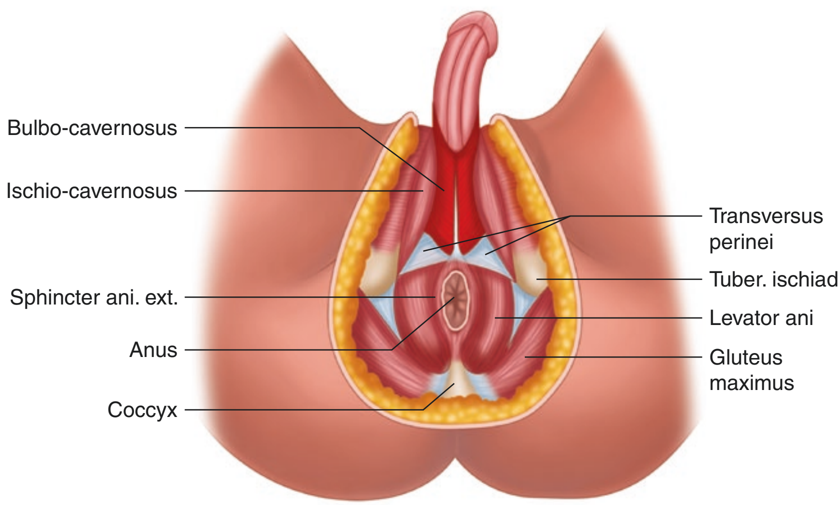


Fig. 18.31 In this schematic, the bulbocavernosus muscle (BCM), also known as the bulbospongiosis muscle, is red. (20th US edition of *Gray's Anatomy of the Human Body*, 1918, open access)

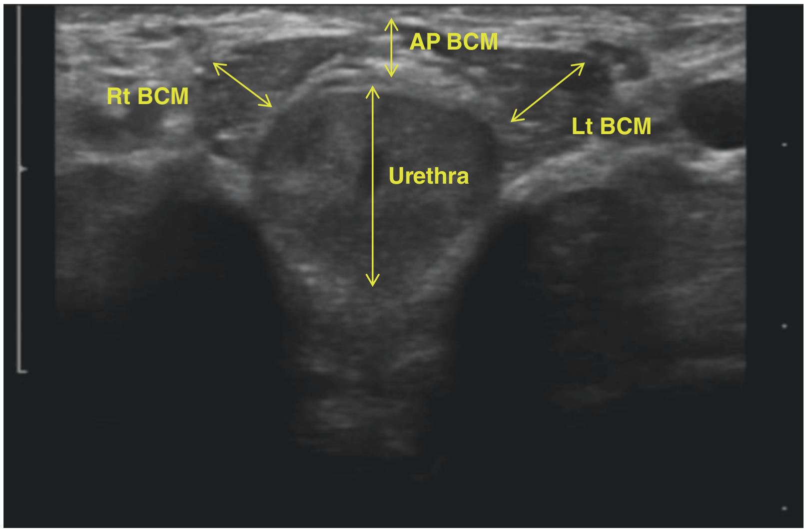


Fig. 18.32 Transverse view in which the urethra cross section is seen as round. Shown are the measurements of the right, mid, and left BCM as well as the urethra

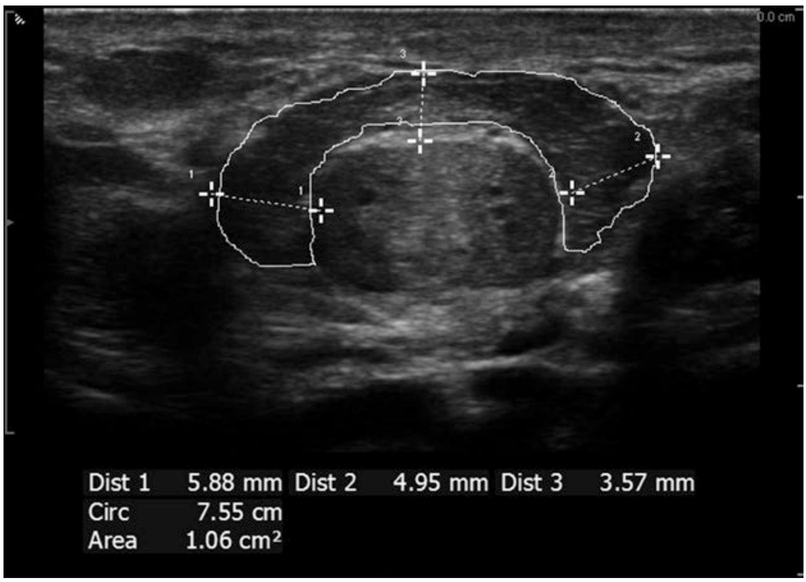


Fig. 18.33 Freehand measurement of the area of the bulbocavernosus muscle

of the bulbar urethra as well as the location of the paired urethral arteries with color Doppler. Try also to follow the cavernosal bodies to their proximal tip and identify the cavernosal artery from its origin and follow it distally. Save a video loop of this survey scan. Also save representative longitudinal images in the region of the BCM which also demonstrates the urethra: Left Longitudinal (Fig. 18.34), Mid Longitudinal (Fig. 18.35) and Right Longitudinal (Fig. 18.36). With color Doppler, scan the cavernosal and bulbourethral arteries throughout their course in the perineum (Fig. 18.37). We also capture a cine loop of this.

A video on penile ultrasound and BCM evaluation can be reviewed at https://www.youtube.com/watch?v=79t3SvINMNE which demonstrates the essential components of these studies.

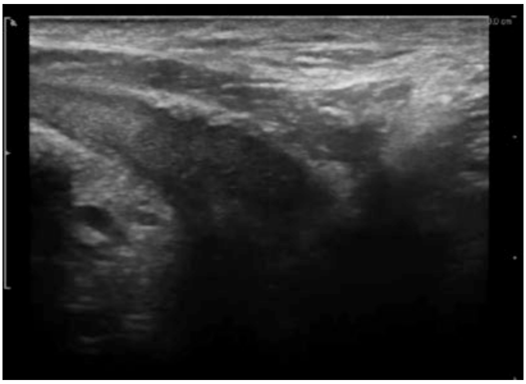


Fig. 18.34 Image of a longitudinal view of the phallus on the left at the level of where the BCM measurement was taken

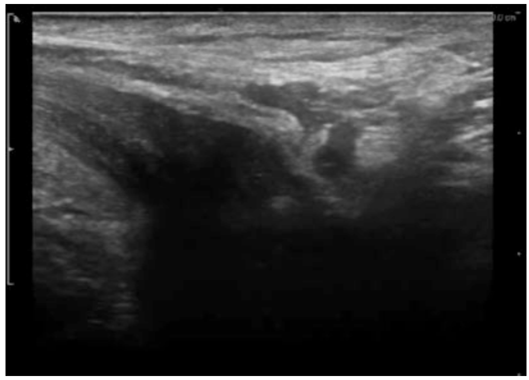


Fig. 18.35 Image of a longitudinal view of the mid phallus at the level of where the BCM measurement was taken

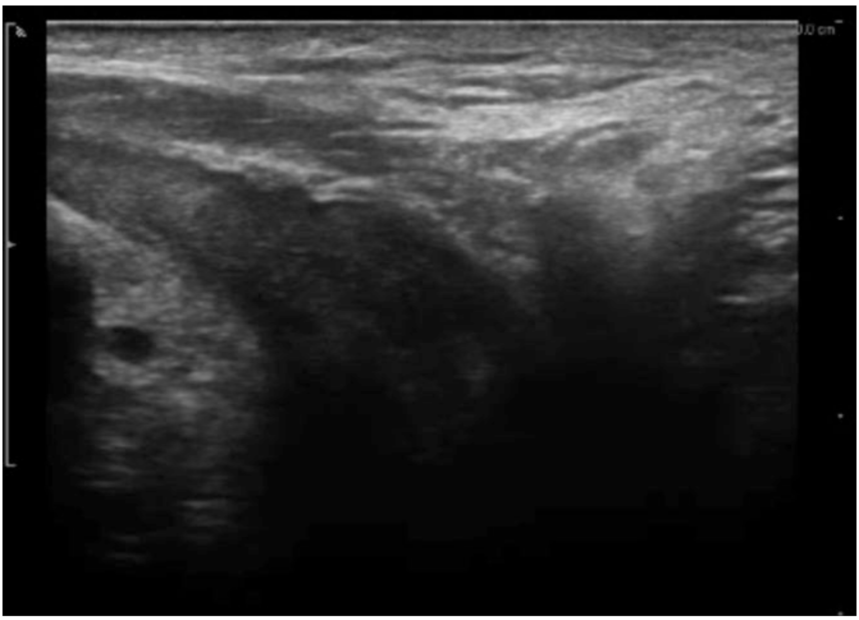


Fig. 18.36 Image of a longitudinal view of the phallus on the right at the level of where the BCM measurement was taken

Bladder

Basic Scanning Technique

An even coating of warm conducting gel is placed on the patient's skin prior to beginning the ultrasound examination. Gentle and firm contact is made with the transducer on the lower abdominal wall. Start the examination in the transverse view. Bone inhibits sound waves. Positioning the transducer so that the waves strike the bones of the pubis will produce posterior acoustic shadowing. The image of the bladder may not appear on the screen or only appear in part. Acoustic shadowing from the pubic bone may be avoided by placing the transducer in the transverse view position superior to the pubic bone and then varying the angle of insonation and pressure applied to the

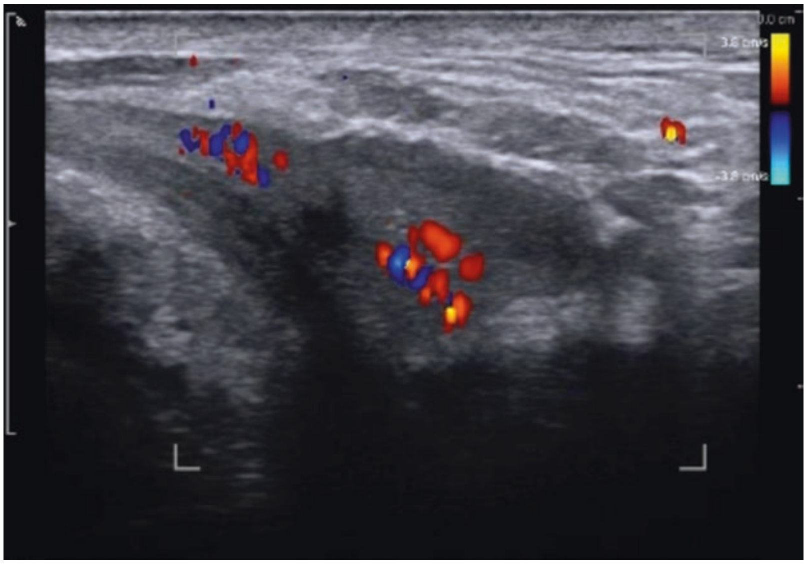


Fig. 18.37 Color Doppler image of a longitudinal view of the mid phallus at the level of where the BCM measurement was taken

transducer as well as fanning inferiorly, to find the echo-free lumen of the bladder.

The machine settings should be adjusted to obtain a good quality image. The image should be of sufficient and uniform brightness, sharp and in focus, of adequate size, with proper image orientation and proper labeling on the image. For this, the Gain-Control setting varies the sensitivity of the transducer to returning sound waves. The Acoustic Output controls the amplitude of the generated sound waves; keep the output at a minimal setting. The Time-gain compensation (TCG) is used to obtain uniform tissue echogenicity as one moves away from the transducer. The Focal Zone Setting brackets the structure or organ of primary interest for maximal resolution. Other controls at the examiner's disposal include the depth/size function, the field of view, and cine function for a live recording of the study.

In the transverse view of the bladder, the right side of the bladder should appear on the left side of the screen. In the sagittal view, the superior aspect of the bladder should appear on the left side of the screen. In the transverse bladder view, measure the height and width of the bladder. Carefully look at the bladder for anomalies such as trabeculations, best seen on the sagittal view, bladder stones, diverticula, and wall lesions that could represent a transitional cell tumor. Look at the bladder base for the presence of dilated ureters, distal ureteral stones, and ureteroceles. Efflux can be appreciated using power or color Doppler and looking over the site where the orifices would be found.

Measurement of bladder wall thickness is taken, by convention, on a bladder filled with 150 cc. The bladder wall thickness is measured at the posterior wall on the sagittal view. If the bladder wall thickness is less than 5 mm, there is a 63% probability that the bladder is not obstructed. However, if the bladder wall thickness is over 5 mm, there is an 87% probability that there is bladder obstruction [20].

Further ultrasound study of the bladder can determine the presence of focal lesions, such as bladder tumors. Ultrasound is sensitive for lesions greater than 1 cm in size but has poor specificity. A lesion found on the bladder wall can be further interrogated by the use of color Doppler to confirm the presence of increased blood flow into the lesion.

Power or color Doppler can be utilized, while imaging the bladder base, to show efflux of urine called ureteral jets. The distal ureters can be examined sonographically for the presence of distal ureteral dilation, suggesting obstruction. A hyperechoic lesion might indicate a distal ureteral stone or distal ureteral scar tissue or lesion.

A basic evaluation of the prostate and seminal vesicles is also performed at this time.

Transabdominal Bladder

Specifics to be Documented on Report

- Indication for Procedure: For example, lower urinary tract symptoms, total painless gross hematuria. Diagnosis code can also be included to document medical necessity.
- Transducer: 3 to 5 MHz curved array transducer with a small footprint.

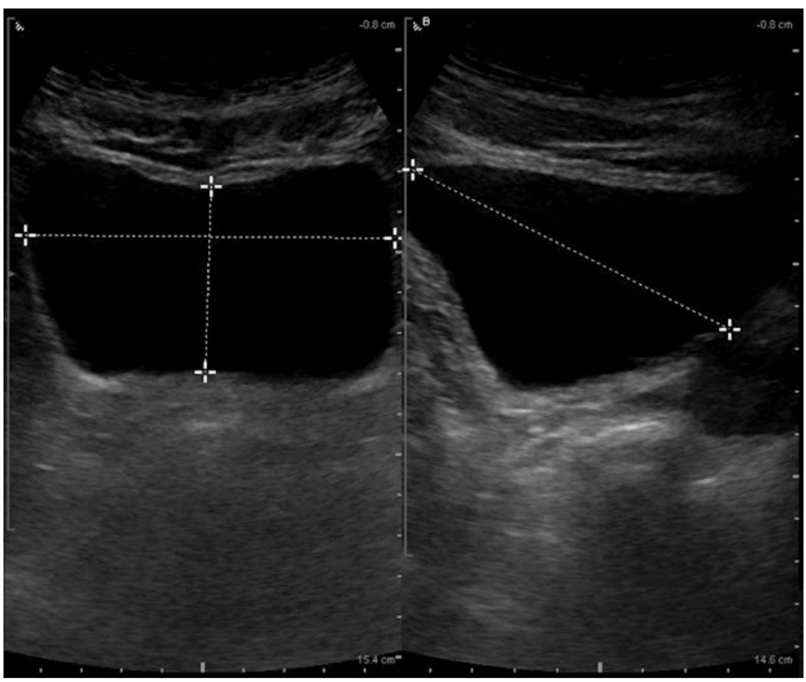
Please note: if all components of the exam are not seen, then the report should document that component was "Not Seen" and why.

Bladder (full bladder >150 cc)

1. Longitudinal and transverse survey scan of the bladder with video clips.
2. Bladder (split-screen): mid-sagittal and mid-transverse views with volume, height (AP), width, and length measurements, Fig. 18.38.
3. Measurement of bladder wall thickness in at least two locations (posterolateral and dome preferred), Fig. 18.39.
4. Representative color flow views of the left and right ureteral jets with video clip if possible, Fig. 18.40.
5. Document post-void residual, Fig. 18.41.

Fig. 18.39 Transverse view of right and left seminal vesicle thickness as seen posterior to the bladder

Fig. 18.38 Split screen view of the transvers (left image) and mid-sagittal (right image) view of the bladder



Transabdominal Prostate

Once examination of the bladder has been concluded and the images stored, attention is given the prostate gland in male patients. Both transverse and sagittal views are employed, as in the bladder. To view the prostate, however, the ultrasound probe must be angled to project the ultrasound beam behind the pubic bone. To do this, additional pressure is required to be applied against the abdominal wall. Measure the prostate first in the transverse view to obtain the height and width of the prostate. Measure the length of the prostate in the sagittal view. The volume of the prostate is automatically determined by most ultrasound equipment, but may also be calculated using the formula: Length × Width × Height × 0.523. The shape of the middle lobe can be described in the sagittal view. The presence of intravesical prostatic protrusion is present when the middle lobe extends into the bladder lumen. On a line drawn across the bladder neck (BN, TRUS 8), connecting the bladder base on either side, the protrusion of the prostate in centimeters is determined by the length of a vertical line (IPP, TRUS 8) perpendicular to line a. The intraprostatic protrusion (IPP) is Grade I if the line is <0.5 cm; Grade II if >0.7 cm and Grade III if >1 cm. The IPP grade corresponds to the probability of bladder outlet obstruction [21].

In examining the prostate, evaluate for calcification in the parenchyma of the prostate, lucent lesions, cysts, and solid mass effects. Further

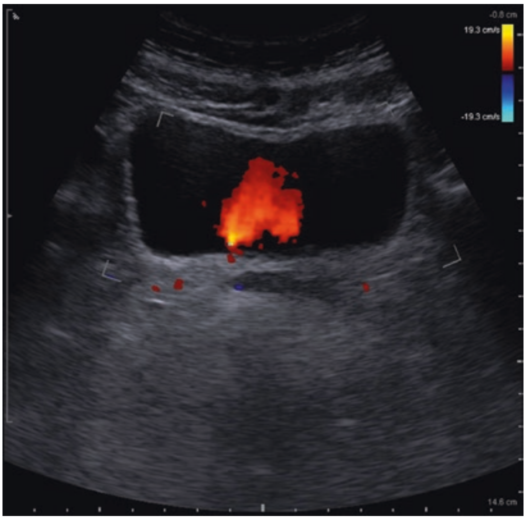


Fig. 18.40 Color Doppler views of left and right ureteral jets

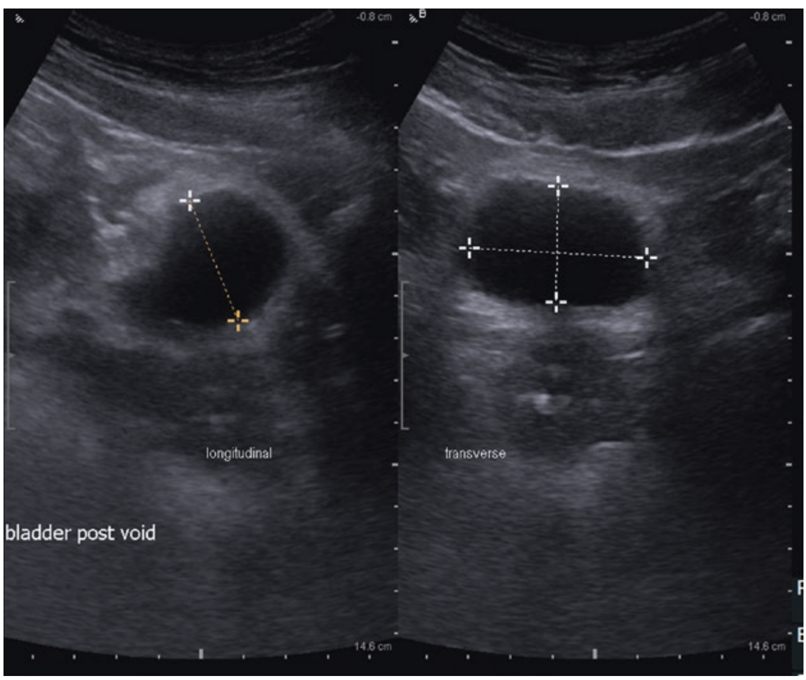


Fig. 18.41 Post void residual measurement of the bladder (split screen images)

characterization of prostatic abnormalities can be made with digital rectal examination, transrectal ultrasound, and computerized tomography if necessary.

Abdominal Prostate Imaging

Specifics to be Documented on Report:

- Indication for Procedure: For example, lower urinary tract symptoms. Diagnosis code can also be included to document medical necessity.
- Transducer: 3 to 5 MHz curved array transducer with a small footprint.

Please note: if all components of the exam are not seen, then the report should document that component was "Not Seen" and why.

1. Longitudinal and transverse survey scan of the prostate with video clips.
2. Split-screen mid-sagittal and mid-transverse views with volume, height (AP), width, and length measurements. Fig. 18.42.
3. Seminal vesicles: transverse views for width measurements. Fig. 18.43.
4. Seminal vesicles: Longitudinal view of the left and right seminal vesicles with length and width measurements Fig. 18.44a,b.

For a complete prostate evaluation, including views of the base and apex as well as evaluation of the seminal vesicles, the transrectal approach is preferred.

Fig. 18.43 Transverse view of right and left seminal vesicle thickness as seen posterior to the bladder

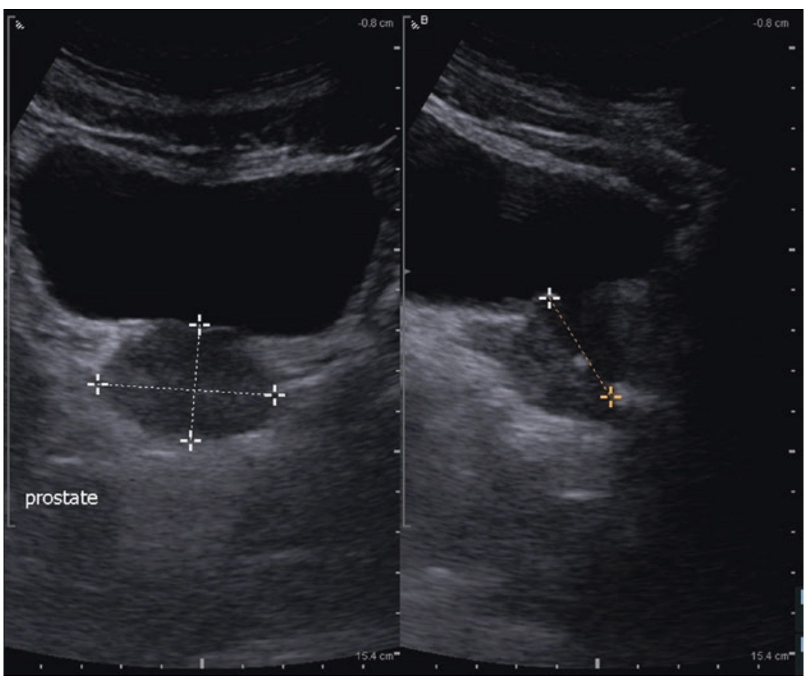


Fig. 18.42 Split screen mid-transverse (left image) mid-sagittal (right image) view of the prostate

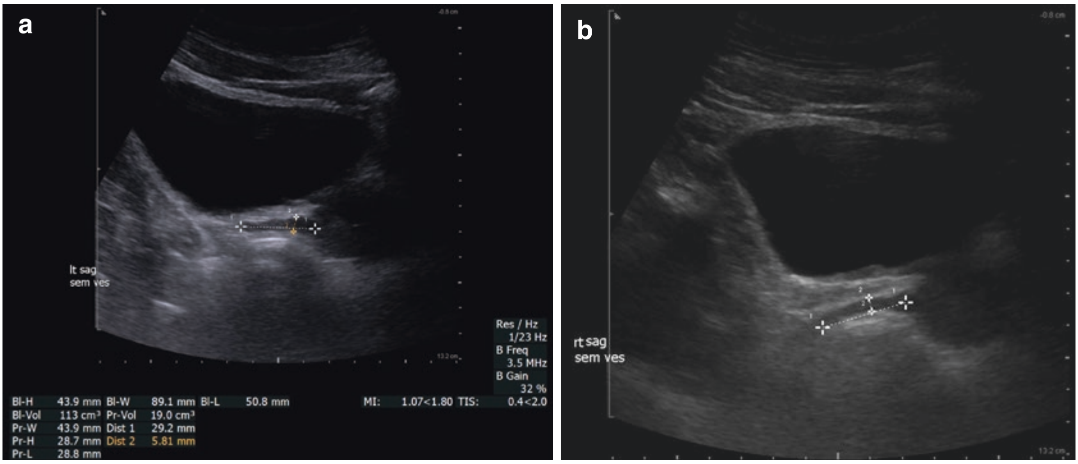


Fig. 18.44 (**a**) Longitudinal view of the left seminal vesicle thickness as seen posterior to the bladder. (**b**) Longitudinal view of the left seminal vesicle thickness as seen posterior to the bladder

Kidneys

A urologic ultrasound examination of the kidneys should include views of the bladder and ureters (if visualized). This is especially important when hydronephrosis is present.

Renal echogenicity should be compared to the echogenicity of the adjacent liver or spleen. The kidneys and perirenal regions should be assessed for abnormalities. Dilation of the collecting system or the presence of solid or cystic masses should be noted. Vascular examination of the kidneys by color Doppler is often used for the following:

a. To assess renal arterial and venous patency.
b. To evaluate adults suspected of having renal artery stenosis. For this application, angle-adjusted measurements of the peak systolic velocity should be made proximally, centrally, and distally in the extrarenal portion of the main renal arteries when possible. The peak systolic velocity of the adjacent aorta (or iliac artery in transplanted kidneys) should also be documented for calculating the ratio of renal to aortic peak systolic velocity. Spectral Doppler evaluation of the intrarenal arteries from the upper and lower portions of the kidneys, obtained to evaluate the peak systolic velocity, may be of value as indirect evidence of proximal stenosis in the main renal artery. A ratio of the peak systolic velocity over the peak systolic velocity–end-diastolic velocity (resistive index) of an intralobular renal artery can be used to evaluate intrarenal vascular resistance.

Urinary Bladder and Adjacent Structures

When performing a complete ultrasound evaluation of the kidneys, transverse and longitudinal images of the distended urinary bladder and its wall should be included if possible. Bladder lumen or wall abnormalities should be noted. Dilatation or other distal ureteral abnormalities should be documented. This is especially important when hydronephrosis is present.

Transverse and longitudinal scans may be used to demonstrate any post-void residual, which may be quantitated and reported. The size and shape of the prostate should be reported when possible.

Renal Ultrasound Protocol

Specifics to be Documented on Report

- Indication for Procedure: For example, renal calculi, hydronephrosis, hydroureter, collecting system abnormalities, and renal tumors. Diagnosis code can also be included to document medical necessity.
- Transducer: 3 to 5 MHz curved array transducer.

Please note: if all components of the exam are not seen, then the report should document that component was "Not Seen" and why.

1. Longitudinal and transverse survey scans of both right and left kidney with video clips.
2. Single- or split-screen mid-sagittal and mid-transverse views of each kidney with height (AP), width, and length measurements (Fig. 18.45a,b). Also Cortical and parenchy-

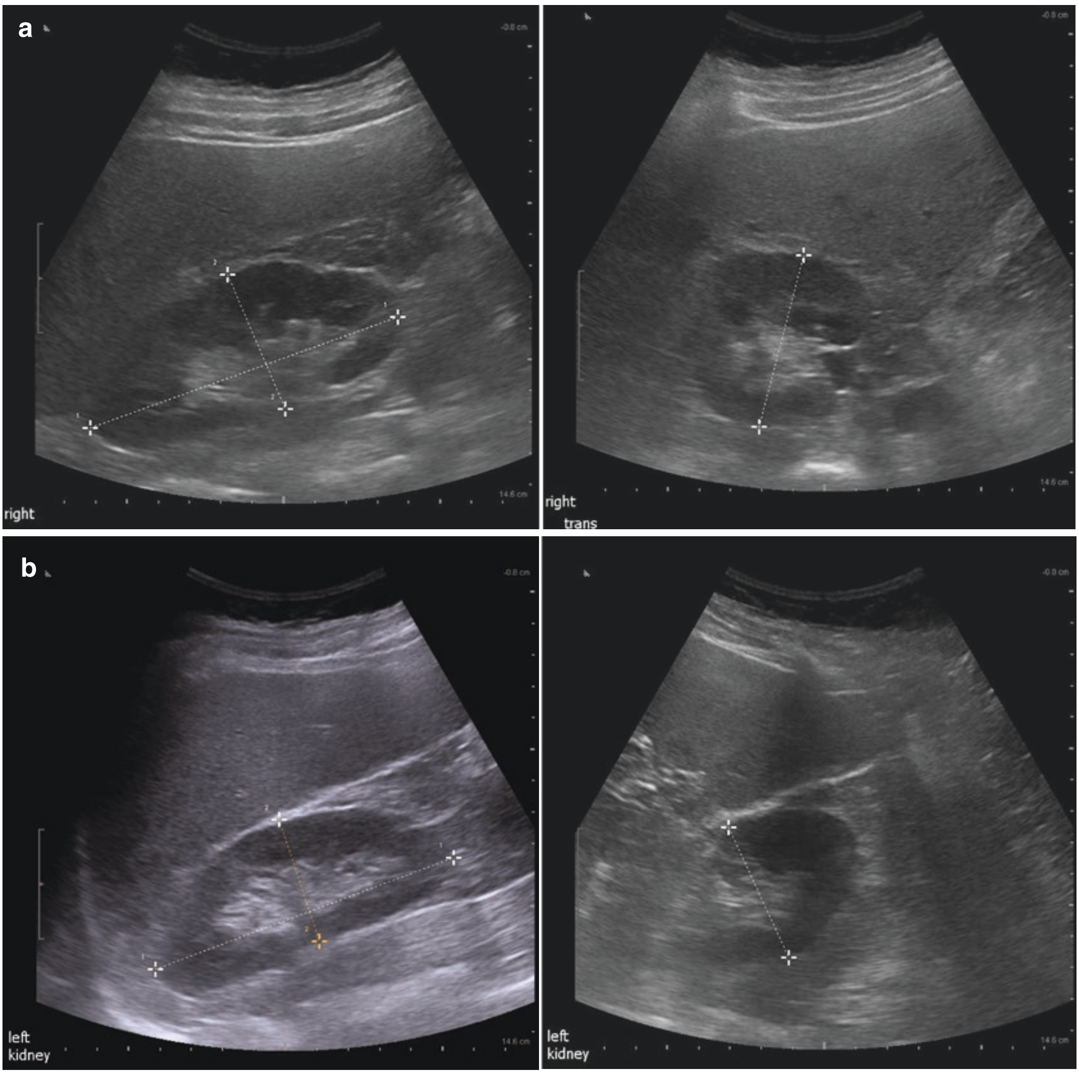
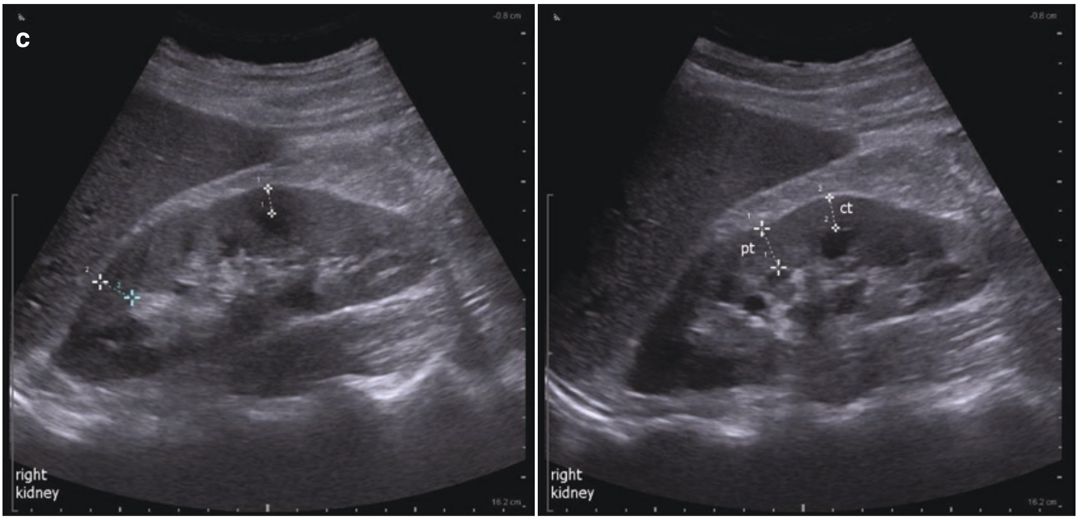


Fig. 18.45 (**a**) Split screen mid-sagittal (left image) and mid-transverse (right image) view of right kidney. (**b**) Split screen mid-sagittal (left image) and mid-transverse (right image) view of left kidney. (**c**) Cortical and parenchymal thickness measurements (right kidney)



Pt = Parenchymal thickness
Ct = Cortical Thickness

Fig. 18.45 (continued)

mal thickness in at least two areas (Fig. 18.45c). Demonstrate Liver on Right and Spleen on Left (if possible) and comment on comparative echogenicity.
3. Medial and lateral coronal (longitudinal views) of both kidneys (color Doppler optional), Fig. 18.46.
4. Upper pole and lower pole transverse views of both kidneys (color Doppler optional), Fig. 18.47.
5. Consider spectral Doppler images with RI measurements of interlobar and arcuate vessels in upper, middle, and lower poles if indicated.
6. B-mode, color images, spectral Doppler and/or elastography images of observed abnormalities, Fig. 18.48.

Transabdominal Bladder

Bladder (full bladder >150 cc)

1. Longitudinal and transverse survey scan of the bladder with video clips.
2. Bladder (split-screen): mid-sagittal and mid-transverse views with volume, height (AP), width, and length measurements, Fig. 18.38.
3. Measurement of bladder wall thickness in at least two locations (posterolateral and dome preferred), Fig. 18.39.
4. Representative color flow views of the left and right ureteral jets with video clip if possible, Fig. 18.40.
5. Document post-void residual.

Transabdominal Prostate

1. Longitudinal and transverse survey scan of the prostate with video clips.
2. Split-screen mid-sagittal and mid-transverse views with volume, height (AP), width, and length measurements (Fig. 18.42).
3. Seminal vesicles: transverse views for width measurements (Fig. 18.43).

Transrectal Prostate Ultrasound (TRUS)

In a young male, the prostate is homogenous with zones that are difficult to visualize. A “sonographic capsule” is seen due to impedance difference between the gland and surrounding fat and you can see it well visualized in this image where you have the hypoechoic

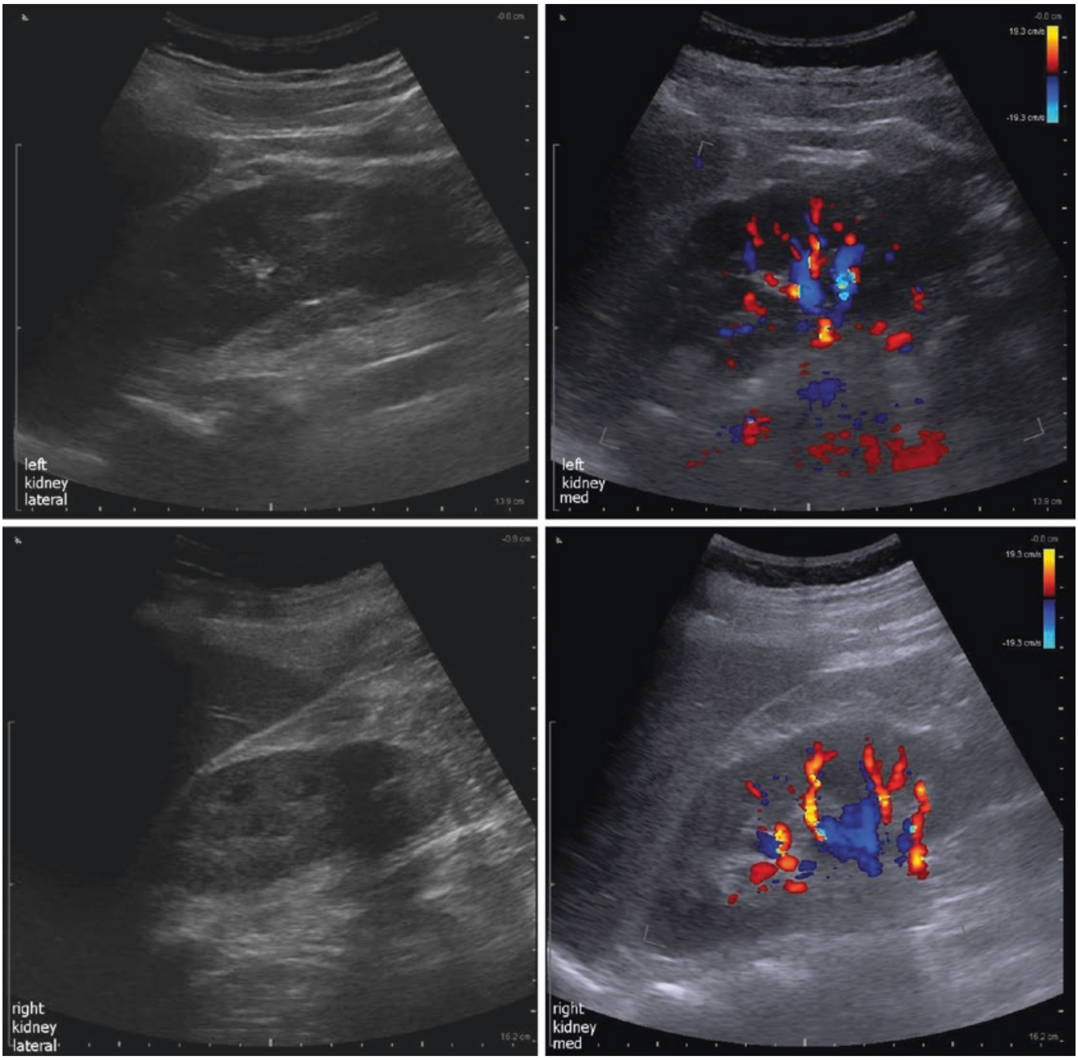


Fig. 18.46 Medial and lateral coronal (longitudinal views) of both kidneys

surrounding fat versus the more isoechoic prostatic tissue. The urethra is seen with the surrounding reflectivity of urethral muscles. The normal peripheral zone is often hyperechogenic in comparison to the central and transition zones. The central and transition are often difficult to differentiate. The fibromuscular stroma lies anterior to the urethra. In the older male, the glandular and stromal elements enlarge increasing the size of the transition zone and occasionally the peripheral zone. The transition zone is seen independent of other zones. The central zone is usually not visualized or difficult to visualize.

We start the TRUS study with a survey scan as we do for all urologic ultrasound studies. Orientation is critical. In a transverse view, the abdominal cavity is superior (at the top of the screen) to the prostate while the rectum is inferior (at the lower portion of the screen) to the prostate. In a longitudinal projection, the bladder is to the left when looking at the ultrasound screen while the urethra is to the right.

The prostate base is located at the superior aspect of the prostate contiguous with the base of the bladder. The prostate apex is located at the inferior aspect of the prostate continuous with the striated muscles of the urethral sphincter.

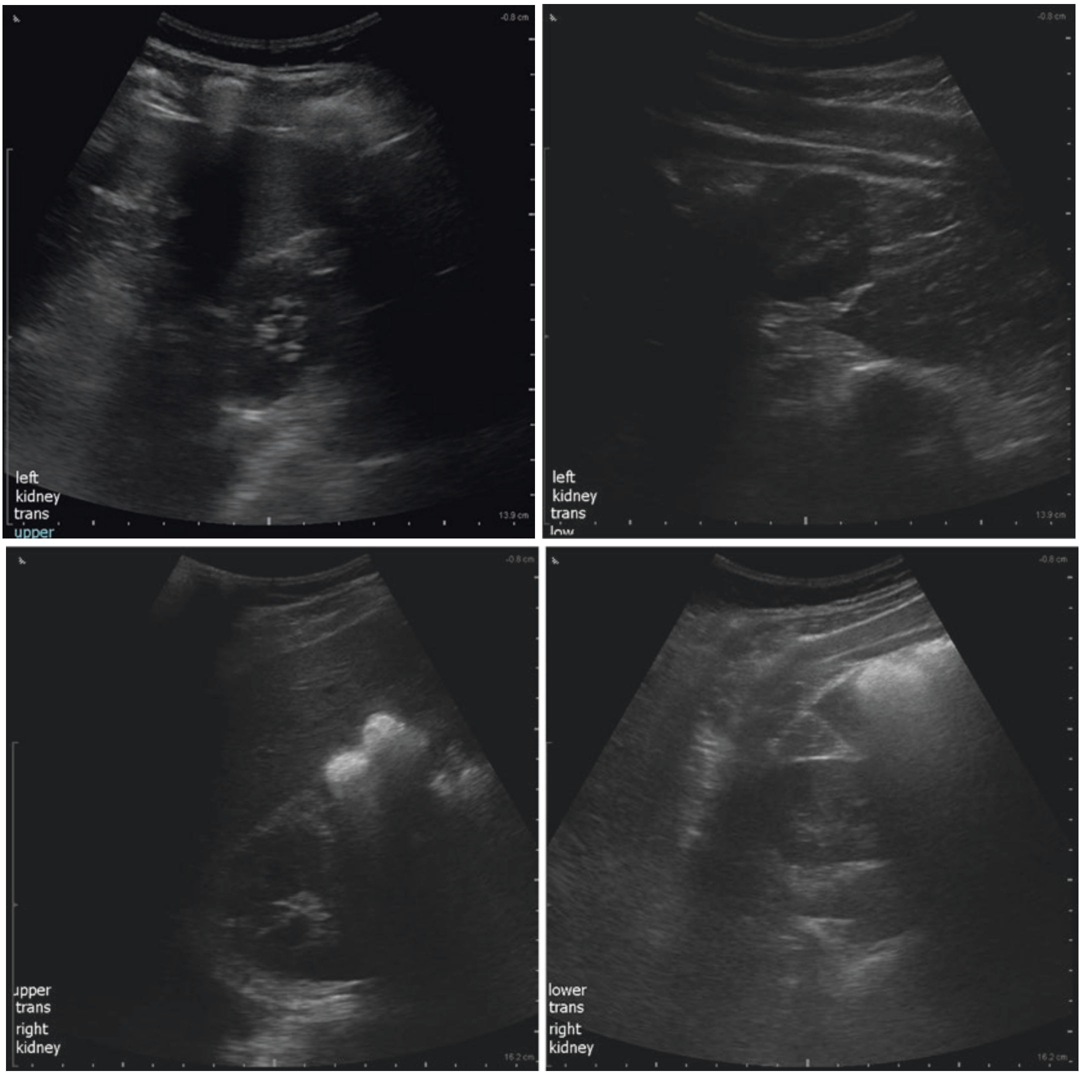


Fig. 18.47 Upper pole and lower pole transverse views of both kidneys

We usually utilize a high-frequency 5–10 Mhz transducer. The transducer can have one, two (bi-planer), or three (tri-planer) sets of crystals. The patient is usually examined in the left lateral decubitus position with his legs in the knee-to-chest position. Before inserting the probe, a digital rectal exam is performed. Pain or tenderness, rectal stricture, mass, lesion, and/or bleeding that is encountered when performing the rectal exam or when inserting the probe might preclude the transrectal examination being done. After probe insertion, the "survey" scan of the prostate commences from base to apex including the seminal vesicles and rectal wall. The rest of the examination and documentation follows.

Prostate Ultrasound Protocol (Split-Screen Views Preferred When Biplane Transducer Is Used)

Specifics to be Documented on Report:

- Indication for Procedure: For example, lower urinary tract symptoms, ejaculatory pain, low volume ejaculate. Diagnosis code can also be included to document medical necessity.

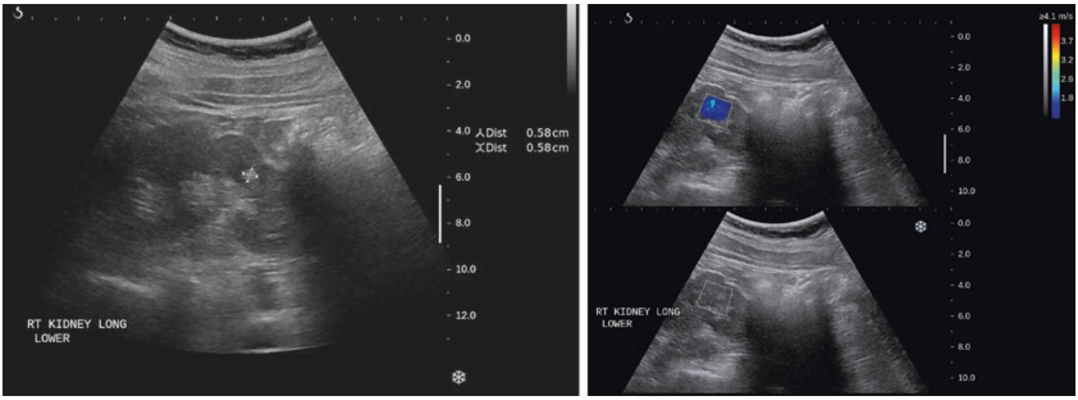
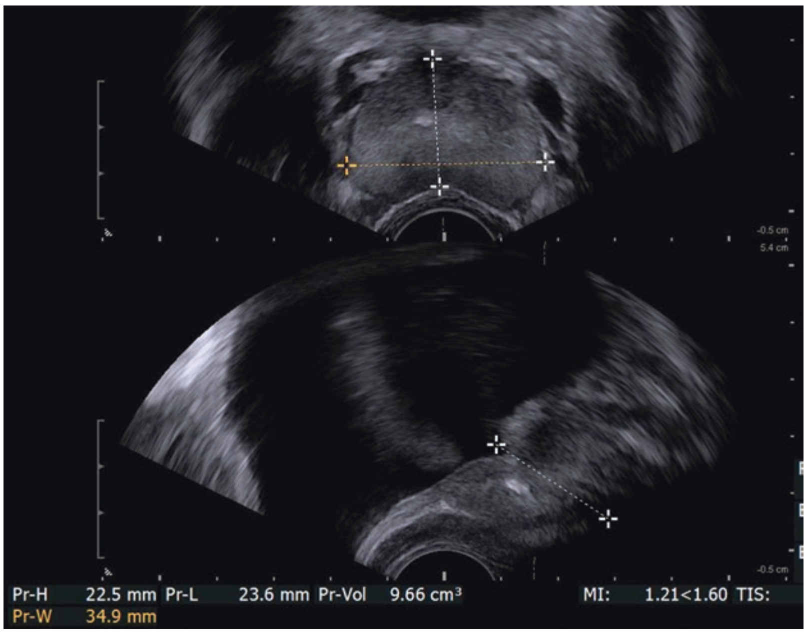


Fig. 18.48 Identification with measurements and color Doppler of observed abnormalities

Fig. 18.49 Mid-transverse (top image) and mid-sagittal (lower image) view of prostate using a biplaner transducer



- Transducer: 5 to 10 MHz transducer. This can be an end-fire, sidefire, biplane, or triplane transducer.

Please note: if all components of the exam are not seen, then the report should document that component was "Not Seen" and the reason why given.

1. Longitudinal and transverse survey scans of the prostate with video clips.
2. Single- or split-screen mid-sagittal and mid-transverse views (transverse view on the left and longitudinal view the on right) with volume, height (AP), width, and length measurements. Prostatic urethra demonstrated (Fig. 18.49).
3. Seminal vesicles: Transverse view for ampulla diameter and seminal vesicle width measurements (Fig. 18.50).
4. Single- or split-screen base (transverse and longitudinal views) and rectal wall thickness measurement (Fig. 18.51).
5. Single- or split-screen apex (transverse and longitudinal views) and rectal wall thickness measurement (Fig. 18.52).

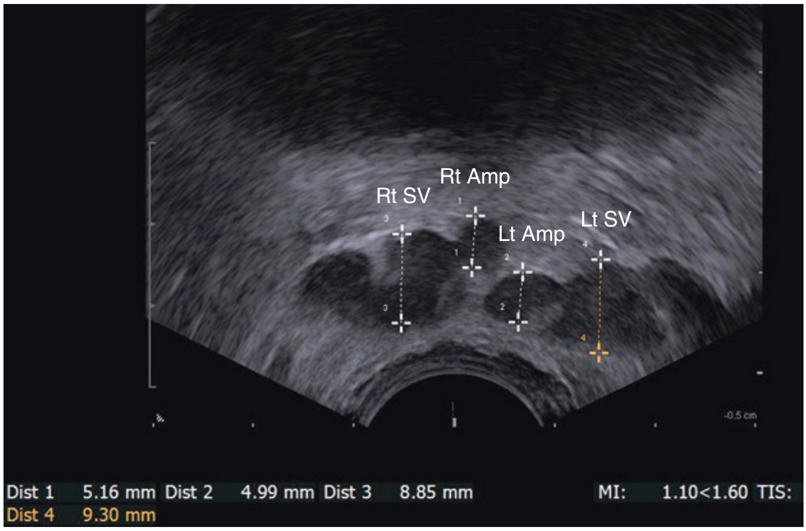


Fig. 18.50 Transverse view of seminal vesicles for ampulla diameter and seminal vesicle width measurements

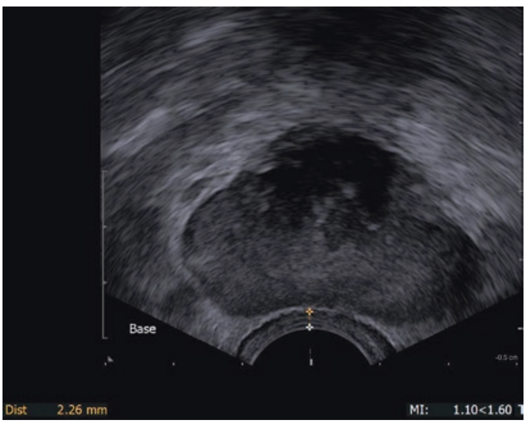


Fig. 18.51 Transverse view at base of prostate for rectal wall thickness measurement

6. Single- or split-screen right lateral longitudinal/sagittal views (split-screen transverse and longitudinal projections) with measurements (length and AP) of the right seminal vesicle. Periprostatic tissues and vas deferens demonstrated (Fig. 18.53).
7. Single- or split-screen left lateral longitudinal/sagittal views (split-screen transverse and longitudinal projections) with measurements (length and AP) of the left seminal vesicle. Periprostatic tissues and vas deferens demonstrated (Fig. 18.54).
8. Representative color flow views of the prostate (split screen) with both transverse and longitudinal views. Video clips are helpful (Fig. 18.55).
9. If intravesicle lobe: Measure the length of intravesicle protrusion in a sagittal view beginning at the bladder neck (Fig. 18.56).
10. Image documentation of any pathology with appropriate measurements.
11. Bladder:
    - Split screen of the bladder with measurement of volume, height (AP), width and length measurements (Fig. 18.57).
    - Measurement of bladder wall thickness in at least two locations (posterolateral and dome preferred).
    - Consider color flow views of the left and right ureteral jets with a video clip if possible (Fig. 18.58).

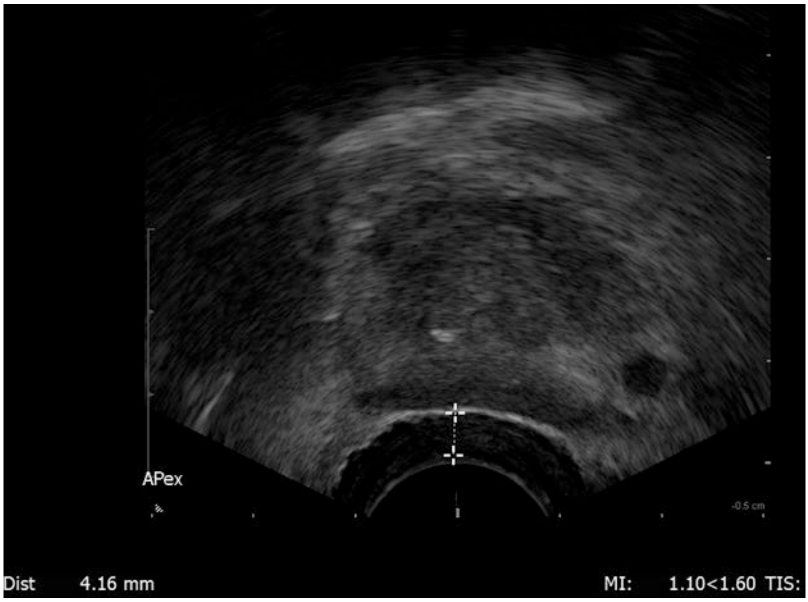


Fig. 18.52 Transverse view at apex of prostate for rectal wall thickness measurement

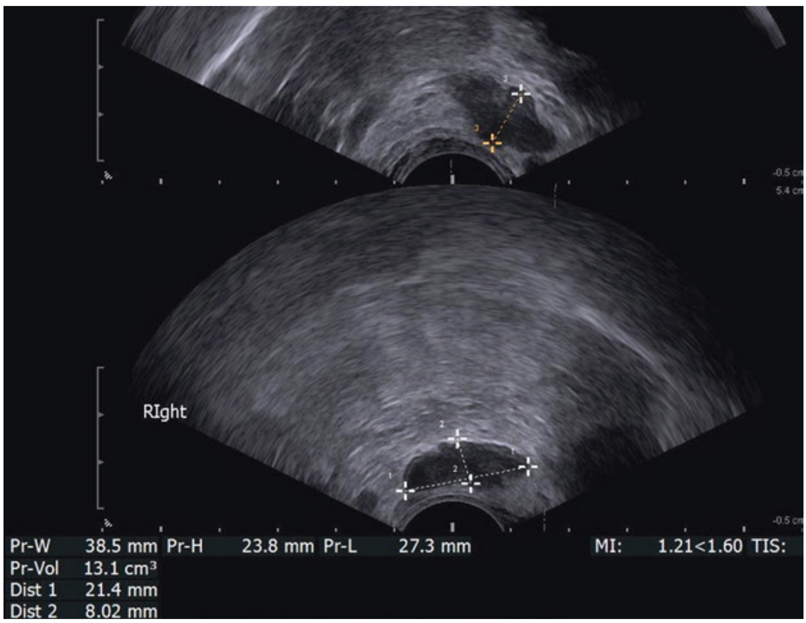


Fig. 18.53 Split screen transverse (top image) and longitudinal (lower image) view of right seminal vesicle

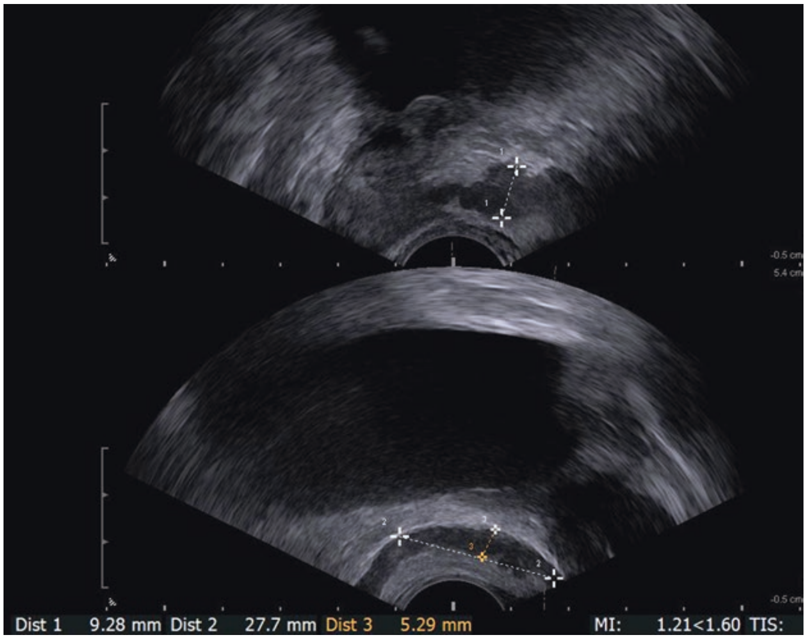


Fig. 18.54 Split screen transverse (top image) and longitudinal (lower image) view of left seminal vesicle

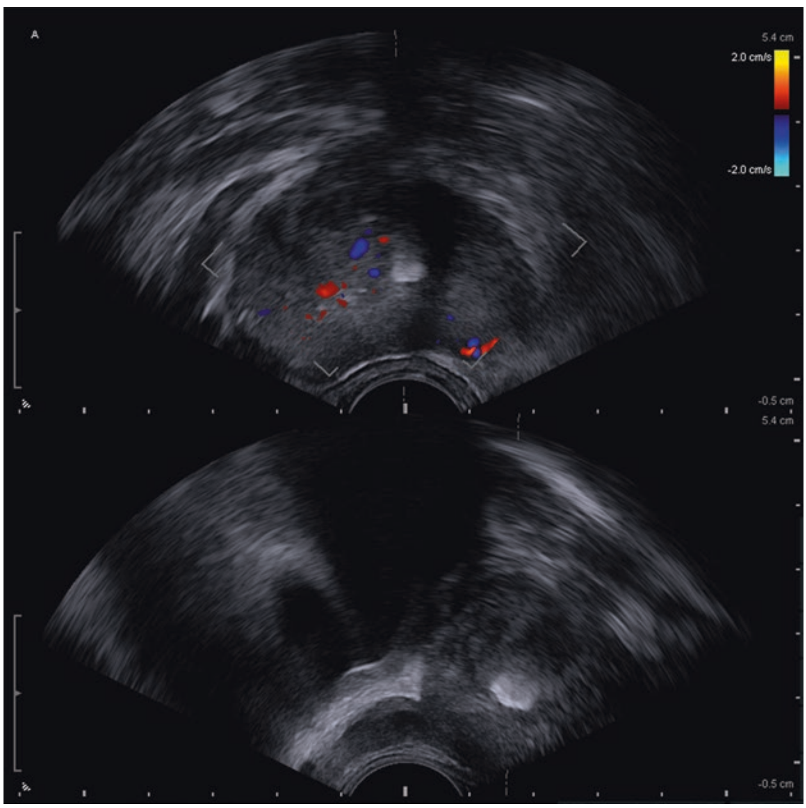


Fig. 18.55 Split screen representative color flow views of prostate with transverse (top image with color Doppler) and longitudinal (lower image) views

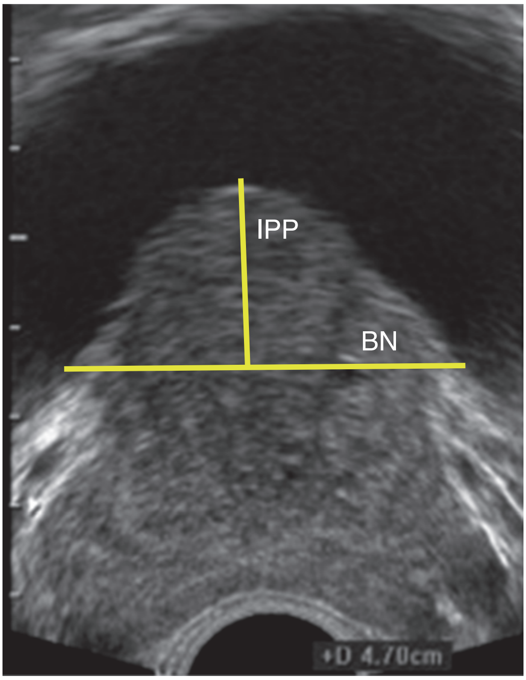


Fig. 18.56 Measure length of intravesical protrusion in sagittal view beginning at the bladder neck (transverse image)

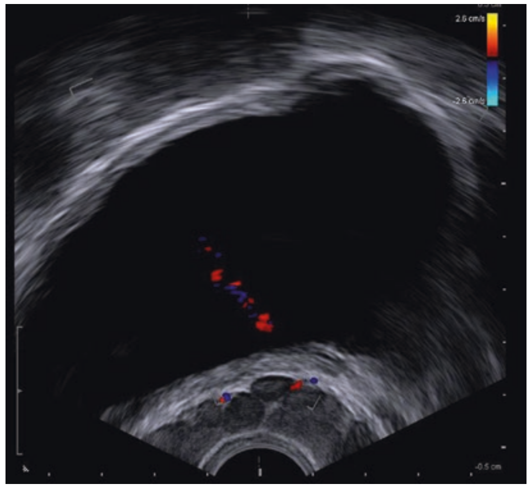
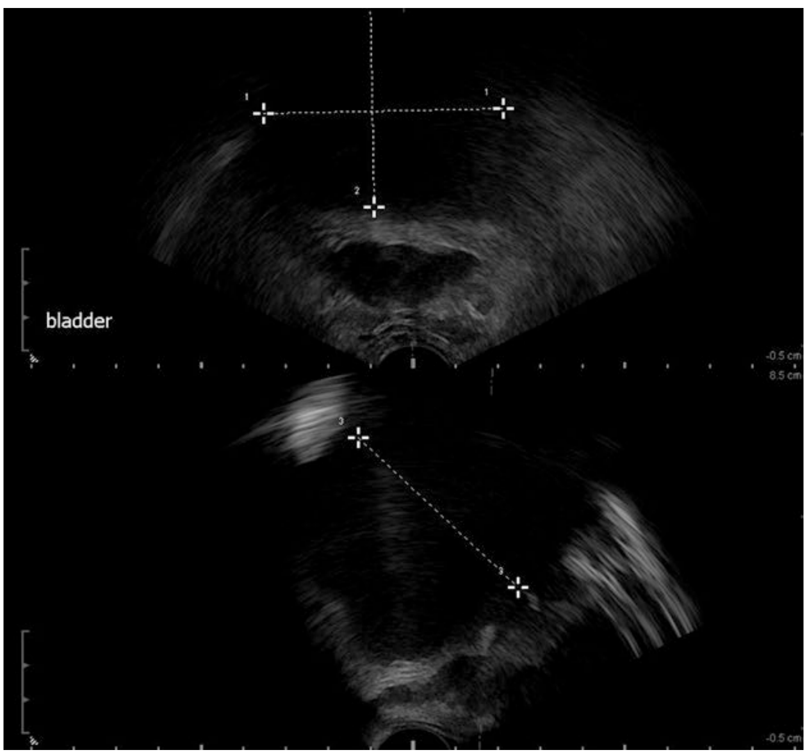


Fig. 18.58 Transverse color Doppler image of left right ureteral jet

Fig. 18.57 Split screen image of bladder in transverse (upper image) and longitudinal (lower image)



Appendix A

					PATIENT LABEL				
PENILE ULTRASOUND									
DATE OF SERVICE:						BP:			
PROCEDURE:						Pulse:			
	INDICATION:								
	US MACHINE:					TRANSDUCER:			
B-MODE FINDINGS (ATTACH IMAGES)									
RIGHT CORPORA CAVERNOSUM					LEFT CORPORA CAVERNOSUM				
AP LONGITUDINALH (cm)					AP LONGITUDINAL (cm)				
PLAQUE_MASS (size,location):					PLAQUE_MASS (size,location):				
SIZE:		LOCATION:			SIZE:		LOCATION:		
ECHOGENICITY:					ECHOGENICITY:				
CALCIFICATIONS (quantity)					CALCIFICATIONS (quantity)				
INTRACORPORA COMMENTS:									
TRANSVERSE		AP	Width		TRANSVERSE		AP	Width	
PROXIMAL (cm)					PROXIMAL (cm)				
MID (cm)					MID (cm)				
DISTAL (cm)					DISTAL (cm)				
LESION (Y/N):		TYPE:			LESION (Y/N):		TYPE:		
SIZE:		LOCATION:			SIZE:		LOCATION:		
ECHOGENICITY:					ECHOGENICITY:				
COMPARATIVE ECHOGENICITY									
CORPORACAVERNOSUS COMMENTS									
BULBOCAVERNOSUS COMMENTS									
COLOR DOPPLER/DUPLEX FINDINGS (ATTACH IMAGES)									
INDICATION FOR COLOR/DUPLEX STUDY:									
COMMENTS:									
PSV	EDV	RI	Dia (mm)	Time	PSV	EDV	RI	DIA (mm)	Tum/Rig
				Baseline					
				5 MIN					
				10 MIN					
				15 MIN					
				20 MIN					
				30 MIN					
				40 MIN					
PHYSICIAN INTERPRETATION									
DATE/TIME									
			PHYSICIAN SIGNATURE						

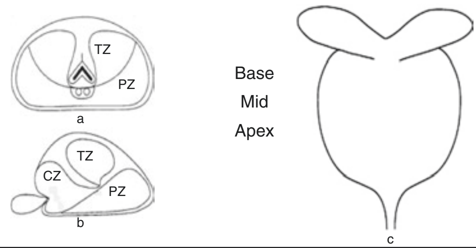
					PATIENT LABEL				
BLADDER ULTRASOUND									
DATE OF SERVICE:									
	INDICATION:								
	US MACHINE:					TRANSDUCER:			
B-MODE FINDINGS (ATTACH IMAGES) CPT 76857 (Limited pelvic US)									
BLADDER LENGTH (cm)				BLADDER URETERAL DILATION (Y/N):					
BLADDER WIDTH (cm)				PROSTATE SIZE (cc):					
BLADDER VOLUME (cc)				PROSTATE MORPHOLOGY:					
BLADDER WALL THICKNESS (cm)									
BLADDER DIVERTICULA (Y/N):									
BLADDER TUMOR (Y/N):									
BLADDER PERIVESICAL MASS (Y/N):									
PRE VOID VOLUME (cc)									
POST VOID RESIDUAL (cc)									
BLADDER CALCULUS (Y/N):									
BLADDER FOREIGN BODY (Y/N):									
COMMENTS:									
COLOR DOPPLER/DUPLEX FINDINGS (ATTACH IMAGES) CPT 93975									
INDICATION:	MASS	PELVIC FLOOR	URETERAL JETS						
	LOCATION	PSV	EDV	RI	AT				
LEFT									
RIGHT									
COMMENTS:									
PHYSICIAN INTERPRETATION									
DATE/TIME									
			PHYSICIAN SIGNATURE						

					PATIENT LABEL			
PERINEAL ULTRASOUND OF BULBOCAVERNOSUS MUSCLE (BCM)								
DATE OF SERVICE:								
	INDICATION:							
	US MACHINE:					TRANSDUCER:		
B-MODE FINDINGS (ATTACH IMAGES) CPT 76857 (Limited pelvic US)								
		#1	#2					
BCM RIGHT (cm)				BCM RIGHT AVG (cm)				
BCM MID (cm)				BCM MID AVG (cm)				
BCM LEFT (cm)				BCM LEFT AVG (cm)				
BCM AREA (cm^2)				BCM AREA AVG (cm^2)				
COLOR DOPPLER/DUPLEX FINDINGS (ATTACH IMAGES) CPT 93975								
	COMMENTS	PSV	EDV	RI	AT			
LEFT								
MID								
RIGHT								
COMMENTS:								
PHYSICIAN INTERPRETATION								
DATE/TIME								
			PHYSICIAN SIGNATURE					

					PATIENT LABEL				
RENAL ULTRASOUND									
DATE OF SERVICE:									
PROCEDURE:									
	INDICATION:								
	US MACHINE:					TRANSDUCER:			
B-MODE FINDINGS (ATTACH IMAGES)									CPT 76775
RIGHT KIDNEY					LEFT KIDNEY				
LENGTH (cm)					LENGTH (cm)				
WIDTH (cm)					WIDTH (cm)				
HEIGHT (cm)					HEIGHT (cm)				
VOLUME (cm^3)					VOLUME (cm^3)				
SCARRING (Y/N):		LOCATION:			SCARRING (Y/N):		LOCATION:		
STONES (Y/N):					STONES (Y/N):				
SIZE:		LOCATION:			SIZE:		LOCATION:		
COMMENT:					COMMENT:				
MASSES (Y/N):					MASSES (Y/N):				
SIZE:		LOCATION:			SIZE:		LOCATION:		
COMMENT:					COMMENT:				
HYDRONEPHROSIS (Y/N):					HYDRONEPHROSIS (Y/N):				
GRADE:		DESCRIPTION:			GRADE:		DESCRIPTION:		
COMMENT:					COMMENT:				
OBSTRUCTION (Y/N):					OBSTRUCTION (Y/N):				
COMMENT:					COMMENT:				
ECHOGENICITY:					ECHOGENICITY:				
PERINEPHRIC FLUID (Y/N) :					PERINEPHRIC FLUID (Y/N) :				
AMOUNT:		LOCATION:			AMOUNT:		LOCATION:		
RENAL CORTICAL THICKNESS (cm):					RENAL CORTICAL THICKNESS (cm):				
RENAL PARENCHYMAL THICKNESS (cm):					RENAL PARENCHYMAL THICKNESS (cm):				
COMMENTS:									
COLOR DOPPLER/DUPLEX FINDINGS (ATTACH IMAGES)									CPT 93975
INDICATION:	RAS	MASS	Graft						CPT 93976
RIGHT KIDNEY					LEFT KIDNEY				
PSV	EDV	RI	AT	Location	PSV	EDV	RI	AT	Location
PHYSICIAN INTERPRETATION									
DATE/TIME									
					PHYSICIAN SIGNATURE				

					PATIENT LABEL				
SCROTAL ULTRASOUND									
DATE OF SERVICE:									
	INDICATION:								
	US MACHINE:					TRANSDUCER:			
B-MODE FINDINGS (ATTACH IMAGES)									
RIGHT TESTIS		Mid Sag	Mid Trans		LEFT TESTIS		Mid Sag	Mid Trans	
LENGTH (cm)					LENGTH (cm)				
WIDTH (cm)					WIDTH (cm)				
AP (cm)					AP (cm)				
VOLUME (cm^3)					VOLUME (cm^3)				
☐ MASS (size,location):					☐ MASS (size,location):				
SIZE:		LOCATION:			SIZE:		LOCATION:		
COMPARATIVE ECHOGENICITY									
☐ MICROCALCIFICATIONS (quantity)					☐ MICROCALCIFICATIONS (quantity)				
INTRATESICULAR COMMENTS:					INTRATESICULAR COMMENTS:				
RIGHT EPIDIDYMIS					LEFT EPIDIDYMIS				
CAPUT (cm)					CAPUT (cm)				
CORPUS (cm)					CORPUS (cm)				
CAUDA (cm)					CAUDA (cm)				
LESION (Y/N):		TYPE:			LESION (Y/N):		TYPE:		
SIZE:		LOCATION:			SIZE:		LOCATION:		
COMPARATIVE ECHOGENICITY									
EPIDIDYMAL COMMENTS:					EPIDIDYMAL COMMENTS:				
RIGHT PARATESTICULAR STRUCTURES					LEFT PARATESTICULAR STRUCTURES				
PARATESTICULAR COMMENTS:					PARATESTICULAR COMMENTS:				
RIGHT SCROTAL WALL					LEFT SCROTAL WALL				
COLOR DOPPLER/DUPLEX FINDINGS (ATTACH IMAGES)									
INDICATION FOR COLOR/DUPLEX STUDY:									
RT TESTES					LT TESTES				
☐ VARICOCELE		Dia (mm)	LOCATION		☐ VARICOCELE		Dia (mm)	LOCATION	
PARATESTICULAR STRUCTURES:					PARATESTICULAR STRUCTURES:				
PSV	EDV	RI		LOCATION	PSV	EDV	RI		
				UPPER					
				MIDDLE					
				LOWER					
				AVERAGE					
PHYSICIAN INTERPRETATION									
DATE/TIME									
			PHYSICIAN SIGNATURE						

					PATIENT LABEL			
PROSTATE ULTRASOUND								
DATE OF SERVICE:						PSA:		
	INDICATION:							
	US MACHINE:					TRANSDUCER:		
B-MODE								
		DR E						
		LEFT	RIGHT					
SIZE								
LEFT								
RIGHT								
	SEMINAL VESICLE							
Length								
Width								
Description								



	TRANSVERSE PROSTATE							
BASE:								
MID-GLAND:								
APEX:								
	SAGITTAL PROSTATE							
ANTERIOR								
MID-GLAND								
POSTERIOR								
	MID-SAGITTAL PROSTATE MEASUREMENTS							
HEIGHT (cm)								
WIDTH (cm)								
LENGTH (cm)								
VOLUME (cm^3)								
COLOR DOPPLER/DUPLEX FINDINGS (ATTACH IMAGES)								
INDICATION FOR COLOR/DUPLEX STUDY:							URETERAL JETS (R/L):	
	LEFT	RIGHT	COMMENTS:					
SV:								
BASE:								
APEX:								
MASS:								
PSV	EDV	RI		LOCATION	PSV	EDV	RI	
				BASE				
				MIDDLE				
				APEX				
				AVERAGE				
PHYSICIAN INTERPRETATION								
DATE/TIME								
			PHYSICIAN SIGNATURE					

References

1. AIUM Practice Guideline for Documentation of an Ultrasound Examination, AIUM practice guidelines.
2. AIUM Practice Guideline for the Performance of an Ultrasound Examination in the Practice of Urology, The American Institute for Ultrasound in Medicine, November 5, 2011.
3. Health Insurance and Portability Accountability Act of 1996 (HIPAA).
4. HiTech Act of 2009, Health Information Technology for Economic and Clinical Health Act, Federal Register, 74(79), Monday, April 27, 2009.
5. Federal Drug Administration, Code of Federal regulations Title 21 CFR, Part 1270 subpart C, Procedures and Records.
6. Biagiotti G, et al. Spermatogenesis and spectral echo-color Doppler traces from the main testicular artery. BJU Int. 2002;90(9):903–8.
7. Unsal A, et al. Resistance and pulsatility index increase in capsular branches of testicular artery: indicator of impaired testicular microcirculation in varicocele? J Clin Ultrasound. 2007;35(4):191–5.
8. Pinggera GM, et al. Assessment of the intratesticular resistive index by colour Doppler ultrasonography measurements as a predictor of spermatogenesis. BJU Int. 2008;101(6):722–6.
9. Balci A, et al. Long-term effect of varicocele repair on intratesticular arterial resistance index. J Clin Ultrasound. 2008;36(3):148–52.
10. Hillelsohn JH, et al. Spectral Doppler sonography: a non-invasive method for predicting dyspermia. J Ultrasound Med. 2013;32(32):1427–32.
11. Herati A, et al. Evaluation of impaired spermatogenesis with spectral Doppler ultrasound: correlation with testicular biopsy., MP68-17. J Urol. 2014;2:2196.
12. Platt JF, Rubin JM, Ellis JH. Acute renal failure: possible role of duplex Doppler US in distinction between acute prerenal failure and acute tubular necrosis. Radiology. 1991;179(2):419–23.
13. Platt JF. Duplex Doppler evaluation of native kidney dysfunction: obstructive and nonobstructive disease. 1992;158(5):1035–42. https://doi.org/10.2214/ajr.158.5.1566663.
14. Onur MR, Poyraz AK, Bozgeyik Z, Onur AR, Orhan I. Utility of semiquantitative strain elastography for differentiation between benign and malignant solid renal masses. 2015;34(4):639–47. https://doi.org/10.7863/ultra.34.4.639.
15. Tan S, Özcan MF, Tezcan F, Balci S, Karaoğlanoğlu M, Huddam B, Arslan H. Real-time elastography for distinguishing angiomyolipoma from renal cell carcinoma: preliminary observations. 2013;200(4):W369–75. https://doi.org/10.2214/AJR.12.9139.
16. Ozkan F, Yavuz YC, Inci MF, Altunoluk B, Ozcan N, Yuksel M, Sayarlioglu H, Dogan E. Interobserver variability of ultrasound elastography in transplant kidneys: correlations with clinical-Doppler parameters. 2013;39(1):4–9. https://doi.org/10.1016/j.ultrasmedbio.2012.09.013.
17. Boehm K, Salomon G, Beyer B, Schiffmann J, Simonis K, Graefen M, Budaeus L. Shear wave elastography for localization of prostate cancer lesions and assessment of elasticity thresholds: implications for targeted biopsies and active surveillance protocols. J Urol. 2015;193(3):794–800. https://doi.org/10.1016/j.juro.2014.09.100.
18. Postema A, Mischi M, de la Rosette J, Wijkstra H. Multiparametric ultrasound in the detection of prostate cancer: a systematic review. 2015;33(11):1651–9. https://doi.org/10.1007/s00345-015-1523-6.
19. Dabaja AA, Wosnitzer MS, Mielnik A, Bolyakov A, Schlegel PN, Paduch DA. Bulbocavernosus muscle area measurement: a novel method to assess androgenic activity. Asian J Androl. 2014;16(4):618–22.
20. Manieri C, Carter S, Romano G, Trucchi A, et al. The diagnosis of bladder outlet obstruction in men by ultrasound measurement of bladder wall thickness. J Urol. 1998;159(3):761–5.
21. Chia SJ, Heng CT, Chan SP, Foo KT. Correlation of intravesical prostatic protrusion with bladder outlet obstruction. BJU Int. 2003;91(4):371–4.