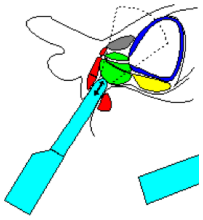
Transrectal Prostate Ultrasound Protocol

I. Patient Preparation

a. Self-cleansing enema preparation 2 to 4 hours prior to procedure
b. Drink 500 ml water approximately 1 hour prior to exam if possible for transabdominal evaluation
c. The rectum should be emptied prior to initiation of exam.
d. Patient will need to change into gown
e. Transrectal ultrasound has expected similar or less discomfort than digital rectal exam. After exam, patient can resume normal activities immediately.
f. Document relevant history (including known diagnoses). Indications may include measurement of prostate volume, hematospermia, suspected congenital abnormality, lower urinary tract symptoms (pelvic pain, prostatitis/prostadynia, obstructive or irritative voiding symptoms), an abnormal digital rectal examination, evaluation of the patient with known prostate cancer, follow-up of patients with prostate cancer, certain cases of infertility (azoospermia, low ejaculate volume or impaired semen quality), voiding studies, and evaluation of prostate in selected patients without previously suspected pathology.
g. Measuring prostate volume is useful in large benign prostatic hyperplasia (BPH) glands to help determine whether transurethral resection or an open procedure is appropriate for prostatectomy. The volume of the prostate gland can also be used to determine treatment options. Both perineal prostatectomy and brachytherapy are easier to perform when the gland is smaller than 50 g. In large glands, the anterolateral portion of the gland is behind the pubic arch, and these areas cannot be reached with the perineal brachytherapy needles. Hormonal downsizing is useful in such cases, and TRUS is used to monitor gland size.

II. Equipment

a. Transrectal approach: Performed with real-time scanner using an end-fire transrectal ultrasound probe (6 to 9 Mhz) should be used to evaluate the



prostate and surrounding structures.
    i. Transrectal ultrasonography (TRUS) of the prostate end-fire probes project an imaging plane either directly or at a slight angle from the end of the probe. Thus, to visualize the lateral areas, the probe handle must be angled away from the side of interest, with

the anus used as a fulcrum to gain accurate placement. For example, to visualize the right side of the prostate, the handle would be moved downward and toward the patient's dependent left side. This probe can produce images in both sagittal and axial planes.

b. Transabdominal approach: Performed with a curved linear array probe (5 Mhz).
c. Care for equipment
    i. Transrectal probes MUST be covered by a disposable sheath before insertion. After the examination and disposal of the sheath, the probe must be disinfected. The method of disinfection depends on the manufacturer and infectious disease recommendations. Disposable accessory items used during the study must be discarded after each examination.

III. Procedure Protocol

a. Patient Positioning

i. Transabdominal ultrasound performed with patient in supine position. Towel draped covering penis and scrotum.
    1. Minimum distension of the urinary bladder of 60 mL needed for adequate transabdominal evaluation of the prostate gland. Ideally half full urinary bladder.
    2. The probe is angled approximately 30 degrees caudal using the bladder as a window. Slight compression to ensure the inferior portion of the prostate is not obscured by the shadow artifact from the base of the bladder.

ii. Transrectal ultrasound (TRUS) performed with the patient in the left lateral decubitus position (preferred) with patient on their side with hips flexed 90 degrees and knees bent. Other positions that can be used include lithotomy (frog leg), or knee-elbow position.
    1. Discuss with patient what to expect in a calming fashion including possibility of needing to reinsert the probe if more gel is required. For example, "With you positioned on your left side and hips bent, I will need to lift your buttocks cheek to place the probe into the rectum. I will apply plenty of gel, but if needed I may need to reinsert the probe with more gel. The discomfort will be similar to digital rectal examination. If you experience unbearable severe discomfort/extreme sharp pain, let me know as that can occur if there is active inflammation of the prostate gland or acute thrombosed hemorrhoid, which typically would be causing you significant pain at this moment as well."
    2. With the end-fire probe, he must be positioned so that the ultrasound probe handle can be dropped far enough to reach beneath the plane of the examination table when the

right lateral border of the prostate is being visualized. This is most readily accomplished if the patient's buttocks are directly over the corner of the table, with his legs flexed toward his chest/knees bent and held by the table extension.

3. Blue "chucks" placed underneath patient in case of rectal evacuation or gel
4. Small amount of urine in the urinary bladder during transrectal evaluation facilitates evaluation of the prostate gland.
5. Ensure that a generous amount of gel is used before inserting the probe.
6. Ask the patient to try and relax and "bear down" to open the sphincter as the transducer is inserted slowly.
7. Ensure the transducer has a latex free dedicated probe cover with plenty of gel.

b. Normal Evaluation

i. The prostate should be carefully scanned from base to apex in the transverse plane and from side to side in the sagittal plane. Specific abnormalities of the prostate should be documented. Surrounding structures including the bladder, seminal vesicles, ejaculatory ducts and vascular structures should be evaluated. Prostate volume should be documented and may be calculated based on measurements of the length, width and height of the prostate. The number of images obtained should be sufficient to document a complete examination and to demonstrate all significant abnormalities.

ii. Current ultrasound techniques using gray scale, color Doppler, and power Doppler imaging are not sufficient to confirm or exclude the presence of prostate cancer, and they should not be used to preclude the performance of prostate biopsy.

iii. Optimize image quality

1. Prostate gland should be majority of image, adjust depth if needed.
2. Adjust 2D gain/time gain compensation curve if needed. Should be able to differentiate hypoechoic inner gland from the hyperechoic outer gland. Should be able to visualize the hypoechoic rectum wall. If gain is too high, will obscure/compromise evaluation of hypoechoic lesions in outer gland.
3. Be aware of the degree of impression of probe on the rectal wall/prostate, if needed back off/pull out slightly (which may allow better visualization of the outer gland/lateral aspects).

iv. Prostate Gland.

1. The prostate should be imaged in its entirety in at least 2

orthogonal planes sagittal and axial from the apex to the base of the gland. Coronal imaging can be used if needed.

2. An estimated prostate gland volume is determined from ellipsoid formula using measurements in 3 orthogonal planes (volume = length × height × width × 0.52). Length and width measured in axial plane at the widest portion of prostate gland. Height measured in the sagittal plane (just off midline as the bladder neck obscures cephalad extent in the midline). The volume of the prostate may be correlated with the PSA level.
    a. Normal volume in young men <20 mL; >25 mL considered enlarged (general cutoff used).
    b. Please note that in older men, prostate volume >40 mL considered enlarged.
    c. Because the specific gravity of the prostate gland is approximately 1, a direct translation to grams can be made from volume. (1mL=1gram)
3. The prostate gland should be evaluated for a focal mass, echogenicity, symmetry, and continuity of margins. Color and power Doppler sonography may be helpful in detecting areas of increased vascularity.
4. The periprostatic fat and neurovascular bundle should be evaluated for symmetry and echogenicity.
5. The course of the prostatic urethra should be documented, when possible, and asymmetry between left and right periurethral tissues as well as their impact on the base of the bladder should be noted.
6. The prostatic urethra, which is the main reference point of the prostate, divides the gland into an anterior fibromuscular stroma and a posterior glandular organ. The urethra is angled 35° anteriorly in the proximal portion of the prostate. The ejaculatory ducts run in the same plane as the distal prostatic urethra to join the verumontanum

v. Seminal Vesicles, Vasa Deferentia, and Perirectal Space.
    1. The seminal vesicles should be evaluated for size, shape, position, symmetry, and echogenicity from their insertion into the prostate via the ejaculatory ducts to their cranial and lateral extents.
    2. As the ejaculatory ducts enter the prostate posteriorly, an invaginated extraprostatic space (IES) surrounds them and invaginates into the prostate. The IES surrounds the ejaculatory ducts, ends at the verumontanum, and communicates with the periurethral space.
    3. Particular attention should be given to the normal tapering of the seminal vesicle as it joins the prostate.
    4. In patients being evaluated for infertility, the vasa

deferentia must be evaluated. The presence and size of seminal vesicle, ejaculatory, müllerian, or utricle cysts or evidence of seminal vesicle or ejaculatory duct obstruction should be noted.

5. Inclusion of the anterior perirectal space, in particular the region that abuts the prostate and perirectal tissues, is important.
6. Normal values
    a. Vas deferens diameter: 4.0 mm +/- 1 mm
    b. Ejaculatory duct diameter: 0.6 mm +/- 0.1 mm (ejaculatory duct > 2mm dilated with or without associated calcification, measured in either axial or sagittal plane)
    c. Seminal vesicle width: 9 mm +/- 2 mm (seminal vesicle dilatation criteria width >15mm measured as the anterior-posterior diameter in the longitudinal/sagittal plane)
    d. Seminal vesicle length: 30 mm +/- 6 mm (between 16 mm and 25 mm hypoplastic, less than 16mm atrophic, measured in sagittal plane; although visual assessment in the axial plane for symmetry is likely more useful)

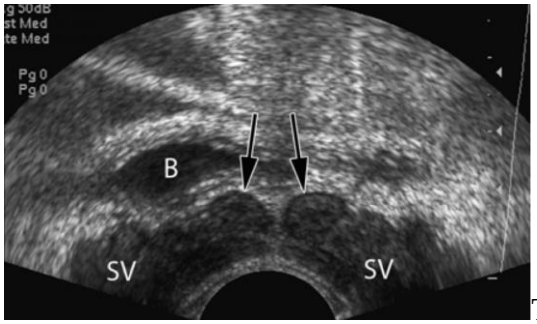
vi. Urinary Bladder.

1. The urinary bladder should be evaluated for indention at the bladder neck secondary to enlarged median lobe of the prostate gland, wall thickening, debris.
2. The internal sphincter runs from the bladder neck to the level of the verumontanum. The smooth muscle fibers of the sphincter are continuous with the superficial layer of the trigone. In healthy males, the bladder neck and the internal sphincter are closed. In males with neurogenic bladder, the bladder neck and the prostatic urethra are wide open, and some investigators have used TRUS to monitor the lower urinary tract in patients with spinal injuries.

c. Prostate Gland/Seminal Vesicles/Ejaculatory Ducts

i. Transverse Views

1. Seminal Vesicles evaluated bilaterally, normal “bow-tie” appearance. Slight asymmetry in size is normal variant.

a. 

Transverse TRUS, obtained above the prostate, shows symmetric SVs and more medially located vasa deferentia (arrows). B = bladder.

2. Base prostate gland
    a. Outer gland (Central zone and Peripheral zone combined, not distinguishable on imaging): Normal homogeneous hyperechoic
    b. Inner gland (Transitional zone): Typically hypoechoic.
    c. Junction between outer gland and inner gland termed surgical capsule, which can have echogenic calcification
    d. Prostate capsule, hyperechoic
    e. Normal periurethral homogeneous hypoechoic appearance of muscular internal sphincter surrounding urethra may be seen.
    f. Prostatic venous plexi located adjacent to prostate gland as hypoechoic structures
    g. Neurovascular bundle identified by adjacent vascular structures on color Doppler located posterior lateral to prostate gland
3. Mid prostate gland (widest part), include at least one image at level of verumontanum ("Eiffel tower" sign).
4. Apex prostate gland (below level of verumontanum and more caudally to apex tip)
    a. Eiffel tower sign (anterior shadowing) allows identification of the urethra and verumontanum
    b. Prostate distal to the verumontanum is mainly composed of outer gland (peripheral zone only), homogeneous hyperechoic

ii. Long Axis Views
1. Midline median lobe allows visualization of urethra (appears curved 35 degrees) from bladder neck to prostate apex end.
2. Parasagittal imaging of the prostate gland from right to left performed.
3. Imaging slightly off axis of midline may provide best longitudinal measurement of the prostate gland (providing

the height measurement of gland from degree of indentation into bladder to the apex)

4. Obtain sagittal elongated image of the seminal vesicle on each side including tapered junction with the base of the prostate gland. Measure the seminal vesicle width (AP diameter on sagittal image). Measure the seminal vesicle length.
5. Obtain sagittal image lower down of the ejaculatory duct on each side from tapering of the seminal vesicle to the entrance to urethra.
6. Evaluate the bladder neck, urethra, verumontanum, ejaculatory duct, seminal vesicles (one at a time, including evaluation of tapering to the junction with the hyperechoic outer prostate gland base, should see surrounding echogenic fat as it tapers to enter the prostate gland)
7. Measure/document any seminal vesicle cyst, ejaculatory duct cyst, utricle or Mullerian duct cyst.
8. Document any hyperechoic calcification of the seminal vesicle, ejaculatory duct.

d. Vascularity

i. Brief Doppler examination using PW, Color Doppler or Power Doppler to document vascularity at each level of the prostate gland. Evaluate for focal areas of increased vascularity within the outer gland. Evaluate for rim of vascularity surrounding anechoic spaces of the central gland (suggestive of prostate abscess if suspected prostatitis).

Additional assessments

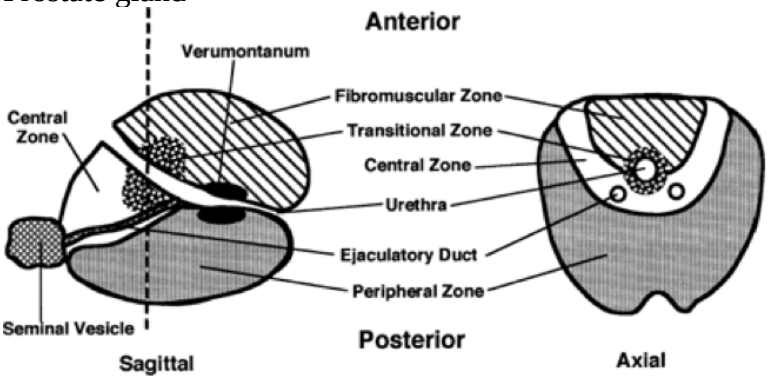
ii. If the prostate gland is enlarged due to BPH,
    1. Evaluate the kidneys to evaluate for obstructive hydronephrosis.
    2. Evaluate the urinary bladder volume before and after voiding

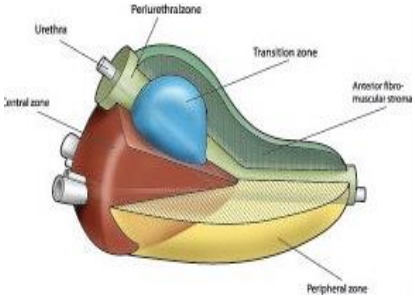
iii. If prostate cancer is suspected, evaluate for
    1. Evidence of capsular or seminal vesicle invasion.
    2. Pelvic and paraaortic lymphadenopathy.

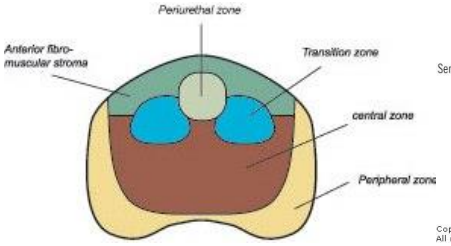
iv. If a seminal vesicle cyst is seen, evaluate for ipsilateral renal agenesis.

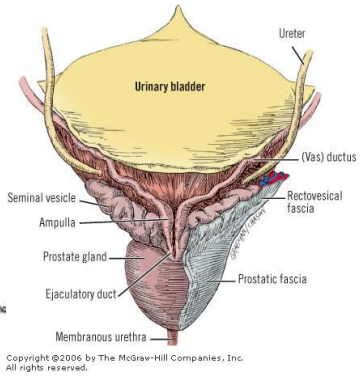
e. Anatomy

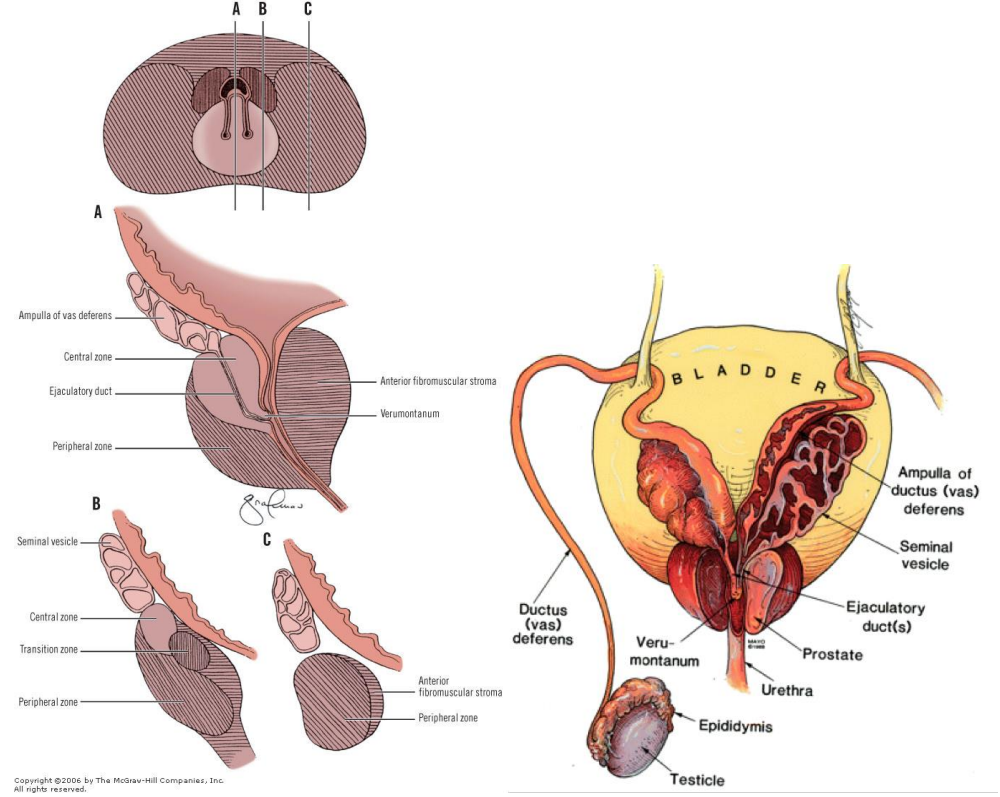
i. Prostate gland











f. Infertility
   i. The prostate ultrasound examination is used to examine the distal vas deferens, vasal ampullae, seminal vesicles, prostate, and ejaculatory ducts.
   ii. Anomalies of the vas deferens can range from complete congenital bilateral or unilateral absence of the vas deferens to vestigial remnants that appear as isoechoic or hyperechoic oval structures, less than 3 mm in diameter and located posterior to the bladder. Vasal agenesis is commonly associated with anomalies of the seminal vesicles and ejaculatory duct. Overall, vasal agenesis has been reported to occur in 1.0 – 2.5% of all infertile men but has been reported to account for 34% of men with low volume azoospermia. Vasal agenesis is also associated with renal anomalies such as ipsilateral renal agenesis, crossed fused ectopia, or ectopic pelvic kidney. In addition, up to 82% of men with bilateral vasal agenesis have at least one detectable gene mutation for cystic fibrosis.
   iii. Ductal obstruction is indicated by abnormal echogenicity of the vas deferens, seminal vesicles, and/or ejaculatory duct. In some cases, the abnormalities can be subtle and diffuse while in others calcification is readily apparent. Calculi may develop in an otherwise normal duct or may develop secondary to obstruction with concretion of static cellular fluid and debris. Evaluate for cause of ejaculatory duct obstruction (cyst or calculi), dilatation of ejaculatory ducts, dilatation of seminal vesicles, agenesis of seminal vesicles or vas deferens.
   iv. Obstructing cysts are most commonly seen in a periurethral location but can affect the seminal vesicles or the vas deferens.

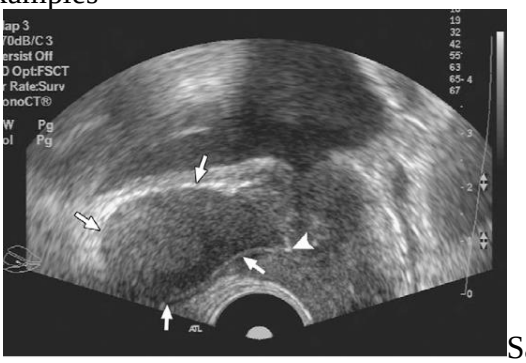
Midline periurethral cysts, also known as utricle cysts, are thought to be derived from an incompletely regressed mullerian duct. Ejaculatory duct cysts, derived from Woolffian ducts, typically contain sperm and can be confused with utricle cysts when they appear midline by ultrasound. Prostatic cysts, also known as retention or degenerative cysts, are more lateral in location and rarely reach sufficient size to compress the adjacent ejaculatory ducts and cause infertility. Seminal vesicle cysts, although rare, are associated with renal disorders and anomalies, including adult polycystic kidney disease, ipsilateral renal dysgenesis, duplication of the renal collecting system, ectopic insertion of the ureter, and ectopic location of the kidney.

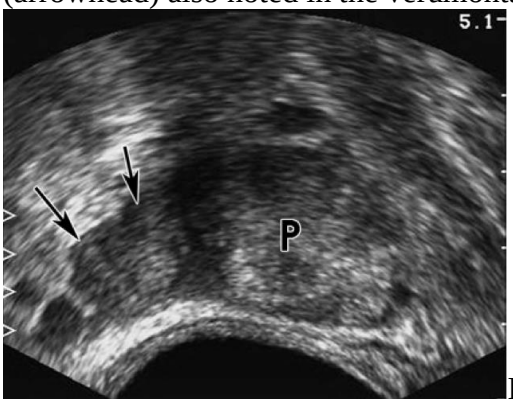
v. http://www.kocatepetipdergisi.aku.edu.tr/PDF/Eylul%202004/Orhan%20Yalcin[1]-12.pdf : Transrectal ultrasound in Male Infertility with Low Volume Ejaculate
vi. Lecture: Infertility http://www.slideshare.net/drho/trus-in-evaluation-of-male-infertility-presentation
vii. http://www.ultrasound-images.com/prostate.htm
viii. Prostate ultrasound findings in infertile men with low volume azoospermia
    1. None (25%)
    2. Congenital bilateral absence of vas deferens (34%)
    3. Bilateral occlusion of ductal system by fibrosis or calcification (16%)
    4. Congenital unilateral absence of vas deferens (11%)
    5. Obstructing cysts of the ductal system or prostate (9%)
    6. Ductal obstruction due to calculi (4%)

g. Pitfalls
    i. The lateral border of the peripheral zone on the dependent side may have a hypoechoic rim suggestive of neoplasm or infection. Because this can be artifactual, when the patient is turned onto the opposite side, this appearance changes
    ii. A small posterolateral hypoechoic area is present adjacent to the peripheral zone on either side. This represents the neurovascular body and is a normal structure. Color flow will show venous structures within.
    iii. Increased gain settings or reverberation artifact may cause a hypoechoic neoplasm to be overlooked. Optimal overall gain and time gain compensation or alter the position of the probe in relation to the rectal wall to change the position of the reverbation artifact.
    iv. Peripheral zone calcifications can obscure hypoechoic areas located more centrally.
    v. Prostate cancer can be present even if no focal lesions are detected within the prostate; therefore, prostate ultrasound cannot be used as a screening tool.

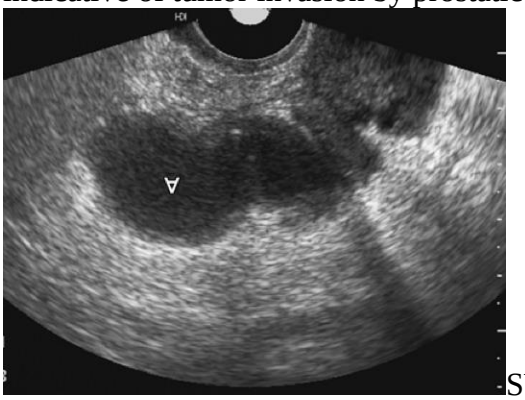
vi. Use a generous amount of lubricant on the probe to minimize patient discomfort.
vii. It is easy to confuse right and left while scanning the patient in left lateral decubitus position. Double check your labeling while scanning the patient.

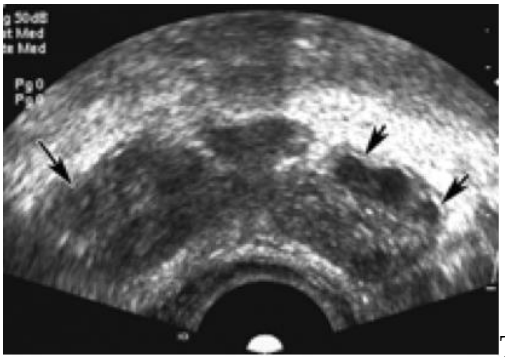
h. Case examples

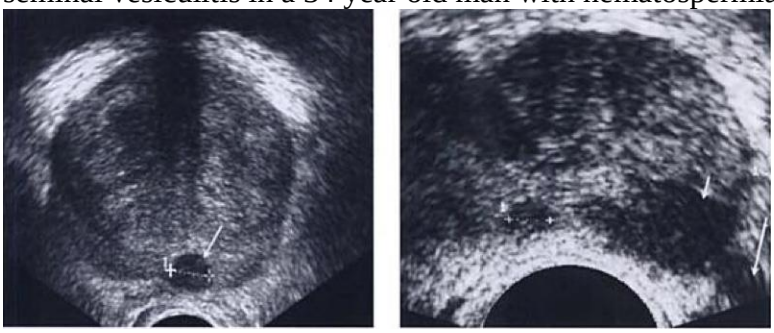
i. 
Sagittal TRUS inflammatory obstruction of the ejaculatory duct shows cystic dilatation of the ejaculatory duct, with the cyst cavity filled with debris (arrows); hyperechoic region suggestive of calcification (arrowhead) also noted in the verumontanum.

ii. 

Longitudinal transrectal US image shows a solid mass in the left SV (arrows), a finding indicative of tumor invasion by prostatic cancer. P = prostate

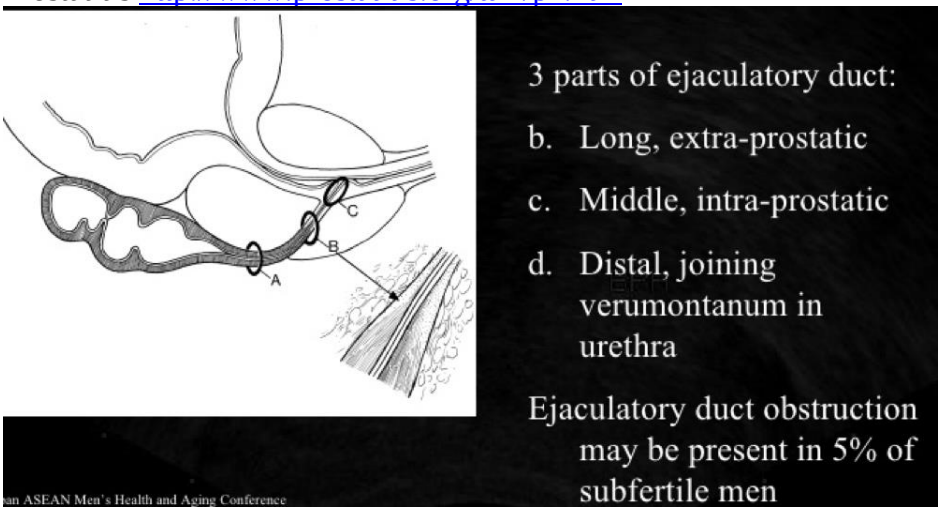
iii. 
SV abscess in a 63-year-old man with fever. Oblique TRUS show a thick-walled cystic lesion in the right SV, a finding consistent with an abscess. Multifocal abscesses were also present in the prostate.

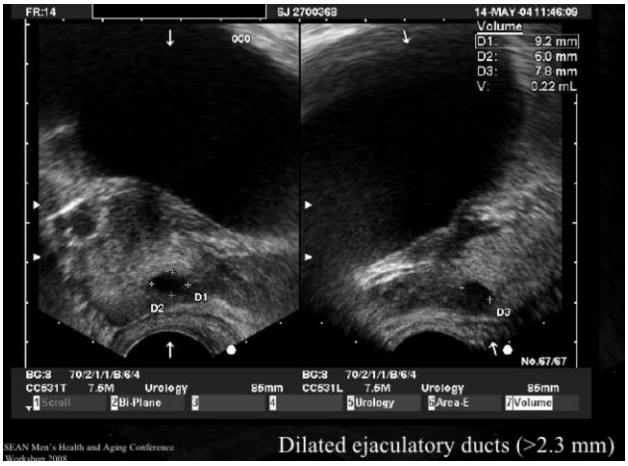
iv. 
Transverse TRUS bilateral seminal vesiculitis in a 34 year old man with hematospermia.

v. 
TRUS Two different examples of prostate cancer. Important to image in 2 planes, especially coronal plane for paramidline lesions to evaluate for seminal vesicle extension.

vi. Seminal vesicle and ejaculatory duct cysts http://www.jultrasoundmed.org/content/25/7/825.full.pdf

vii. Prostatitis http://www.prostatitis.org/tarf/p4.htm

viii. 

ix. 

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