Penile Ultrasound Protocol

I. Patient Preparation

a. None
b. Document relevant history (including known diagnoses). Indications may include priapism, dorsal vein thrombosis, penile fibrosis and penile curvature, abnormal findings on physical exam of phallus or urethra, penile tumors, urethral diverticulum or cyst, calculus or foreign body of phallus or urethra, penile trauma.
c. We DO NOT perform evaluation of erectile dysfunction (as this requires injection), evaluation of urethral stricture (as this requires intraluminal saline administration, sonourethrography).

II. Equipment

a. Performed with real-time scanner using a linear 12.5MHz transducer. Occasionally a linear 17 MHz transducer may be needed for pediatric/infant studies or for optimizing resolution and flow detection. Stand off pad should be employed if better image resolution achieved.
b. Microcalcification detection increases with highest frequency probes and real time spatial compounding

III. Procedure Protocol

a. Patient Positioning

i. Performed with the patient in either the supine or lithotomy (frog leg) position with the penis lying on the anterior abdominal wall or supported with towels between the thighs.
ii. Ask patient to rest penis over anterior abdomen
iii. Use warm gel. A sufficient amount of sonographic acoustic gel should be used on the surface of the penis to obtain good-quality images, and excessive compression by the transducer should be avoided, especially in patients with trauma. The examination is performed in transverse and longitudinal planes starting at the level of the glans and moving down to the base of the penis.
iv. A transperineal approach may be used if required to assess the base of the penis. The 2 corpora cavernosa are homogeneous in echo texture and identified as 2 hypoechoic circular structures. The tunica albuginea is visualized as a linear hyperechoic structure covering the corpora cavernosa. The cavernosal artery is visualized on the medial portion of the corpora cavernosa. The corpus spongiosum is often compressed and difficult to visualize optimally from the ventral aspect.
v. Ventral and/or dorsal placement of the transducer should be used to obtain the best visualization of the corporal bodies and urethra.

vi. Color Doppler examination of the penis should be performed in both transverse and longitudinal planes. Peak systolic velocities of the cavernosal arteries should also be recorded. Cavernosal artery velocities in healthy volunteers measure 10 to 15 cm/s in the nonerect condition

b. Normal Evaluation

i. Always scan the penis in its entirety. Compare size, shape, vascularity and echogenicity of the corporal bodies to opposite side. Document a hematoma, mass or lesion to include size, shape, vascularity, and location.

ii. Transverse images should be obtained in the proximal, mid, and distal portions of the external portion of the phallus. Longitudinal views of the external portion of the phallus should be obtained of the right and left corpora cavernosa including the cavernosal artery. The nonexternal portions of the corpora cavernosa and urethra might best be visualized by perineal placement of the transducer. The evaluation of corporal vascular integrity requires the use of color and spectral Doppler imaging.

iii. The size and echogenicity of each corpus cavernosum should be compared to the contralateral side. If a palpable abnormality is the indication for the sonogram, this area should be directly imaged. Any abnormality should be documented.

iv. Tunica albuginea typically 2mm thickness in flaccid state and thinner with erection

c. Penis (Phallus)

i. Transverse Views
   1. Glans penis
   2. Distal portion of external portion of penis
   3. Mid portion of external portion of penis
   4. Proximal portion of external portion of penis
   5. Cavernosal arteries and Dorsal vessels color Doppler
   6. Cavernosal arteries pulsed Doppler
   7. Deep dorsal vein (inside Buck's fascia) pulsed Doppler
   8. Superficial dorsal vein (outside Buck's fascia) pulsed Doppler

ii. Long Axis Views
   1. Right longitudinal image (includes right corpora cavernosum and corpora spongiosum)
   2. Right longitudinal image right cavernosal artery and helicine artery branches
   3. Left longitudinal image (includes left corpora cavernosum and corpora spongiosum)
   4. Left longitudinal image left cavernosal artery and helicine artery branches

iii. Transperioneal Views

1. Base of penis (internal portion of penis) transverse view
2. Base of penis right corpora cavernosum longitudinal view
3. Base of penis left corpora cavernosum longitudinal view

d. Vascularity

i. Normal vascular findings

1. Brief Doppler examination using PW, Color Doppler or Power Doppler to document flow in each cavernosal artery, deep dorsal vein, superficial dorsal vein

2. Normal Flow Pattern

a. Color Doppler US allows excellent depiction of penile vasculature. In the normal cavernosal and dorsal arteries, peak systolic velocities of 11–20 cm/sec in flaccid state (normal monophasic flow with minimal or no diastolic flow) and more than 35 cm/sec during onset of erection. Cavernosal arterial Doppler waveforms are different in the flaccid state and during the different phases of erection. In the flaccid state, monophasic flow is present with minimal diastolic flow. With the onset of erection, there is an increase in systolic and diastolic flows; then, diastolic flow declines to zero and undergoes reversal

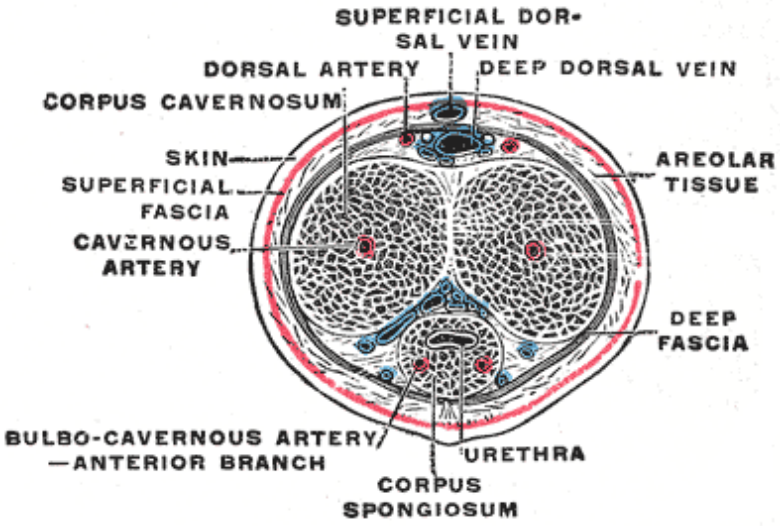
e. Additional assessments

i. Palpable area must be directly imaged

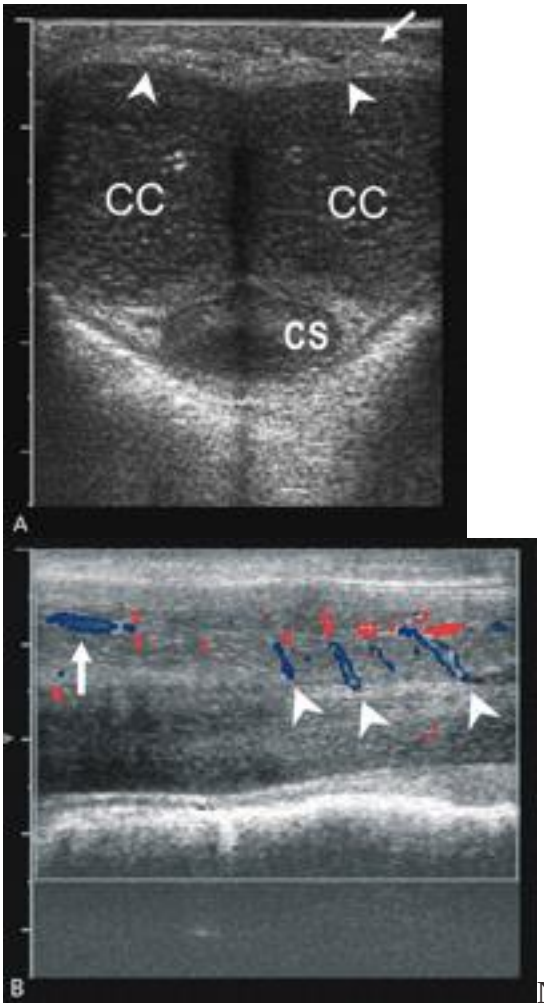
ii. In the setting of penile wall thickening/edema, assess the extent of involvement (i.e., perineum), abscess.

iii. In the setting of penile/urethral tumor, evaluation of the inguinal region for lymphadenopathy can be performed.

f. Anatomy



i.

ii. 

Normal penis. A, Transverse gray scale sonogram of the penis shows the 2 corpora cavernosa (CC) surrounded by the tunica albuginea (arrowhead). The corpus spongiosum (CS) is shown inferior to the corpora cavernosa. All 3 corpora are surrounded by Buck's fascia (arrow). B, Longitudinal color flow image of the normal penis shows the cavernosal artery (arrow) with its helicine branches (arrowheads) radiating into the corpus.

iii. The penis is composed of 2 dorsal corpora cavernosa and 1 ventral corpus spongiosum. The 2 corpora cavernosa are enclosed in a fibrous sheath, the tunica albuginea, which partially covers the corpus spongiosum. The glans penis is formed by expansion of the corpus spongiosum.

iv. The corpus spongiosum is traversed throughout its length by the anterior urethra, which begins at the perineal membrane. Buck's fascia (deep fascia) surrounds both cavernosal bodies dorsally and splits to surround the spongiosum ventrally

g. Peyroine's disease

i. When a patient seeks medical attention for painful penile induration, an important part of taking the history involves asking

when the induration appeared, if it appeared after an incidental or sexual trauma, whether it is stable in size, and if it has changed location or orientation. Clinical assessment is of foremost importance. In most patients with Peyronie disease, a clearly palpable albugineal plaque is identified and differentiated from induration of the cavernosal tissue.

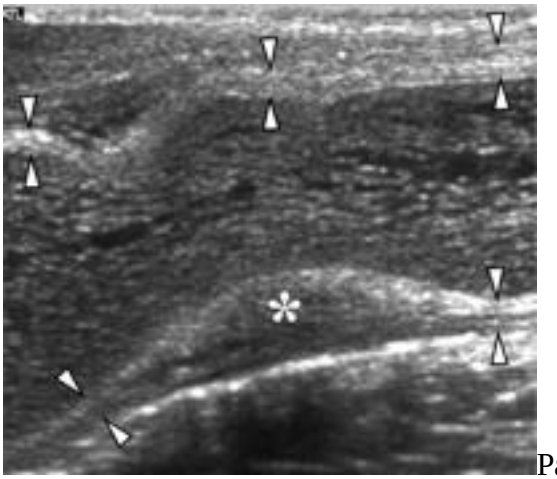
ii. The location, size, and consistency of the plaque and the presence of pain or tenderness are factors that direct imaging management.

iii. Imaging is often required to evaluate extension of the plaques, involvement of the penile septum, and the relationship between the plaques and the penile vasculature.

iv. During pharmacologically induced erection, Peyronie plaques are identified as localized or diffuse areas in which the tunica albuginea is thickened. The plaques are more often located on the dorsal aspect of the penis, but they can also be found ventrally or, less frequently, along other aspects. US has 100% sensitivity in detection and measurement of gross calcifications; the detection rate for microcalcifications increases when highest-frequency probes and real-time spatial compounding are used.

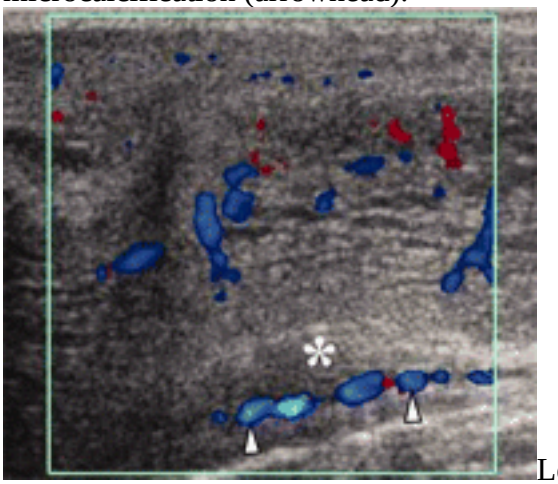
v. Encasement of the neurovascular bundle must be recognized before surgical correction of the curvature to minimize the risk of postoperative penile numbness. US allows identification of such encasement when the dorsal arteries are embedded in the plaque. Cavernosal artery encasement is more frequently observed when septal plaques are present. Although rare, this situation must be identified because it represents a cause of arteriogenic erectile dysfunction.

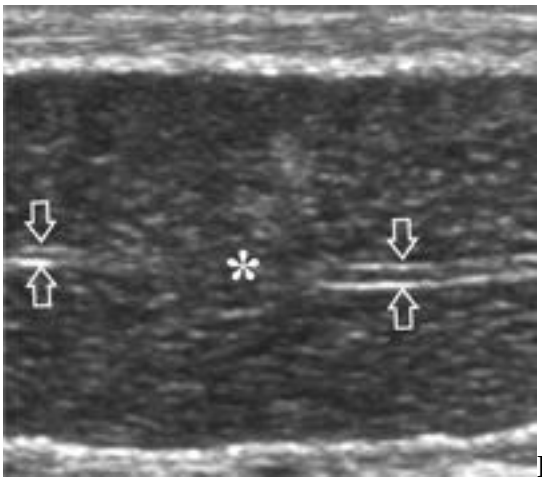
vi. Detection of color signals around the plaques usually results from patency of drainage pathways, from emissary veins passing through the plaque, or from twinkling artifacts produced by calcifications.

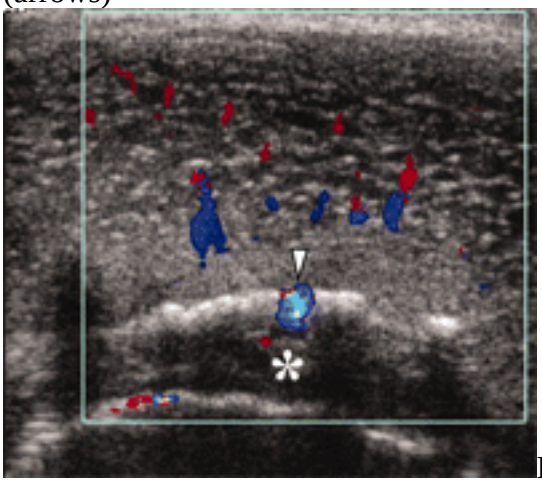
vii.  Painful circumscribed dorsal penile induration. Penile shortening and deformation were evident during erection. US was performed after intracavernous administration of vasoactive drugs. Longitudinal US image of the

penile shaft, obtained along the ventral aspect of the penis, shows diffuse thickening of the tunica albuginea (arrowheads) and a large circumscribed dorsal plaque (*).

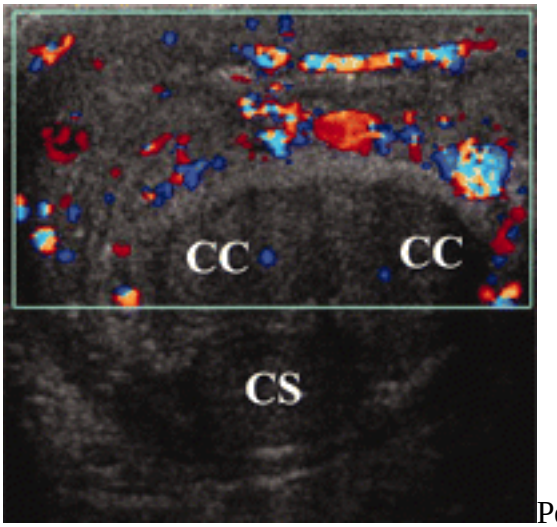
viii. 
Painful penile induration during erection with penile shortening and deformation. US was performed after intracavernous administration of vasoactive drugs. Longitudinal US image, obtained along the ventral aspect of the penis by using real-time spatial compounding, shows a large dorsal plaque (*) with a large calcification (arrows) and a microcalcification (arrowhead).

ix. 
Longitudinal color Doppler image, obtained along the ventral aspect of the penis in a 73-year-old man, shows a large dorsal plaque (*) encasing the dorsal vessels (arrowheads).

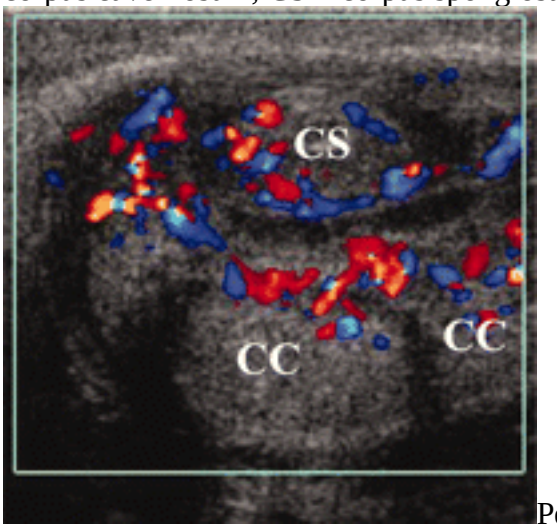
x. 
Longitudinal US image, obtained along the ventral aspect of the penis in a 75-year-old man, shows a Peyronie plaque (*) encasing the cavernosal artery (arrows)

xi. 
Longitudinal color Doppler image obtained along the ventral aspect of the penis shows an emissary vein (arrowhead) passing through a large calcified dorsal plaque (*).

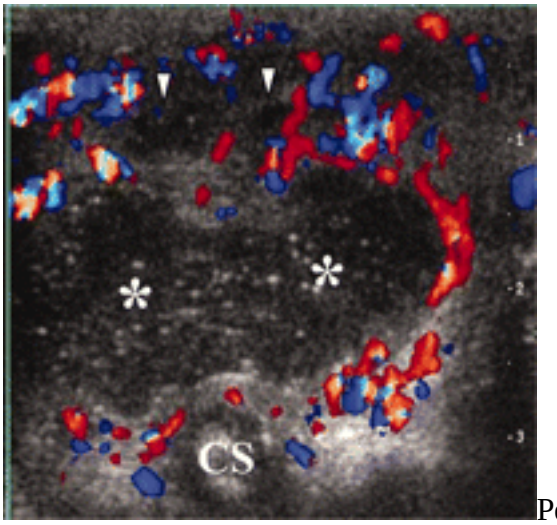
h. Inflammation
    i. Penile cellulitis and balanitis are common and can be treated successfully with appropriate antibiotics. On the contrary, penile abscesses and infection of the corpora cavernosa can be life-threatening
    ii. At color Doppler US and MR imaging, cellulitis appears as superficial tissue thickening and hyperemia. The vascularity of the corpora is not increased. Cavernositis and spongiositis appear as markedly increased vascularity of the corpora. At US, the echotexture of the corpora may be altered; edema produces increased echogenicity, while microabscesses appear as hypoechoic areas.
    iii. At US, penile abscesses appear as hypoechoic collections with internal echoes, internal debris, or even gas.

iv. 

Penile cellulitis in a 69-year-old diabetic patient with painful penile induration. Transverse color Doppler image obtained along the dorsal aspect of the penis shows hyperemia of the soft tissues surrounding the corpora. CC = corpus cavernosum, CS = corpus spongiosum.

v. 

Penile cavernositis in a 73-year-old diabetic patient with diffuse painful induration after self-injection of prostaglandin into the corpora cavernosa. Transverse color Doppler image obtained along the ventral aspect of the penis shows hypervascularity of the corpora cavernosa (CC) and corpus spongiosum (CS)

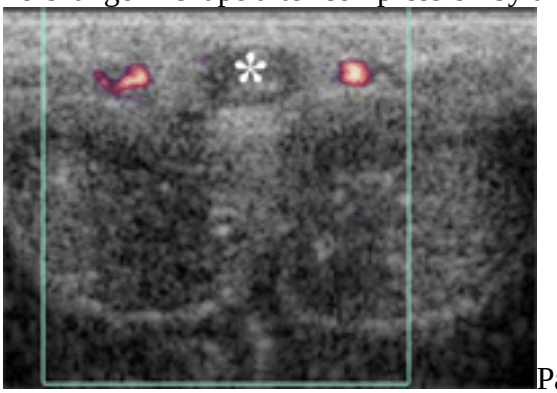
vi. 

Penile abscesses in an 83-year-old diabetic patient. Transverse color Doppler image obtained along the dorsal aspect of the penis shows a corpusculated fluid collection within the corpora cavernosa (*), a finding consistent with an abscess. The soft tissues surrounding the erectile bodies are thicknened and hypervascularized with small abscesses (arrowheads). CS = corpus spongiosum.

i. Trauma
    i. Patients with penile injury usually present with painful swelling and deformity of the shaft, either diffuse or circumscribed. The integrity of the tunica albuginea is the most important factor in determining the necessity for surgical intervention. Surgical repair is generally recommended in patients with a suspected tunical tear or urethral injury, whereas other injuries may be treated conservatively.
    ii. Imaging may be required to evaluate the extent of the penile injury, locate hematomas, identify involvement of the penile urethra, or rule out albugineal disruption.
    iii. US allows differentiation of cavernosal, septal, and extra-albugineal hematomas; recognition of associated vascular injury; and identification of a tunical tear as an interruption in the echogenic interface of the normally appearing albuginea

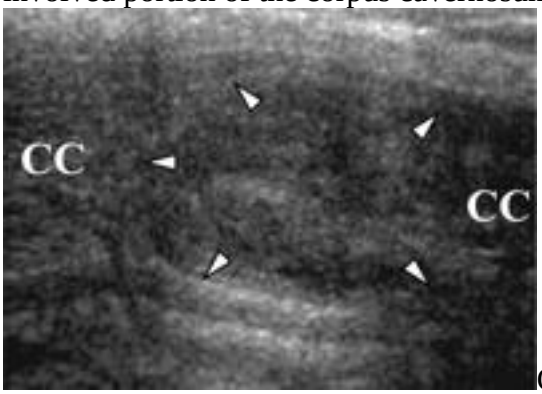
iv. 
Penile fracture. Transverse image obtained along the ventral aspect of the penis shows an interruption (arrow) in the echogenic line of the tunica albuginea (arrowheads) of the right corpus cavernosum. There is an associated extra-albugineal hematoma (*).

j. Dorsal Vein Thrombosis
   i. Patients with dorsal vein thrombosis present with a rod-like painful induration in the dorsal aspect of the penile shaft. Thrombosis can be associated with thrombophilia but may also be idiopathic or follow inflammation, trauma, and vigorous intercourse.
   ii. US can be useful in confirming the diagnosis and excluding any underlying mass lesion within the penis. In patients with dorsal vein thrombosis, US shows absence of color flow and the presence of echogenic material within the dorsal and circumflex veins, with no change in shape after compression by the transducer.

iii. 
Patient with rod-like painful induration of the dorsal aspect of the penis. Transverse power Doppler image obtained along the dorsal aspect of the penis shows echogenic material and absence of flow within the dorsal vein (*).

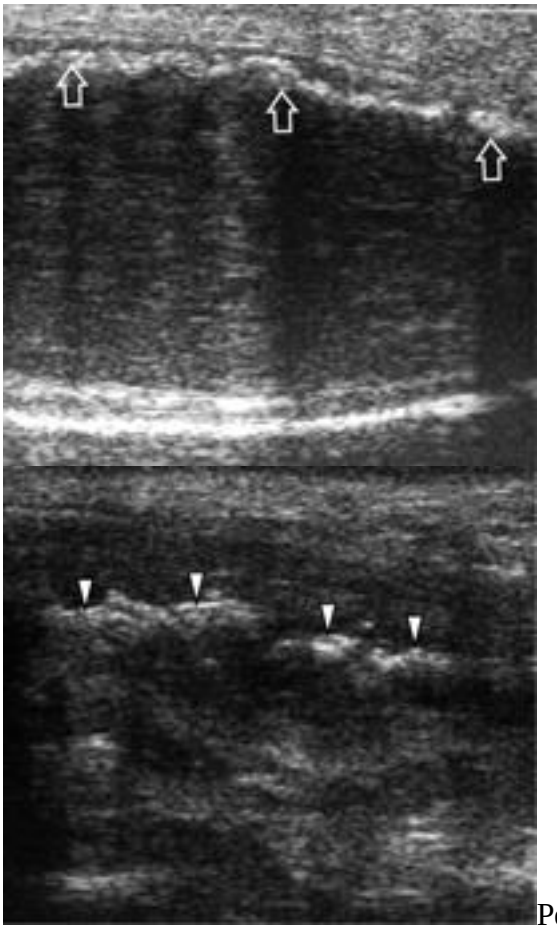
k. Corporal Thrombosis
   i. Persistent pain and induration of the proximal portion of the penile shaft may result from partial segmental thrombosis of a corpus cavernosum.

ii. Imaging allows differential diagnosis between corporal thrombosis and other causes of penile induration. At US, a heterogeneously hypoechoic lesion with no vascularization is identified in the involved portion of the corpus cavernosum.

iii. 

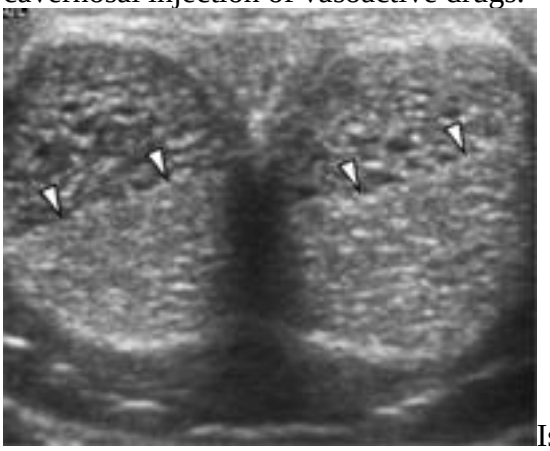
Corporal thrombosis in a patient with painful induration of the proximal corpus cavernosum. Longitudinal image obtained along the ventral aspect of the penis shows a predominantly isoechoic, slightly heterogeneous lesion (arrowheads) in the proximal portion of the right corpus cavernosum (CC). The lesion represents partial segmental thrombosis of the corpus cavernosum.

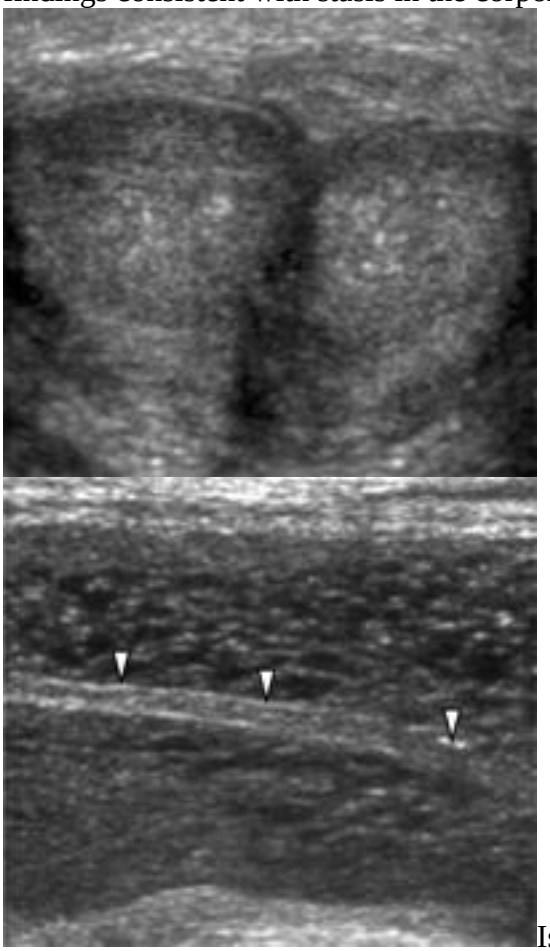
l. Calciphylaxis
   i. Patients with penile calciphylaxis present with severe penile pain that is unresponsive to narcotics and associated with diffuse penile induration. This rare, life-threatening disorder is characterized by progressive vascular calcification and ischemic tissue loss in patients with end-stage renal disease
   ii. US and CT show obliteration of the penile vessels and widespread calcification of the tunica albuginea and cavernosal arteries.

iii. 
Penile calciphylaxis in a 52-year-old man with long-standing end-stage renal disease who presented with severe penile pain unresponsive to narcotics. Diffuse penile induration was appreciable at palpation. Longitudinal US images obtained along the ventral aspect of the penis (a, b) show diffuse calcifications of the tunica albuginea (arrows in a) and calcified and obliterated cavernosal arteries (arrowheads in b).

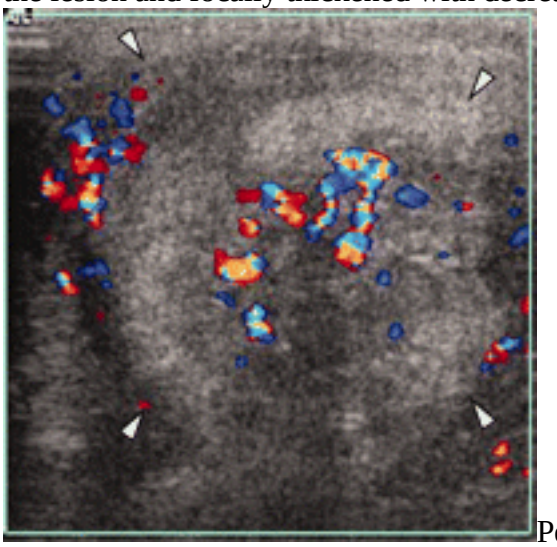
m. Low Flow Priapism
    i. Patients with low-flow priapism seek urgent medical attention for a prolonged painful erection. Immediate treatment is needed.
    ii. US is able to demonstrate whether the cavernosal arteries are patent and whether pathologic changes in the echotexture of the corpora cavernosa have occurred. Initially, the corpora cavernosa appear normal. Blood stasis is demonstrated as dependent sedimentation of blood, forming a fluid-fluid level.
    iii. In more advanced situations, tissue edema produces an increase in the echogenicity of the corpora cavernosa.
    iv. In long-standing ischemic priapism, wide echotexture alterations of the corpora cavernosa are recognized, consistent with fibrotic changes.

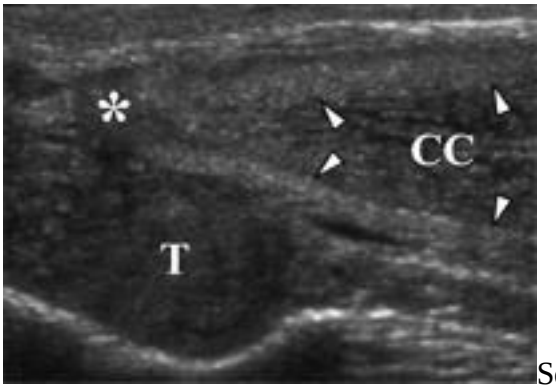
v. Because the penis is already erect, US must be performed without cavernosal injection of vasoactive drugs.

vi. 
Ischemic priapism in a 44-year-old man with a painful erection lasting for 8 hours. Transverse US image obtained along the ventral aspect of the penis shows a fluid-fluid level (arrowheads) in each corpus cavernosum, findings consistent with stasis in the corpora cavernosa.

vii. 
Ischemic priapism in a 32-year-old man with a painful erection lasting for 27 hours. (a) Transverse US image obtained along the ventral aspect of the penis shows increased echogenicity of the corporal bodies, a finding

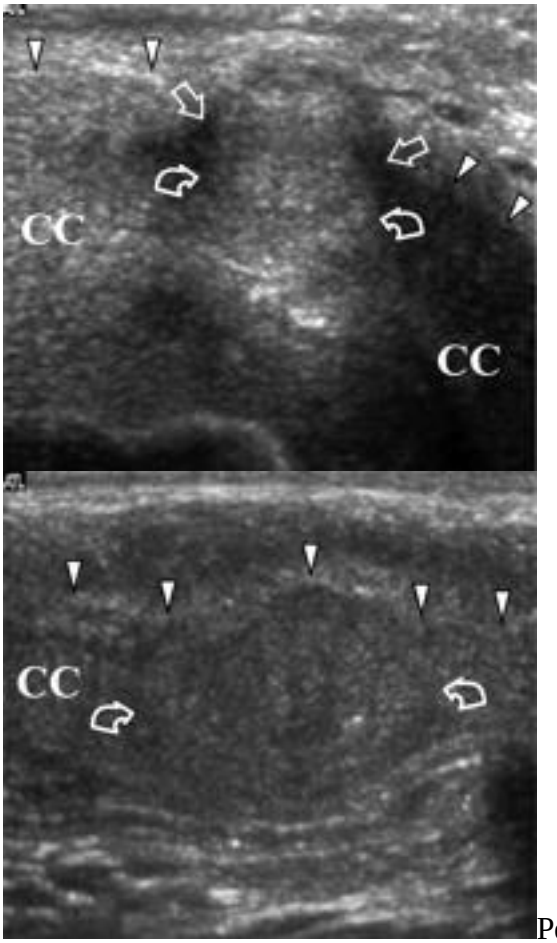
consistent with tissue edema. (b) Longitudinal US image obtained along the ventral aspect of the penis shows obliteration of the cavernosal artery (arrowheads).

n. Primary Tumors
    i. An area of induration or a warty exophytic growth is a common manifestation of a primary penile tumor. Pain may be present in cases of tumor inflammation.
    ii. In patients with primary penile tumors, imaging is indicated for staging purposes. Because the relationships between the tumor and adjacent structures are better evaluated when the penis is erect, US and MR imaging should be performed after intracavernous prostaglandin injection.
    iii. At US, primary penile tumors usually have variable echogenicity and poor vascularization. Inflamed tumors may demonstrate increased vascularity (Fig 21). Infiltration of the corpora cavernosa appears as interruption of the interface of the tunica albuginea (Fig 22) (45,47,48). However, in patients with initial infiltration, the tunica albuginea may not be interrupted but may be in contact with the lesion and focally thickened with decreased echogenicity.
    iv.  Penile cancer in a 74-year-old man with painful induration of the glans. Transverse color Doppler image obtained along the ventral aspect of the penis shows a hyperemic mass involving the entire glans (arrowheads), a finding consistent with an inflamed tumor.

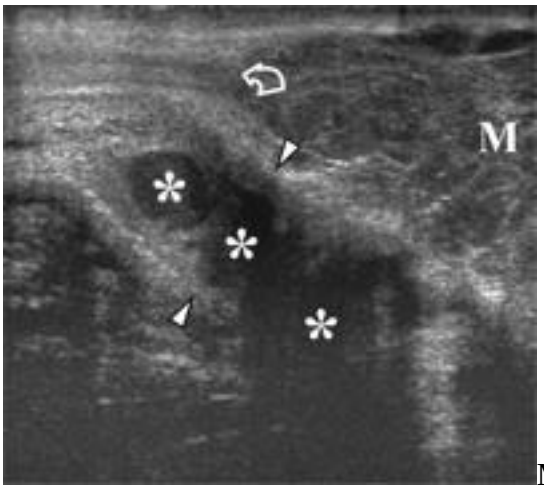
v. 

Squamous cell carcinoma of the penis in a 54-year-old man with an area of induration in the glans. Longitudinal US scan obtained at the distal portion of the penile shaft shows a lesion (T) involving the glans. There is an interruption (*) in the echogenic interface of the tunica albuginea (arrowheads), a finding consistent with focal infiltration of the corpus cavernosum (CC).

o. Secondary Tumors
    i. Metastatic invasion of the corpora cavernosa by a malignant neoplasm can manifest as painful penile induration, either circumscribed or diffuse.
    ii. At US and MR imaging, metastatic involvement of the shaft may appear as circumscribed tumor nodules within the corpora cavernosa (Fig 25), diffuse infiltration (Fig 26), or both (48). Venous stasis and thrombosis can be associated as a result of infiltrations of the normal venous drainage pathways. Direct infiltration of the tunica albuginea can be identified as a tunical interruption at the base of the penis or in other portions of the shaft.

iii. 

Penile metastases. (a) Longitudinal US image, obtained along the ventral aspect of the penis in a 67-year-old patient with advanced lung cancer, shows a metastatic nodule (curved arrows) with bulging of the corpus cavernosum (CC). The tunica albuginea (arrowheads) is interrupted (straight arrows). (b) Longitudinal US image, obtained along the ventral aspect of the penis in an 83-year-old patient with advanced bladder cancer, shows a metastatic nodule (arrows) within the corpus cavernosum (CC). The nodule distorts the corporal profile without interruption of the tunica albuginea (arrowheads).

iv. 

Metastatic infiltration of the penis in a 68-year-old man who underwent cystectomy 6 months earlier for bladder cancer and who presented with painful induration of the proximal portion of the penile shaft. (a) Longitudinal US image, obtained along the ventral aspect of the penis at its base, shows a perineal mass (M) infiltrating the corpus spongiosum (arrow) and corpora cavernosa (*). The tunica albuginea (arrowheads) is interrupted at the base of the penis.

Reviewed and Approved by:

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