

Penile Ultrasound

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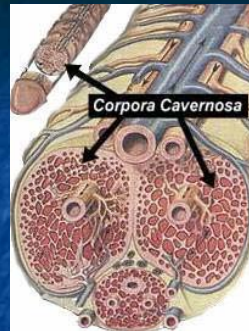
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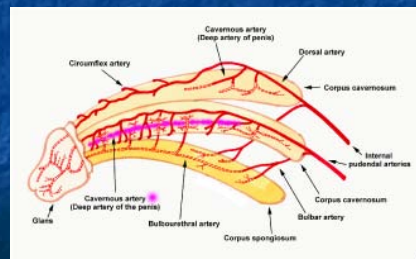
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Penile Ultrasound Anatomy

- Phallus consists of the two corpora cavernosa (cc) and the corpora spongiosum (cs) which surrounds the urethra. All three covered by the tunica albuginea
- The penile arteries arise from branches of the internal pudendal arteries giving rise to:
 - Bulbourethral Artery
 - Penile bulbar artery
 - Urethral artery
 - Superficial dorsal artery
 - Cavernosal artery (deep penile a) which within the cc branch into helicine arteries which open into the sinusoids.
- The cc are drained by subtunical veins that empty into the deep dorsal vein

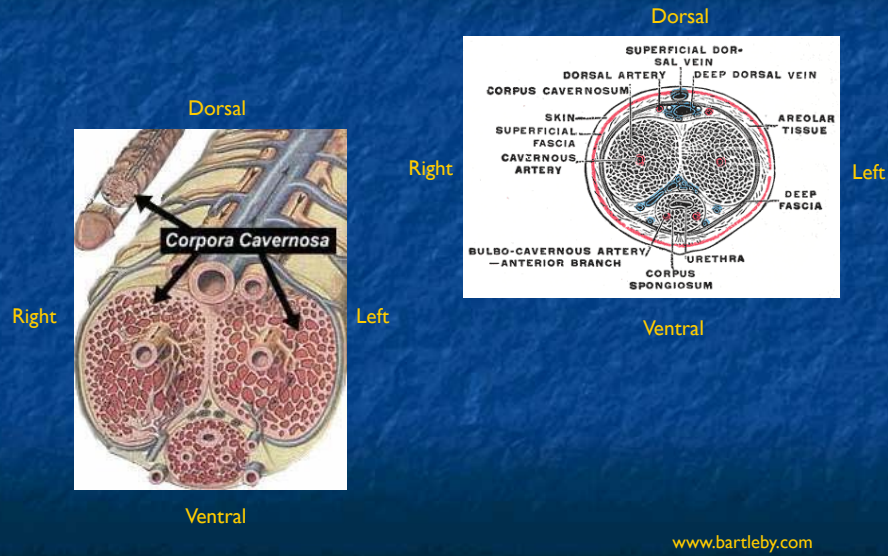


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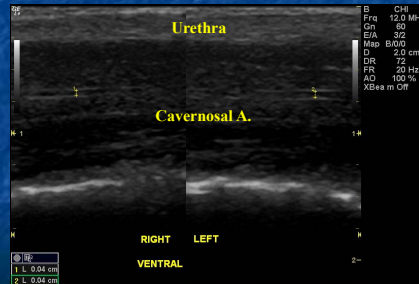
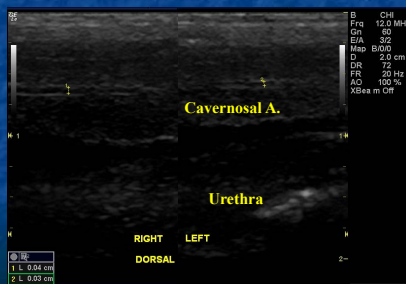
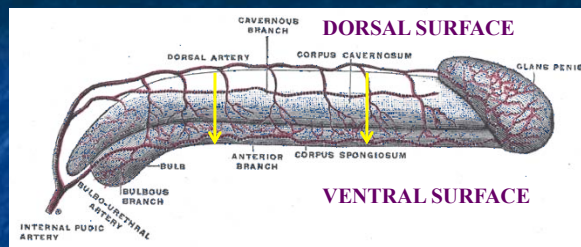


modified after RA Santucci, RP Terlecki. eMedicine, 2009

Transverse Orientation



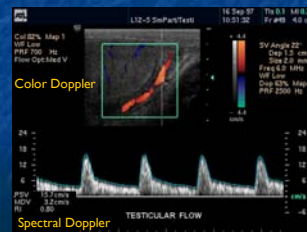
Longitudinal (Axial) Orientation



Physical Principles

Doppler ultrasonography

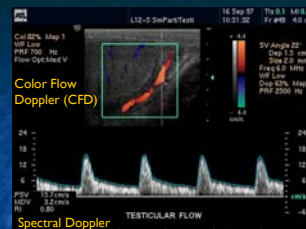
- Pulsed Wave Doppler (PW)
 - Pulse wave machines transmit pulses of ultrasound then switch to receive mode
 - Measure the phase shift between the received and transmitted signal
 - The echo delay time can be converted into distance.
 - Therefore, velocity (speed and direction) and distance (depth) information can be obtained



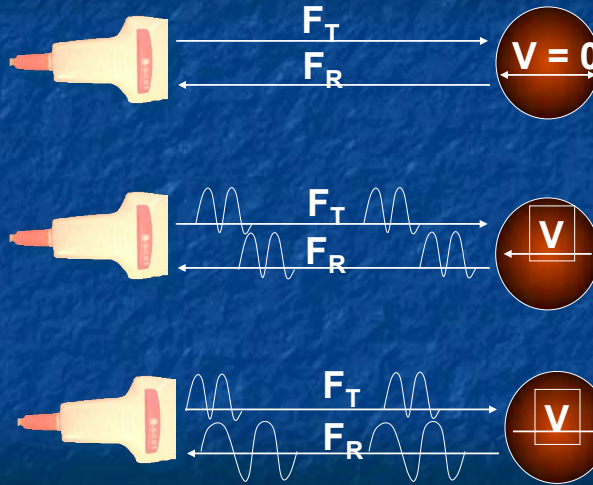
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Doppler Ultrasound

- Pulsed Wave Doppler (PW)
 - Single crystal, phase shift measured, speed: direction: depth
- Color Doppler
 - Speed and direction encoded in color as indicated by the color bar (BART)
- Spectral Doppler
 - Spectrum of flow velocities represented graphically on the Y-axis and time on the X-axis



Doppler Effect

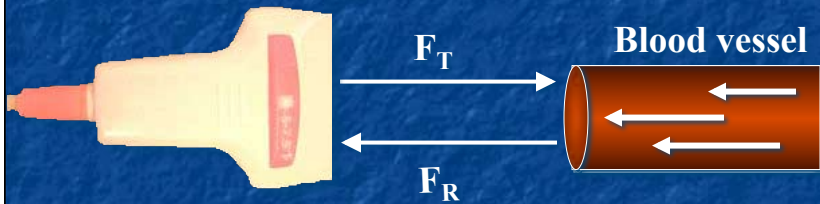


Stationary target
($F_R - F_T$) = 0

Target motion toward transducer
($F_R - F_T$) > 0

Target motion away from transducer
($F_R - F_T$) < 0

Doppler Frequency Shift

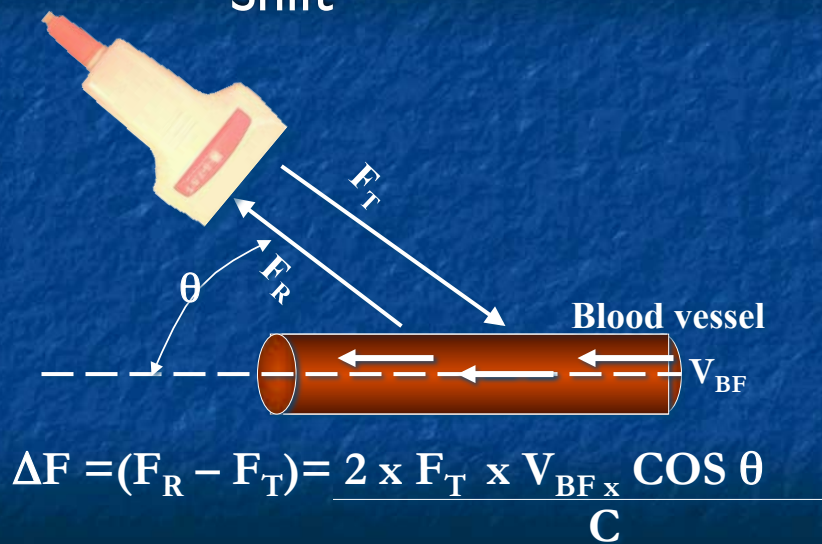


$$\Delta F = F_R - F_T = \frac{2 \times F_T \times v}{C}$$

v = Velocity of object

C = Speed of sound in medium (1540 m/s)

Doppler Frequency Shift



Angle of Insonation

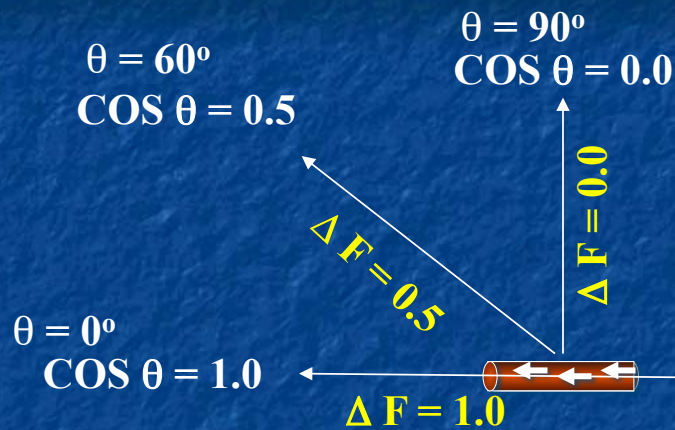
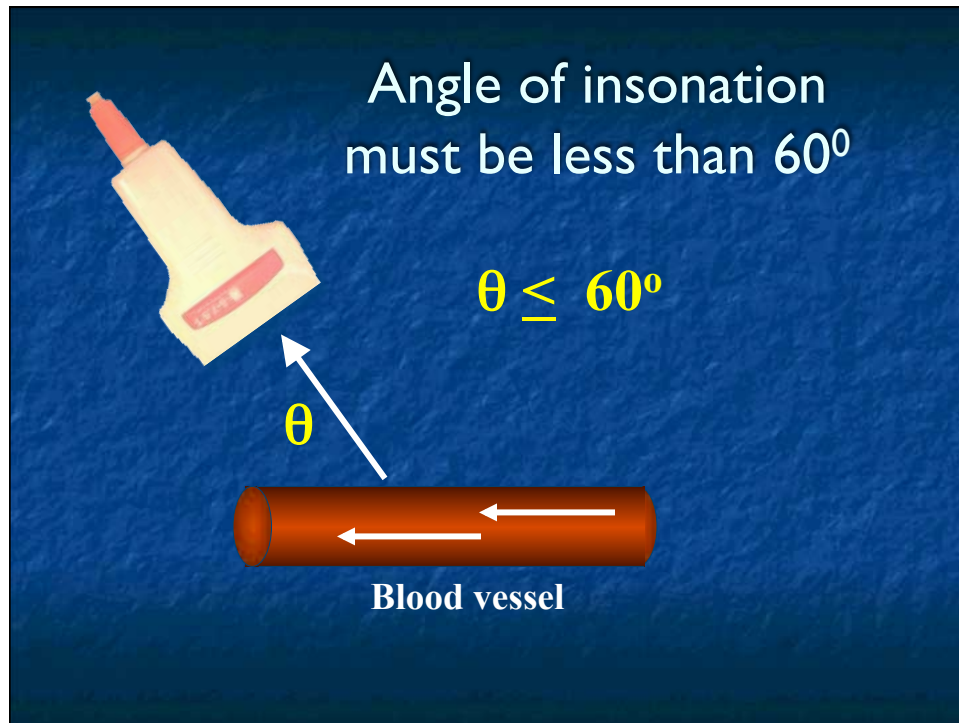


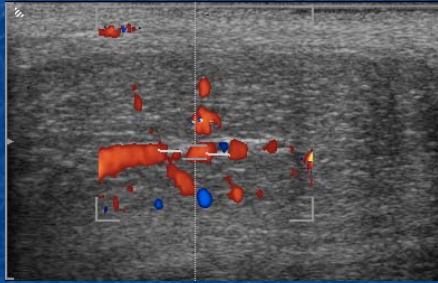
Fig 140-C Radiographics 1991;11:109-119



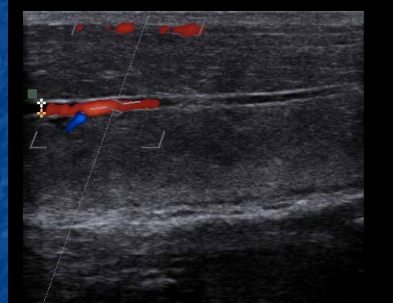
Scanning Protocol penile ultrasound - overview

- High resolution, small footprint with transducers from 6 to 18 MHz
- Color and spectral Doppler capabilities are essential
- Transverse and longitudinal views obtained from ventral and/or dorsal surfaces
- The specific measurements obtained should be documented on the images.
- The specific images obtained should document the findings discussed in the report.

Transducer Frequency



12 mHz



18 mHz

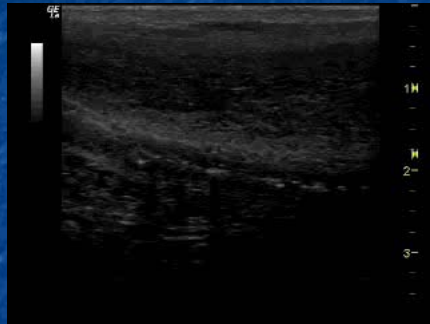
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Scanning Protocol

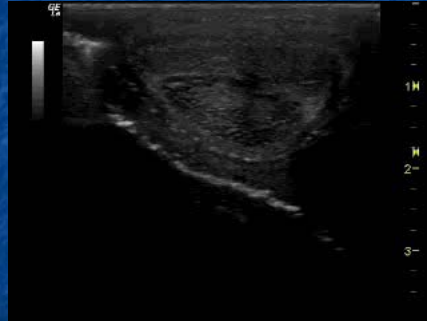
B-mode survey scan and measurements

- Ventral and/or dorsal surfaces can be used
- A survey scan is first performed from the distal to proximal phallus and from the left to right lateral borders
- Identify and record any plaques (calcified or not) or stippling
- The images obtained should document all findings

Survey Scan

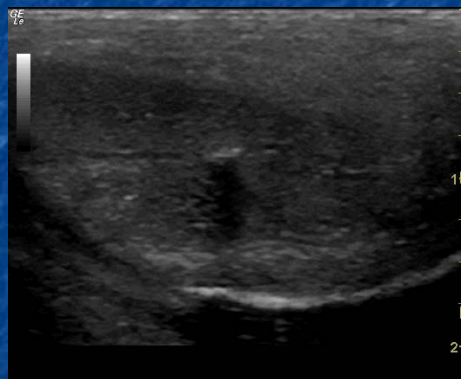


Longitudinal - Left to Right



Transverse - Proximal to Distal

Survey Scan - Plaque



Transverse - Proximal to Distal

Normal Imaging Documentation

- The report should include:
 - patient identification
 - date of examination
 - measurement parameters and anatomical findings of examination.
- The report is **signed** by the physician who performed the ultrasound examination
- **Indication** for performing the examination is clear and provided on the report.
- Images should include:
 - patient identification
 - date and time of each image
 - Clear image with orientation and measurements
 - Labeling of anatomy and any abnormalities
- Images should be attached to the report

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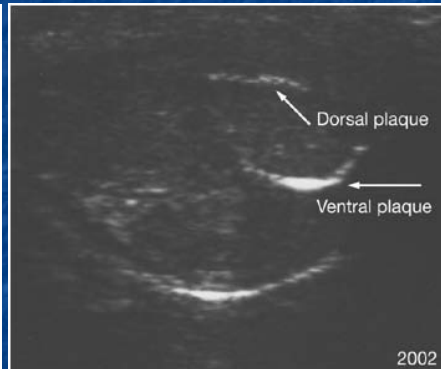
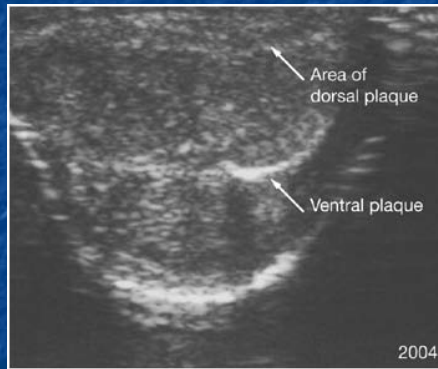
Indications

- Structural Pathology
 - **Penile plaque**
 - Peyronie
 - Iatrogenic fibrosis
 - **Penile mass**
 - Penile fracture
 - Penile tumor
 - Hematoma
 - Cavernosal herniation
- Vascular Pathology
 - **Erectile dysfunction**
 - **Priapism**
 - High flow
 - Low flow
 - **Thrombosis**
- Urethral Pathology
 - **Diverticula**
 - **Abscess**
 - **Stricture**
 - **Calculus**
- Post surgical follow up

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Indications

structural - Peyronie plaque

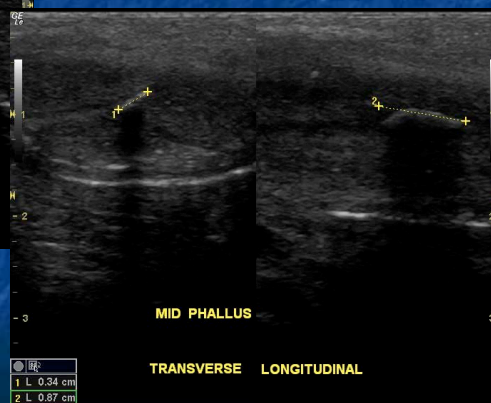
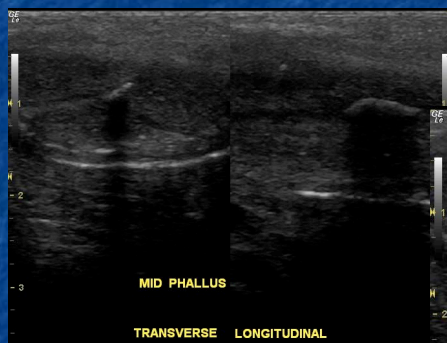


- Plaques may or may not be calcified
- May be better visualized with tumescence
- Arterial venous disease more common with Peyronie's disease

- Images/Measurements
 - thickness and length of the plaque
 - blood flow of the corpora cavernosa and corpora spongiosa

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Plaque Identification



Indications

structural - penile fracture

- Usually presents with pain, swelling and sudden loss of erections with intercourse
- Ultrasound is useful for **initial diagnosis** (hematoma, tunica albuginea defect) and **long term follow up** (corporal fibrosis, plaque formation)



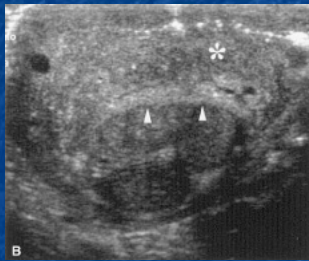
- Images/Measurements
 - width of defect
 - Transverse and longitudinal image of defect
 - Color flow confirmation of viable tissue

CJ Wi kin, PS Sidhu, in Ultrasound of the Urogenital System, GM Baxter, PS Sidhu, Thieme, 2006

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Indications

structural - penile tumor



- Squamous cell carcinoma of penis confined to subepithelial tissue
- Tunica albuginea of the corpora cavernosa is intact



- Bladder cancer metastatic to penis with diffuse and nodular involvement (N) of the corpora cavernosa

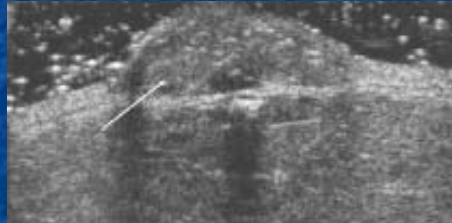
CJ Wi kin, PS Sidhu, in Ultrasound of the Urogenital System, GM Baxter, PS Sidhu, Thieme, 2006

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Indications

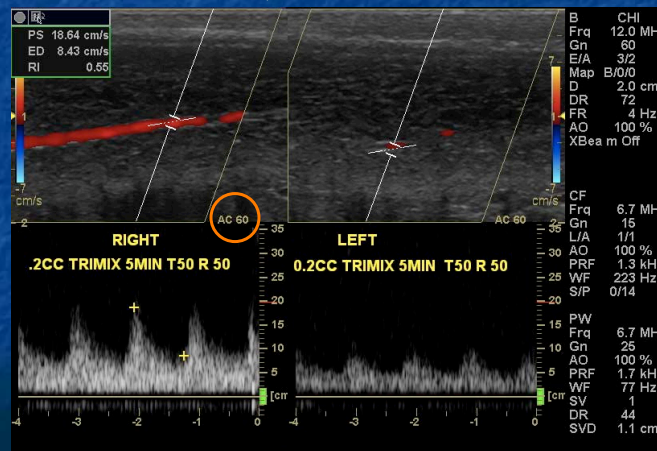
structural - herniation of corpora cavernosa tissue

- Congenital or acquired focal weakness in the tunica albuginea
- Herniation often results in failure of compression of the emissary veins and erectile dysfunction



CJ Wi kin, PS Sidhu, in Ultrasound of the Urogenital System, GM Baxter, PS Sidhu, Thieme, 2006

Penile Duplex Ultrasound



Indications

vascular - ED protocol

- Informed consent is obtained
 - The need for patient to call the physician should an erection last more than 4 hours from the time of injection must be emphasized and documented
- Supine position with scrotum supported
 - Dorsal, Ventral and Lateral approaches are employed
- High frequency (7 - 18 mHz) “small parts” transducer with small footprint
- Baseline imaging for fibrosis, plaque or other pathology
- Baseline measurements of inner cavernosal artery diameter and vascular parameters (PSV, EDV, Ri)
 - Normal baseline velocity parameters (i.e., without pharmacologic stimulation) are often difficult to obtain and have not been well described

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Indications

vascular - ED protocol

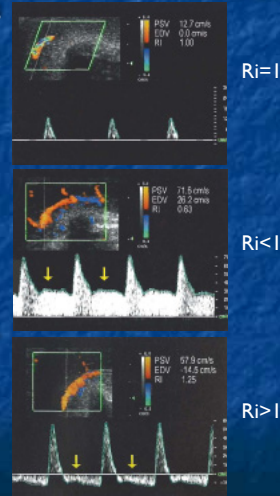
- Pharmacostimulation with single or combination agent (Prostaglandin E-1, Phentolamine, Papaverine)
 - 0.1 ml TriMix (10-1-30)
 - 5 or 10 μ g/ml PGE1 (my preference)
- Vascular parameters and a clinical evaluation of tumescence and rigidity are measured at the base of the penis at 5 minute intervals for 30 minutes.
- Erection must be dissipated prior to sending the patient home.
 - Reported incidence of priapism > 11%
 - Absence of cavernous blood flow or a Ri > 1 (absent diastolic blood flow) often predicts post procedure priapism (J Cormio et al, Eur Urol, 33:94-97, 1998)
- Follow up phone call with patient within 4 hours to confirm that the erection has dissipated

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Indications

vascular - duplex basics

- Measurements taken prior to and at 5 minute intervals after injection, for at least 30 minutes:
 - Width - inner vessel diameter
 - 0.2 to 1.0 mm at baseline
 - With stimulation should increase > 75% from baseline
 - PSV - Peak systolic velocity
 - Erect phallus: 25 to 35 cm/s with > 35 cm/s normal and < 25 cm/s abnormal. With maximal rigidity PSV decreases.
 - Flaccid phallus: 5 - 20 cm/s
 - Asymmetry < 10 cm/s
 - EDV - End diastolic velocity
 - < 5 cm/s (when PSV is normal) (JP Quam et al, AJR, 153:1141-1147, 1989 and HS Bassiouny et al, J Vasc Surg. 13:75-82, 1991)
 - Ri - Resistive (Resistance) Index: (PSV-EDV)/PSV
 - Erect phallus: falls below 0.7 at first then above 1.0 indicating bi-directional blood flow in the penile arteries.
 - Flaccid phallus: ~1.0 (no detectable EDV)
 - Tumescence and Rigidity



M Hofer et al, Teaching Manual of Color Duplex Sonography, Thieme, 2004

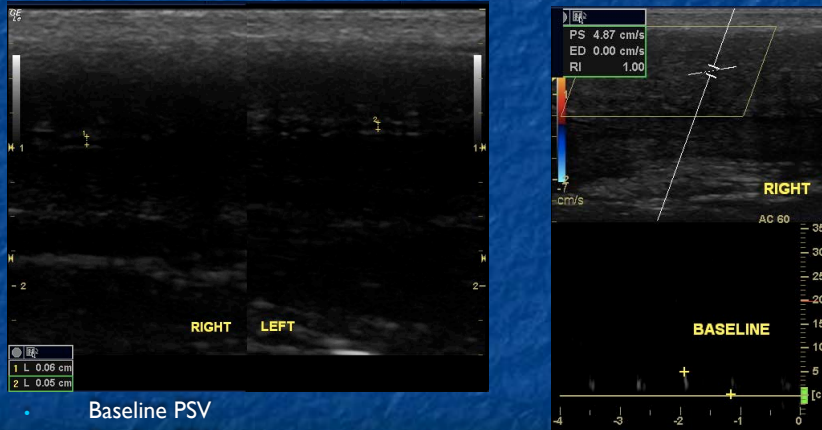
Indications

vascular - blood flow with pharmacostimulation



Indications

vascular - pre injection



- Baseline PSV
- Baseline EDV
- Baseline Cavernosal artery inner diameter
- Baseline (Subjective) Tumescence and Rigidity

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Indications

vascular - 5 min post injection

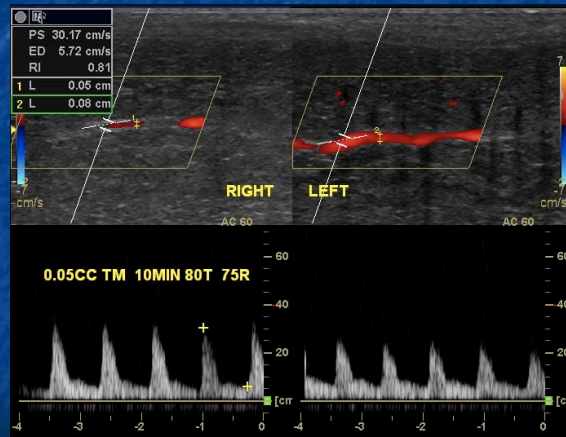


- 5 min PSV
- 5 min EDV (calculate Ri)
- 5 min Cavernosal artery inner diameter
- 5 min (Subjective) Tumescence and Rigidity

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Indications

vascular - 10 min post injection



- 10 min PSV
- 10 min EDV (calculate Ri)
- 10 min Cavernosal artery inner diameter
- 10 min (Subjective) Tumescence and Rigidity

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Indications

vascular - 20 min post injection



- 20 min PSV
- 20 min EDV (calculate Ri)
- 20 min Cavernosal artery inner diameter
- 20 min (Subjective) Tumescence and Rigidity

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Documentation Sample Template

PENILE ULTRASOUND									
DATE OF SERVICE:					BP:				
PROCEDURE:					Pulse:				
INDICATION:									
US MACHINE:					TRANSDUCER:				
B-MODE FINDINGS (ATTACH IMAGES)									
RIGHT CORPORA CAVERNOSUM					LEFT CORPORA CAVERNOSUM				
AP LONGITUDINAL (cm)					AP LONGITUDINAL (cm)				
MASS (size/location):					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									
CORPORA CAVERNOSUM COMMENTS									
BUCCORPORA COMMENTS									
COLOR DOPPLER/DUPLEX FINDINGS (ATTACH IMAGES)									
INDICATION FOR COLOR/DUPLEX STUDY:									
COMMENTS:									
PSV	EDV	RI	Dia (mm)	Time	PSV	EDV	RI	DIA (mm)	Turn/Rtg
				Baseline					
				5 MIN					
				10 MIN					
				15 MIN					
				20 MIN					
				30 MIN					
				40 MIN					
PHYSICIAN INTERPRETATION									
DATE/TIME									
PHYSICIAN SIGNATURE									

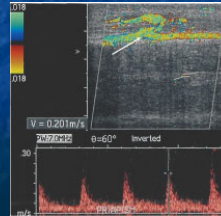
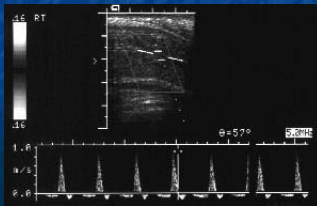
Duplex study – Reported Complications

- Local complications (common)
 - Pain (medication or injection)
 - Hematoma (at injection site)
 - Priapism (low flow)
- Local complications (uncommon)
 - Nerve damage
 - Penile skin irritation
 - Urethral injury
 - Scarring of corpora cavernosum
 - Infection
- Systemic complications
 - Vasovagal reactions
 - Myocardial events (including infarction and stroke)
 - Elevation of liver function enzymes
 - Hypersensitivity reactions

Indications

vascular - priapism

- Low Flow
 - Deoxygenated corporal blood on aspiration
 - *High Ri with low (or no) diastolic flow*
 - Edema
 - *Medical Emergency*
- High Flow
 - Oxygenated corporal blood on aspiration
 - *Low Ri with increased systolic and diastolic flow*
 - Arteriovenous fistula may be present (with trauma)



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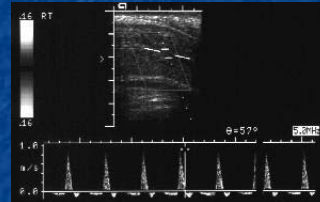
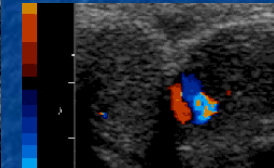
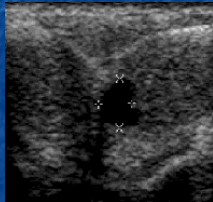
Duplex study

Treatment - Priapism

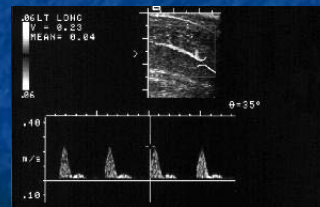
- Observation
- Aspiration
- Pharmacological Detumescence
 - Phenylephrine 250 to 500 μ g Q15 minutes for a maximum of 6 injections
 - Monitor blood pressure (HTN)
 - EKG (arrhythmias)

Indications

vascular - arterial (“high flow”) priapism



before embolization



after embolization

Priapism: prolonged, persistent and painful erection

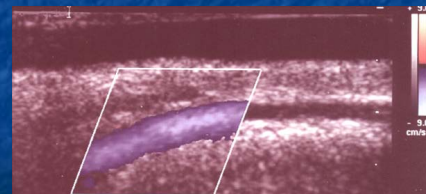
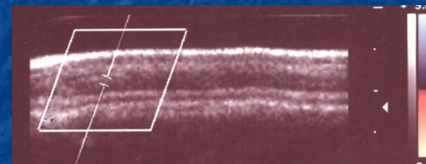
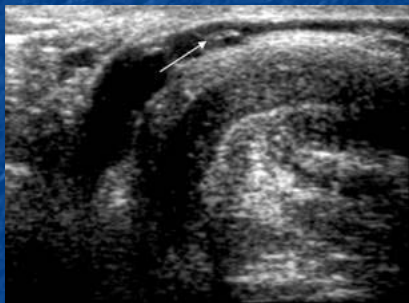
- 60% primary, 20% secondary
- 20% of secondary are hematologic (Sickle cell disease, leukemia, heparin therapy)
- Other causes: neurogenic, traumatic, and infectious

High flow (arterial)

- Arterial priapism: secondary to arteriovenous fistula, frank arterial laceration with extravasation or a pseudoaneurysm
- Treatment: most effective-arterial ligation or percutaneous embolization. Less effective-perineal compression, ice packs or intracavernous administration of alpha-adrenergic agonists

Indications

vascular - dorsal vein thrombosis

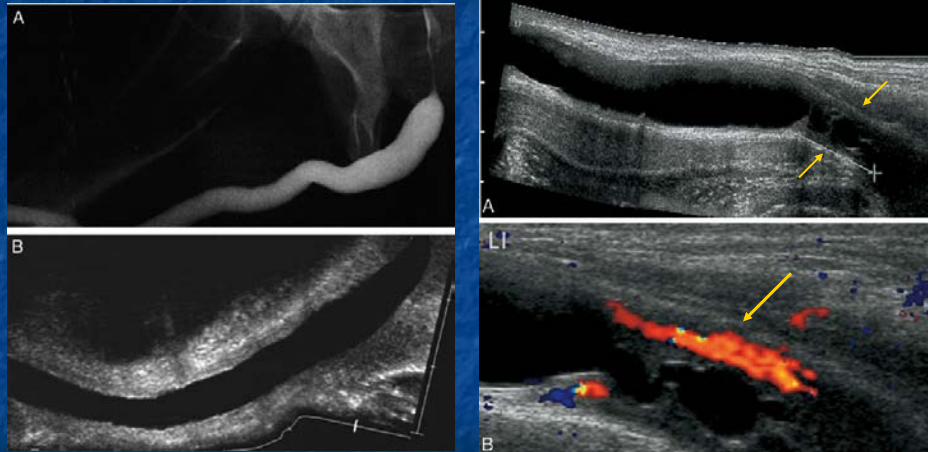


“Mondor’s phlebitis”

- Acute: inflammation, pain fever
- Subacute: induration and minimal pain
- Spontaneous recanalization in 6 to 8 weeks

Indications

structural - urethral stricture



M Mitterberger et al, J Urol, 177, 992-997, 2007

Normal

- A. Radio-urethrography
- B. Sono-urethrography

Urethral Stricture

- A. Sono-urethrography
- B. Color Doppler 39

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