

Penile Ultrasound

Bruce R. Gilbert, MD, PhD

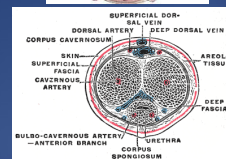
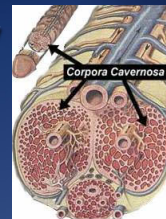
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Penile Ultrasound Anatomy

- 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 two penile arteries arise from branches of the internal pudendal arteries giving rise to:
 - Penile bulbar artery
 - Urethral artery
 - Superficial dorsal artery
 - Deep penile artery 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

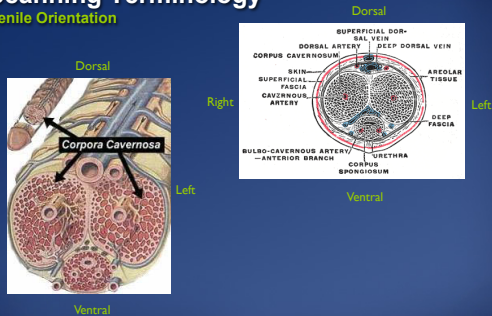


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Scanning Terminology

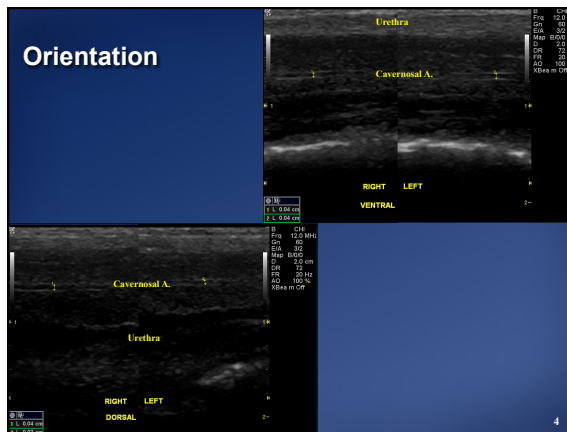
Penile Orientation



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Orientation

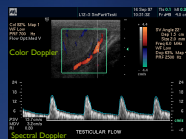


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Physical Principles

Ultrasonography

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



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Scanning Protocol

penile ultrasound - overview

- High resolution grey scale imaging with transducers from 7 to 18 mHz
- Color and spectral Doppler capabilities are essential
- Transverse and longitudinal views obtained from ventral and/or dorsal surfaces
 - Survey Scan (Video Clips)
 - Specific Images (Proximal, Mid, Distal, Lateral)
- The specific measurements obtained should be documented on the images.
- The specific images obtained should document the findings discussed in the report.

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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

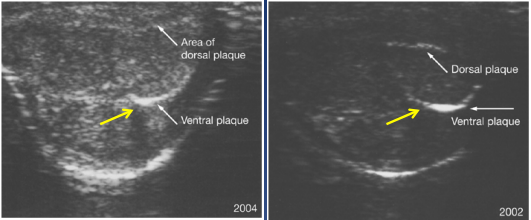
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Indications

- Structural Pathology**
 - **Penile plaque**
 - Peyronie's
 - Iatrogenic fibrosis
 - **Penile mass**
 - Penile fracture
 - Penile tumor
 - Hematoma
 - Cavernalos 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's 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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Indications structural - penile fracture

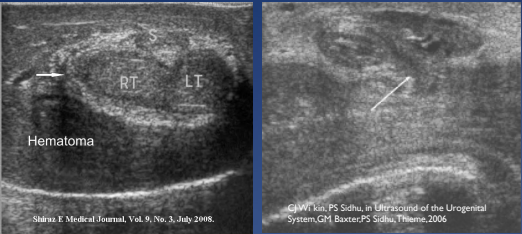
- Usually presents with pain, swelling and sudden loss of erections with intercourse
- Ultrasound is useful for **initial diagnosis** (hematoma, tunica albuginea defect) **and long term follow up** (corporal fibrosis, plaque formation)



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

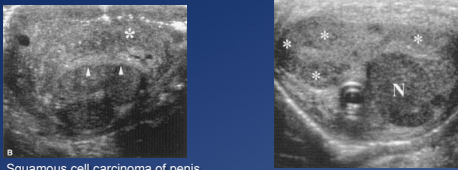
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Indications structural - penile fracture



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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

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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



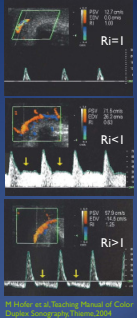
CJ Wi kon, PS Sidhu, in Ultrasound of the Urogenital System, GM Baxter, PS Sidhu, Thieme, 2006

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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



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Indications

vascular - ED protocol

- Informed consent is obtained
 - The need for the 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

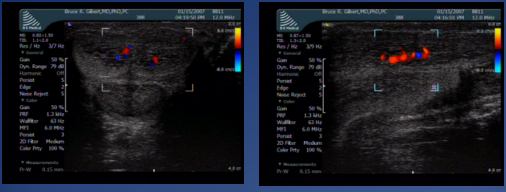
vascular - ED protocol

- Pharmacostimulation with single or combination agent (Papaverine, Phentolamine, Prostaglandin E-1)
- 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

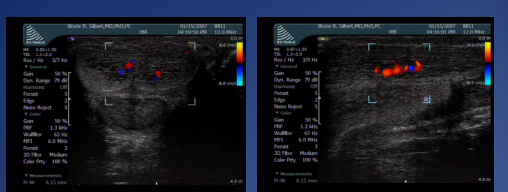
vascular - blood flow with pharmacostimulation



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Indications

vascular - blood flow with pharmacostimulation



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Indications

vascular - pre injection – Flaccid Phallus

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

PS: 9.65 cm/s ED: 0.12 cm/s RI: 0.99 MI: 0.65+1.50 TIS: 0.2

AT: 136 ms Dist: 0.38 mm

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Indications

vascular - 5 min post injection

Measurements Obtained every 5 minutes until RI = 1 or high dose of injectable agent does not increase PSV further:

- PSV
- EDV (calculate Ri)
- Cavemosal artery inner diameter
- (Subjective) Tumescence and Rigidity
- Angle of Incidence

PS: 8.19 cm/s ED: 2.17 cm/s RI: 0.73 MI: 0.84+1.50 TIS: 0.2

AT: 224 ms Dist: 0.59 mm

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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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Indications

vascular - arterial (“high flow”) priapism

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 intracavernosal administration of alpha-adrenergic agonists

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Assessing CVD risk in ED

- ED presents about 39 months before CAD possibly because the smaller penile arteries reach critical narrowing and decreasing blood flow earlier than larger vessels.
- A normal penile Doppler test virtually excludes CAD with a 98% negative predictive value.
- An abnormal penile Doppler test had a 30% positive predictive value for CAD – a value many times higher than 4% found in the general population.

1. Feldman HA et al. Importance and its medical and psychosocial correlates: results of the Massachusetts Male Aging Study. J Urol 1994; 151: 54-61.
 2. Shimamoto WA, Gomez-Camacho A, Jao S, Vignamaggi V. Should erectile dysfunction be considered as a marker for acute myocardial infarction? Results from a retrospective cohort study. Int J Impot Res 2004; 16: 200-203.
 3. Koster DR et al. Impaired brachial artery endothelium-dependent and -independent vasodilation in men with erectile dysfunction and no other clinical cardiovascular disease. J Am Coll Cardiol 2000; 35: 179-184.
 4. O'Keefe JH, Jackson G. Erectile dysfunction: is there value obstructive coronary artery disease? Int J Clin Pract 2001; 55: 119-120.
 5. Pritsker MB. The penile stress test: a window to the heart of Man? Circulation 1999; 100(suppl 1): 1-10.
 6. Montano P, Montano J, Schalkham CC. Is erectile dysfunction the "tip of the iceberg" of a systemic vascular disorder? Eur Urol 2003; 44: 352-354.

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Assessing CVD risk in ED

- 77% of those with high-grade ischemic heart disease had an abnormal penile Doppler test with peak systolic velocity (PSV) of less than 25 cm/s.
- Those with angiographically confirmed silent CAD had over seven times the rate of ED (33.8% vs 4.7%) than control type II diabetics without CAD.
- As more information accrues confirming ED as an early manifestation of peripheral vascular disease, PDDU testing may play a key role in selecting those who do or do not need further coronary artery vascular assessment.

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Assessing CVD risk in ED

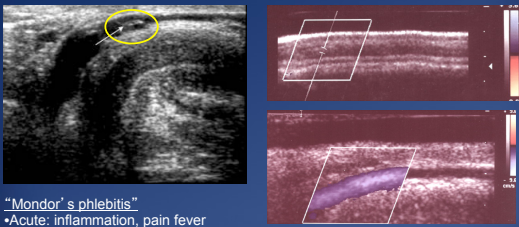
- The physician evaluating ED has a unique opportunity to diagnosis vascular impairment at a time when lifestyle changes and possible medical intervention have the potential to change morbidity and mortality of cardiovascular disease.
- As suggested by Miner there might be a "window of curability" in which the significant risk of future cardiovascular events might be averted through early diagnosis and treatment

Miner MM. Erectile Dysfunction: A Harbinger or Consequence: Does Its Detection Lead to a "Window of Curability?". *J Androl.* Sep 23 2011;32(2): 125-134

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Indications

vascular - dorsal vein thrombosis



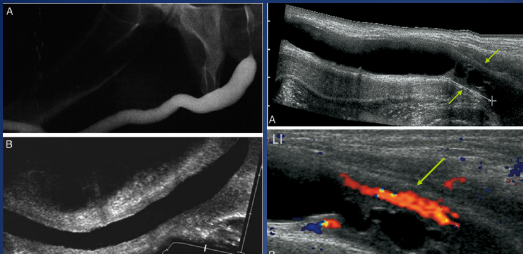
"Mondor's phlebitis"

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

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Indications

structural - urethral stricture



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

Normal	Urethral Stricture
A. Radio-urethrography	A. Sono-urethrography
B. Sono-urethrography	B. Color Doppler

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