Penile US and Doppler US

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Introduction

US and Doppler US are being used as primary imaging modalities in the evaluation of the patient with erectile dysfunction and various other penile diseases. This exhibit will illustrate (1) the technique and normal findings of penile US and Doppler US (2) color / power / spectral Doppler US in the normal variation, arteriogenic and venogenic impotences, diabetic arteriopathy, arteriovenous fistula and Peyronie’s disease. This exhibit will also include the Doppler findings of priapism. The findings in other imaging modalities such as penile arteriography and corpus cavernosography will be compared.

Penile anatomy

The penis is made up of three corporal bodies: Two corpora cavernosa and a single corpus spongiosum. Corpora cavernosa are main erectile bodies and corpus spongiosum contains the urethra. A septum divides two corpora cavernosa but contains fenestrations that provide communications between both corpora. The blood supply of the penis is primarily from the internal pudendal arteries that originate from the anterior division of the internal iliac arteries. Each internal pudendal artery gives off the penile artery proper which branches into a cavernosal artery and a dorsal artery at the base of the penis. The cavernosal arteries are the primary source of blood flow to the corpora cavernosa while dorsal arteries supply blood to the skin and glans of the penis. Venous drainage from the corpora cavernosa is through small emissary veins, which drain into the dorsal, crural, and cavernosal veins.

Penile Doppler: Technique

Illustration showing penile Doppler technique (reprinted from reference 5)

Doppler US is performed with the patient supine and the penis in the anatomic position, lying on the anterior abdominal wall. High-resolution US scanners with frequencies of 5-10MHz are used. The followings are our protocol of penile Doppler US. In the flaccid state, the inner diameter of the cavernosal artery is measured. Two or three minutes after an intracavernosal injection of 10-15 µg of prostaglandin-E1, the inner diameter of the cavernosal artery is measured again and Doppler spectra are obtained from the proximal cavernosal arteries at the base of the penis. The dorsal penile arteries and deep dorsal vein are also evaluated. Doppler angle is kept between 30-60 degrees. The sample volume and wall filter are fixed at minimum. Color or power Doppler US improves the localization of the penile vessels and thus permits more rapid acquisition of Doppler waveforms.

Normal Penile US & Doppler US

Normally the corpora cavernosa are symmetric and have homogeneous medium-level echoes. The tunica albuginea appears as a thin echogenic line surrounding the corpora. The cavernosal arteries (asterisk) are located slightly medially in the corpora.

The normal progression of cavernosal arterial flow during penile erection(A) is well known. In the flaccid state, monophasic flow is present with minimal diastolic flow. With the onset of erection, there is an increase in both systolic and diastolic flow(B). As intracavernosal pressure increases, a dicrotic notch appears and a decrease in diastolic flow occurs. With continuously increasing pressures, end-diastolic flow declines to zero and then undergoes diastolic flow reversal(C). Then the systolic envelop is narrowed and diastolic flow disappears completely with firm erection.

Erectile Dysfunction

Erectile dysfunction can result from psychogenic, neurogenic, arteriogenic, and venogenic causes. Often more than one causes are combined. Establishing a specific cause is important particularly in young men because of the frequency of correctable vascular abnormalities. Organic causes of erectile dysfunction are found in 50-90%, and organic impotence in the presence of normal endocrine balance and intact nervous system is vascular in origin in about 50-70%, either arterial insufficiency or venous incompetence. Pure arteriogenic impotence accounts for about 30% of cases and isolated venogenic impotence is found in about 15%.

Arteriogenic Impotence

A 32 year-old man with posttraumatic arteriogenic impotence

A. Iliac angiogram shows near total occlusion of left internal iliac artery.
B. On selective internal pudendal angiogram (right), left cavernosal artery is also seen (arrow).
C. Transverse color Doppler flow image shows collateral supply (arrow) from right cavernosal artery.
D. On spectral waveform obtained after prostaglandin-E1 injection, the peak systolic velocity is less than 25 Cm/sec, indicating arterial insufficiency.
The parameters that indicate the presence of arterial disease are a subnormal clinical response to vasoactive agents, a less than 60% increase in the diameter of the cavernosal artery, and a peak systolic velocity of the cavernosal arteries less than 30 cm/sec.

### Venogenic Impotence

A 47 year-old man with venogenic impotence. Spectral waveform (A) obtained after PG-E1 injection shows persistent diastolic flow of cavernosal artery. Cavernosogram (B) confirms veno-occlusive failure.

In the presence of normal arterial function, Doppler findings suggestive of an abnormal venous leak are persistent end-diastolic velocity of the cavernosal artery greater than 5 cm/sec and demonstration of flow in the deep dorsal vein. The development of diastolic flow reversal after an injection has been found to be a reliable indicator of venous competence.

### Diabetic Arteriopathy

A 52 year-old man with diabetes mellitus. Color Doppler image (A) shows calcification of cavernosal arterial wall. On spectral waveform (B), obtained from cavernosal artery after PG-E1 injection, the peak systolic velocity is less than 30 cm/sec.

Diabetes mellitus in particular is thought to be responsible for a significant number of cases of erectile failure. The detrimental effects of diabetes on male sexual function appear to be manifestations of generalized damage to both blood vessels and peripheral nerves. Peripheral sensory and autonomic neuropathy has been well documented in the diabetic patient population. Evidence also suggests that this disease leads to development of profound arterial small vessel disease involving penile arteries and their tributaries.

### Priapism

A 27 year-old man with drug induced priapism. Color Doppler image shows no demonstrable blood flow within cavernosal artery (A). After needle aspiration, blood flow through cavernosal artery is restored (B).

A 34 year-old man with penile trauma. Transverse sonogram (A) shows fluid collection (arrows) on the ventral aspect of the penile shaft. This fluid collection has posterior shadowing (asterisk), regarded as calcified plaque.

### Peyronie’s Disease

A 34 year-old man with Peyronie’s disease. Plain radiograph (A) demonstrates linear radiopacity (arrow). Transverse sonogram (B) & longitudinal sonogram (C) shows echogenic line with posterior shadowing (asterisks), regarded as calcified plaque. Peyronie’s disease is fibrosis of the tunica albuginea covering the corpora cavernosa. The cause is unknown, but it is thought to represent an inflammatory response or a vasculitis. The disease usually involves the dorsum of the penis, but it can involve any portion of the tunica albuginea including intercavernosal septum. During erection the penis bends toward the side of the fibrosis, since the involved portion of the corpora can not lengthen normally. The condition can be painful, and it can be a cause of impotence. The sonographic findings include a thick echogenic plaque with echogeneity similar to or higher than the tunica albuginea; a calcified plaque in thickened tunica albuginea; and are occasionally associated with calcification in the corpora cavernosa.

### Penile Fracture

A 34 year-old man with penile trauma. Transverse sonogram (A) shows fluid collection (arrows) on the ventral aspect of the penile shaft. This fluid collection has partial septation (arrow in B). In this patient, interruption of the tunica albuginea is not demonstrated.

A penile fracture is a tear in the tunica albuginea. Penile fractures results from acute bending of the erect penis. Fractures can be diagnosed sonographically by visualizing interruption of the thin echogenic line of the tunica albuginea. Heterogeneous echoes caused by blood and disrupted corporeal tissue usually are seen in the lesion of tear.

### Reference