Invited update

Doppler US evaluation of erectile dysfunction

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Penile erection is a complex phenomenon comprising coordinated interaction between the nervous, arterial, venous, and sinusoidal systems. A defect in any of these systems can result in erectile dysfunction. Erectile dysfunction is defined as the consistent inability to generate or maintain an erection of sufficient rigidity for sexual intercourse. Although the introduction of sildenafil citrate made the information from imaging studies less critical in the management of patients with erectile dysfunction, the imaging studies such as Doppler sonography (US), penile arteriography, and cavernosometry or cavernosography remain the major modalities in the evaluation of erectile dysfunction.

Physiology of erection

The normal chain of events leading to penile erection begins with psychological factors that cause transmission of parasympathetic impulses to the penis. The walls of the arterioles and sinusoids of the corpora cavernosa relax, leading to increased inflow of blood through the cavernosal artery. The corporal veno-occlusive mechanism begins with filling of the sinusoidal spaces. The emissary veins leaving the corpora are compressed passively against the fibrous tunica albuginea, and rigid penile erection is achieved and maintained (Fig. 2). Detumescence occurs after neurologically stimulated contraction of trabecular smooth muscle in the corpora cavernosa [1, 2].

Erectile dysfunction is caused by an interruption of that sequence from psychogenic, neurogenic, arteriogenic, and venogenic causes. Often there is more than one cause. 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% of cases, and organic impotence in the presence of normal endocrine balance and an intact nervous system is vascular in origin in about 50–70% of cases from arterial insufficiency or venous incompetence. Pure arteriogenic impotence accounts for about 30% of cases and isolated venogenic impotence is found in about 15%. Erectile dysfunction often is caused by combined arteriogenic and venogenic causes. Occasionally, organic impotence is caused by morphologic abnormalities of the penis such as Peyronie’s disease [2].

Penile Doppler US

During the past several years, important changes have occurred in the understanding, diagnosis, and treatment of erectile dysfunction. Although there is controversy concerning the value of imaging studies in the evaluation of erectile dysfunction, Doppler US of penile vessels remains a first-line test to discriminate between hemodynamic abnormalities in the penile inflow and outflow.
tracts. The diagnosis of an arteriogenic or venogenic impotence, however, should be confirmed by penile arteriography and cavernosometry with cavernosography, respectively [1–13].

The hemodynamic function of the penis can be evaluated noninvasively by performing color or power Doppler US with spectral analysis after injection of a vasoactive pharmacologic agent such as papaverine, phentolamine, or prostaglandin E1 as a single agent or in combination to induce an erection. Compared with papaverine, prostaglandin E1 has the advantage of slower onset, longer maintenance, less chance of priapism, and is at least as effective as papaverine in increasing penile blood flow. Doppler US is performed in a longitudinal, parasagittal plane from a ventral approach, with the patient supine and the penis in an anatomic position on the anterior abdominal wall (Fig. 3). High-resolution US scanners with frequencies of 5–10 MHz are used. Color or power Doppler US improves the localization of the penile vessels and thus permits more rapid acquisition of Doppler waveforms. Power Doppler US is superior to conventional color Doppler US in visualizing cavernosal microcirculation. The value of spectral Doppler in the flaccid penis is questionable. Audiovisual stimulation can be used to accelerate the erectile response. There are controversies with regard to the value of a second injection of vasoactive agents when the results are not conclusive [14].

The following is the protocol for using penile Doppler US at Seoul National University Hospital. In the flaccid state, the inner diameter of the cavernosal artery is measured. Three to five 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. Some recommend using a tourniquet after an injection, but we do not. Because the time after intracavernosal injection at which the highest peak systolic velocity is achieved varies among individuals, it is important to obtain multiple measurements, especially when the velocity is subnormal. Proximal corporal spaces are drained by the cavernosal (crural) veins directly into the periprostatic venous plexus. Venous flow in the cavernosal veins usually is not visualized on Doppler US.