

# The use of penile Doppler ultrasonography in the detection of vascular erectile dysfunction

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Manuscript received August 10, 2020; revised manuscript September 25, 2020; published online October 05, 2020

## Abstract

**Background:** Erectile dysfunction is defined as the inability to get sufficient erection for a satisfactory sexual intercourse. Penile erection is a complex phenomenon that involves a coordinated interaction of psychological, hormonal, nervous, arterial, venous and sinusoidal systems. According to recent studies, on average about 10% of men aged 40–70 years have severe or complete erectile dysfunction, and about 20–40% – partial erectile dysfunction. According to the 2018 European Association of Urologists (EAU) Guide, up to 12% of the European male population up to the age of 40 has a certain degree of erectile dysfunction (from minor to severe), after 40 years, this figure exceeds 50%. The prevalence of erectile dysfunction (ED) in the Republic of Moldova is significantly higher in men over the age of 40–67.4%, compared to men up to the age of 40–21.1%. Imaging-directed Doppler ultrasound of the cavernous arteries provides a functional and quantifiable assessment of the arterial flow of the penis during a pharmacological erection. Subjects without vascular disease show arterial dilation after intracavitary injection, the vessels appearing with thin and parallel walls, homogeneous lumen and following a straight course, subjects with arteriogenic problems had thickened walls and an inhomogeneous lumen. It is also mentioned that no differences were observed between the two drugs. At the same time, to achieve maximum erection using intravenous injections with a vasodilator is a sign of the veno-occlusive cause, which is independent of both penile stiffness and tumescence. Patients with arterial insufficiency were relatively older than other patients. They also had complicated medical conditions for diabetes and hypertension.

**Conclusions:** Vascular etiologies are important contributors to erectile dysfunction. Arterial insufficiency is suspected with poor blood flow, while veno-occlusive dysfunction is lower in the face of adequate blood flow and poor erectile response.

**Key words:** penile vascularization, Doppler ultrasonography, erectile dysfunction.

## Cite this article

Toncoglaz S. The use of penile Doppler ultrasonography in the detection of vascular erectile dysfunction. *Mold Med J.* 2020;63(6):49-51. doi: 10.5281/zenodo.4028387.

## Introduction

Erectile dysfunction is defined as the inability to get a sufficient erection for a satisfactory sexual intercourse. Penile erection is a complex phenomenon that involves a coordinated interaction of psychological, hormonal, nervous, arterial, venous and sinusoidal systems. The etiological diagnosis of erectile dysfunction usually requires a study of penile vasculature. Arterial origin involves a high percentage of erectile dysfunction. Eco-Doppler allows the study to be performed in a fast, non-invasive and efficient way, providing information about the morphological aspects of the arteries and flow parameters. The study was aimed to assess the importance of using Doppler ultrasonography in detecting vascular problems that lead to erectile dysfunction and its use in differential diagnosis with other causes of erectile dysfunction.

The literature review was performed by analyzing articles from the databases MEDLINE, Hinari. The words used as a search engine were the following: penile vascularization, doppler ultrasonography, erectile dysfunction. Only full-text articles were analyzed.

## Results

The corpora cavernosa are homogeneous and relatively hypoechoic cylindrical structures [1] lined with tunica albuginea, a thin membrane that has a thickness of approximately 2 mm when the penis is flaccid and 0.25 mm when it is erect [2]. The corpus spongiosum, a ventral, medial body that is more echoic than the corpora cavernosa, is also covered by the tunica albuginea and contains the urethra, it is more dilated and prominent in its proximal segment, known as the bulb, and in its distal segment, constituting the glans [1]. Buck's fascia is superficial to the tunica albuginea and covers all of the structures described. Venous drainage is performed by the deep and superficial dorsal veins of the penis. The dorsal arteries of the penis are located adjacent to the deep dorsal vein and a cavernous artery is located in the center of each corpus cavernosum. On color Doppler, the cavernous arteries present single-phase flow. In the flaccid penis the normal cavernous arteries show a systolic peak between 11 and 20 cm/s [3]. At the beginning of erection, the systolic and diastolic flows undergo progressive increases. When vein occlusion begins, the diastolic flow decreases

progressively, and once stiffness is established, it becomes negative [3].

Psychological factors (mental impulse) cause transmission of parasympathetic impulses to the penis. This causes relaxation of arterioles and corpora cavernosa sinusoids. As the sinusoidal spaces start filling, the corporal veno-occlusive mechanism activates, and the fibrous tunica albuginea compresses the emissary veins of the corpora, and rigid erection is achieved [3, 4].

According to recent studies, on average about 10% of men aged 40-70 years have severe or complete erectile dysfunction, and about 20-40% – partial erectile dysfunction [5, 6]. According to the 2018 European Association of Urologists (EAU) Guide, up to 12% of the European male population up to the age of 40 has a certain degree of erectile dysfunction (from minor to severe), after 40 years this figure exceeds 50%. [7]. The prevalence of erectile dysfunction (ED) in the Republic of Moldova is significantly higher in men over the age of 40-67.4%, compared to men up to the age of 40-21.1% [8].

The underlying processes of vascular erectile dysfunction are arterial insufficiency, venoocclusive disease or a combination of both, as well as the Peyronie's disease and priapism [9]. Imaging-directed Doppler ultrasound of the cavernous arteries provides a functional and quantifiable assessment of the arterial flow of the penis during a pharmacological erection. A high-frequency transducer (7.5-9.0 MHz) is used for penile Doppler examination. The patient is placed in a supine position and the penis is positioned in its anatomical position along the anterior abdominal wall. Doppler angle is set at 30-60 degrees. In case of using drugs for pharmacological erection, pre-injection and post-injection measurements are required. Pre-injection measurements: inner diameter of the cavernosal artery (normal value is 0.3-0.5 mm), baseline peak systolic velocity and end diastolic velocity. Corpora cavernosa are localized as two well-defined oval compartments with central cavernosal artery on both sides of the corpus spongiosum (urethra is in center of corpus spongiosum). Insulin syringe is used for injection under sonographic guidance. Post-injection measurements (at 5, 10, 15, 20 minutes): inner diameter of cavernosal artery (normal value is 0.6-1.0 mm), peak systolic velocity, end-diastolic velocity, visual tumescence and erection. In this sense, this method is superior to arteriography as a means of assessing arteriogenic impotence. Maximum flow rate, arterial dilation and pulsation of vessels are the most reliable ultrasonic indicators of arterial health. It is advisable to cease smoking three days prior to the examination. Medication history and cardiac status should be enquired. Aberrant arterial anatomy should be noted, as it can significantly contribute to the total blood flow to the penis. Recognition of the pathological pattern helps to choose the best treatment method [10].

Vidal Moreno in a study of 93 subjects, aged 20 to 66 years, without vascular disease: 20 healthy volunteers and 73 with psychogenic dysfunctions, who underwent a reference study and 89 – a second study after intracavitary injection

(ICI) (10 papaverine and 79 PgE1) showed that subjects without vascular disease showed arterial dilation after ICI, the vessels appearing with thin and parallel walls, homogeneous lumen and following a straight course; subjects with arteriogenic problems had thickened walls and an inhomogeneous lumen. It is also mentioned that no differences were observed between the two drugs [11, 12]. At the same time, Yafi FA states that failure to achieve maximum erection using intravenous injections with a vasodilator is a sign of the veno-occlusive cause, which is independent of both penile stiffness and tumescence [13].

He ZJ, Cheng M. in a 2006 study of 527 patients who were evaluated using color Doppler ultrasonography after intracavernous injection of 20 micrograms prostaglandin E1 revealed 112 patients (26.99%) with nonvasculogenic ED, 207 patients (49.88%) with arteriogenic ED, 144 patients (34.70%) with venogenic ED, and 64 patients (15.42%) with mixed ED [13]. He also mentions that patients with arterial insufficiency were relatively older than other patients. They also had complicated medical conditions for diabetes and hypertension [14]. Golubinski and Sikorski in a similar study, using an intracavernous injection of papaverine of 40 mg analyzed the maximum systolic velocity (MSV), end diastolic velocity (EDV) and resistive index (RI). After papaverine injection, 7 patients had a normal erection and adequate waveform patterns; their mean MSV was 30.7 cm/s, EDV 4.42 cm / s and RI 0.85; five patients had no erection. Abnormal flow values showed insufficient arterial vessels in a quarter of men, venous discharge in 15% and mixed ED in 20% [15].

Ismail in a study of 21 patients up to the age of 40 described that 5 patients had normal findings, while 10 had evidence of venous discharge. Five patients had arterial insufficiency; of which 3 patients showed calcifications of the albuginea tunic, suggesting the Peyronie's disease. Interestingly, one patient showed the characteristics of a combined arterial insufficiency and venous discharge. Those with arterial insufficiency were relatively older than other patients [16].

Two important parameters must be considered for assessing the cause of erectile dysfunction. Peak systolic velocity is the best Doppler indicator of arteriogenic impotence. Its value <30 cm/sec during the examination indicates arterial dysfunction. Some people consider <25 cm/sec as definite arterial dysfunction and 25-30 cm/sec as borderline case. Less than 60% increase in cavernosal diameter after papaverine injection is also an indicator of arterial impotence. End-diastolic velocity is the best Doppler indicator of venogenic impotence. Its value >5 cm/sec indicates venous dysfunction. A good diastolic reversal virtually rules out venous insufficiency.

## Conclusions

Doppler ultrasonography with intracavernous injection of papavarin and prostoglandin E1 shows promises for the accurate evaluation of patients with erectile dysfunction.

Vascular etiologies are important contributors to erectile dysfunction. Arterial insufficiency is suspected with poor blood flow and is more common for older male, while veno-occlusive dysfunction is lower in the face of adequate blood flow and poor erectile response and is more common in younger men.

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### Author's contribution

ST designed the study, drafted the first manuscript and completed the final design.

### Funding

This study was supported by *Nicolae Testemitanu State University of Medicine and Pharmacy*. The review study was the author's initiative.

### Ethics approval and consent to participate

No approval was required for this review study.

### Conflict of Interests

Author declares no competing interests and no funding support.