

## ORIGINAL RESEARCH

# The efficacy of penile duplex ultrasound in erectile dysfunction management decision-making: facing the opinion leader

Andrea Cocci<sup>1,\*</sup>, Marta Pezzoli<sup>1</sup>, Mattia Lo Re<sup>1</sup>, David Ralph<sup>2,3</sup>, Nim Christopher<sup>2,3</sup>, Daniar Osmonov<sup>4</sup>, Carlo Bettocchi<sup>5</sup>, Rados Djinovic<sup>6</sup>, Gabriele Antonini<sup>7</sup>, Laurence Levine<sup>8</sup>, Juan Ignacio Martínez Salamanca<sup>9</sup>, Javier Romero Otero<sup>10</sup>, Paulo Egydio<sup>11</sup>, Ignacio Moncada Iribarren<sup>12</sup>, Georgios Hatzichristodoulou<sup>13</sup>, Paul Perito<sup>14</sup>, Faix Antoine<sup>15</sup>, Hyun Jun Park<sup>16,17</sup>, Luigi Rolle<sup>18</sup>, Ateş Kadioğlu<sup>19</sup>, Eduard Ruíz-Castañe<sup>20</sup>, Koenraad Van Renterghem<sup>21</sup>, Robert J Valenzuela<sup>22</sup>, Steven K Wilson<sup>23</sup>, Nuno Tomada<sup>24</sup>, Marco Capece<sup>25</sup>, Marco Falcone<sup>18</sup>

<sup>1</sup>University of human health sciences of Florence, 50134 Florence, Italy

<sup>2</sup>University College London Hospitals NHS Foundation Trust, NW1 2PG London, UK

<sup>3</sup>St. Peter's Andrology Centre, W1G 6AA London, UK

<sup>4</sup>University Medical Center Schleswig-Holstein, 24105 Kiel, Germany

<sup>5</sup>University of Foggia, 71122 Foggia, Italy

<sup>6</sup>Center for Genito-Urinary Reconstructive Surgery, RF25+4V Belgrade, Serbia

<sup>7</sup>Antonini Urology, 00185 Rome, Italy

<sup>8</sup>Rush University Medical Center, Chicago, IL 60612, USA

<sup>9</sup>Puerta de Hierro-Majadahonda University Hospital, 28222 Madrid, Spain

<sup>10</sup>12 de Octubre University Hospital, 28041 Madrid, Spain

<sup>11</sup>Egydio Medical Center, 04552-040 São Paulo, SP, Brazil

<sup>12</sup>Hospital Sanitas La Zarzuela, 28023 Madrid, Spain

<sup>13</sup>'Martha-Maria' Hospital Nuremberg, 90491 Nuremberg, Germany

<sup>14</sup>Perito Urology, Coral Gables, FL 33146, USA

<sup>15</sup>Clinique Saint-Roch, 34000 Montpellier, France

<sup>16</sup>Pusan National University School of Medicine, 49241 Busan, Republic of Korea

<sup>17</sup>Medical Research Institute of Pusan National University Hospital, 49241 Busan, Republic of Korea

<sup>18</sup>Molinette University Hospital, 10126 Turin, Italy

<sup>19</sup>Istanbul University İstanbul School of Medicine, 34093 İstanbul, Turkey

<sup>20</sup>Fundació Puigvert, 08025 Barcelona, Spain

<sup>21</sup>Jessa Ziekenhuis, 3500 Hasselt, Belgium

<sup>22</sup>The Icahn School of Medicine at Mount Sinai, New York, NY 10029, USA

<sup>23</sup>Institute for Urologic Excellence, La Quinta, CA 92253, USA

<sup>24</sup>Hospital da Luz Arrábida, 4400-346 Porto, Portugal

<sup>25</sup>University of Naples Federico II, 80138 Naples, Italy

\*Correspondence: [andrea.cocci@unifi.it](mailto:andrea.cocci@unifi.it) (Andrea Cocci)

## Abstract

Erectile dysfunction (ED) poses a significant challenge in clinical practice, necessitating accurate diagnostic strategies to distinguish between organic and psychogenic causes. Current guidelines advocate a comprehensive approach involving medical history, physical examination and blood tests, with second-level analyses like the intracavernous injection of vasoactive drugs (ICI test) and penile duplex ultrasound (PDU) reserved for specific cases. A survey involving 24 urologists experienced in ED was conducted to assess their opinions on the appropriateness of the ICI test and PDU in six clinical scenarios. Results were analyzed using pie charts, revealing varied preferences among experts. The responses indicated diverse viewpoints, with preferences for the ICI test or PDU depending on the patient's age, comorbidities, response to phosphodiesterase type 5 inhibitors (PDE5i) and concomitant Peyronie's disease. In some cases, a significant proportion of experts opted for neither test. The study highlights the lack of consensus among experts regarding the routine use of PDU in ED management. Despite its diagnostic capabilities, the clinical utility of PDU remains unclear, and its role may be more justified in certain populations with anatomical abnormalities or specific conditions. The need for rigorous research to determine the impact of PDU on ED management decision-making is emphasized.

## Keywords

Erectile dysfunction; Penile duplex ultrasound; Intracavernous injection

## 1. Introduction

The inability to get or keep an erection strong enough for satisfying sexual activity is known as erectile dysfunction (ED) [1]. The goal of the diagnostic procedure is to determine if

erectile dysfunction is primarily of an organic or psychogenic origin. Arterial or venous vascular changes play a predominant role in the first case [2].

The European Association of Urology's current guidelines

include blood tests, such as hormonal profile testing, for the aim of diagnosis, together with a focused physical examination and accurate medical history collection [3]. Second level analyses, such as dynamic penile duplex ultrasonography (PDU) and intracavernous injection of vasoactive substances (ICI test), are recommended exclusively in certain groups (*i.e.*, patients with previous pelvic or perineal trauma, penile deformities of primary ED) or for medico-legal purposes [3].

In clinical practice, these tests are frequently requested in the diagnostic evaluation of ED. In particular, PDU is typically used in cases where a possible vasculogenic aetiology of ED is suspected, in consideration of the patient's comorbidities or poor response to PDE5-inhibitors (PDE5i).

This is the reason why it would be useful to comprehend whether these tests are helpful for making therapeutic decisions and whether their habitual use is suitable. Given the limited updated literature on the subject, we asked urologists and/or andrologists specialized in the field of ED to specify the situations in which they would need to do these tests; the responses they provided are included in this article.

## 2. Material and methods

Twenty-four urologists belonging to international associations on sexual health were asked to respond to an anonymous survey. Authors chose six clinical scenarios that could include different presentations of ED, in terms of patient age and comorbidities, severity of ED, response to PDE5i, presence or absence of associated penile curvature and intolerance and/or unwillingness to receive oral treatment. For each scenario, participants were asked whether it was appropriate to perform an ICI test, a PDU, or neither. The responses were collected and analyzed.

The six clinical scenarios are reported in Table 1.

## 3. Results

All experts answered the survey. Pie charts of results are shown in Fig. 1. In the case of a 60-year-old patient with ED, refractory to PDE5i, 10 (41.7%) participants would ask to perform an ICI test, 10 (41.7%) a PDU and 4 (16.7%) none of the above (Pie chart number 1). When approaching a 50-year-

old patient with moderate ED who has never tried PDE5i, 16 (66.7%) experts would not ask any of the mentioned diagnostic procedures, 6 (25%) would require a PDU and 2 (8.3%) an ICI test (Pie chart number 2). For a 40-year-old diabetic patient, with occasional ED and fluctuating response to PDE5i, 10 (41.7%) participants would ask for a PDU, 8 (33.3%) for an ICI test and 6 (25%) for none of them (Pie chart number 3). In the case of a 30-year-old patient, with mild-moderate ED and an excellent response to PDE5i, 4 (16.7%) experts would recommend a PDU; the rest of them (83.3%) do not consider an ICI test or doppler necessary (Pie chart number 4). To evaluate a 70-year-old patient with ED and an excellent response to PDE5i, who is unwilling to receive medical therapy and is evaluating the implantation of penile prosthesis, 4 (16.7%) participants would require an ICI test, 4 (16.7%) a PDU and 16 (66.7%) none of the above (Pie chart number 5). In the case of a 50-year-old patient with moderate ED and Peyronie's disease with a 70° dorsal curvature, 8 (33.3%) experts would ask for a PDU, 8 (33.3%) for an ICI test and 8 (33.3%) for none of them (Pie chart number 6).

## 4. Discussion

PDU, a second-level analysis in the diagnostic evaluation of ED according to current European guidelines, can assess its hemodynamic pathophysiology. Consequently, when a possible vasculogenic etiology of ED is suspected, it is typically employed in clinical practice [3]. PDU aids in identifying whether biological or psychogenic factors contribute to ED. It also defines elements like end-diastolic velocity (EDV) and peak systolic velocity (PSV), which can indicate if veno-occlusive dysfunction or arterial insufficiency are present [4, 5].

There are several known benefits and drawbacks, but there is still no clear guidance on when and in which patients its use is truly effective in determining which treatment to choose.

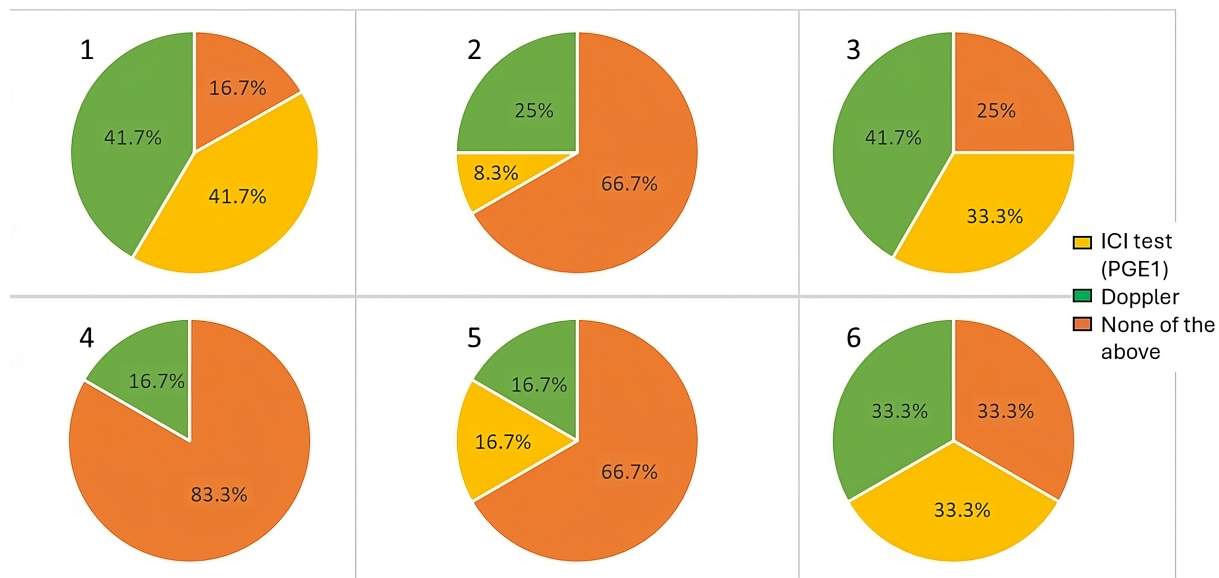
PDU's non-invasiveness and capacity to provide real-time penile vascular imaging are two of its benefits. For the safe evaluation of penile hemodynamics, PDU offers an alternative to invasive methods such as cavernosography [5].

The effectiveness of oral medications may be predicted by performing PDU. In fact, a relationship has been shown

**TABLE 1. Clinical cases.**

1. In the case of a 60-year-old patient with erectile dysfunction, refractory to PDE5i, what WOULD (not SHOULD) you ask for?
2. In the case of a 50-year-old patient with moderate erectile dysfunction who has never tried PDE5i, what WOULD (not SHOULD) you ask for?
3. In the case of a 40-year-old diabetic patient with occasional erectile dysfunction and fluctuating response to PDE5i, what WOULD (not SHOULD) you ask for?
4. In the case of a 30-year-old patient with mild-moderate erectile dysfunction and excellent responses to PDE5i, what WOULD (not SHOULD) you ask for?
5. In the case of a 70-year-old patient with erectile dysfunction and excellent response to PDE5i, who does not like medical therapy and is evaluating the implantation of a penile prosthesis, what WOULD (not SHOULD) you ask for?
6. In the case of a 50-year-old patient with moderate erectile dysfunction and Peyronie's disease with a 70° dorsal curvature, what WOULD (not SHOULD) you ask for?

*PDE5i: phosphodiesterase type 5 inhibitors.*



**FIGURE 1. Pie charts of results.** ICI: intracavernous injection; PGE1: prostaglandin E1.

between the kind and extent of penile vascular injury and the way the body reacts to PDE5i, with a reduced response in patients with mixed ED or severe venous occlusive dysfunction [6, 7]. Moreover, the use of PDU may be useful before addressing patients to therapies like low-intensity shock wave treatment (LI-SWT), according to Capogrosso *et al.* [8].

Studies suggest that ED can be the first sign of arterial damage in people at vascular risk. Identifying vascular penile alterations, PDU can be the starting point for a more comprehensive artery examination for the purpose of finding unidentified lesions, especially in the aorta and coronary arteries [9, 10].

When combined with color and pulsed-wave Doppler, high-resolution gray-scale imaging could be an effective modality for diagnosing penile abnormalities that may be associated with ED, such as Peyronie's disease, corpora cavernosa fractures and thickening of the septum and tunica albuginea [5]. Regarding this, Erdogru *et al.* [11] showed that performing PDU in patients with Peyronie's disease can guide appropriate therapy choices.

Most experts stated that they would have performed second-level analysis in the cases of ED and Peyronie's disease, but only one-third of them would have selected PDU. A possible problem with the ICI test and PDU in these patients is the fact that the use of Caverject® is currently contraindicated in the case of Peyronie's disease or fibrosis of the corpora cavernosa, as there are no studies confirming its safety in these conditions; its use, therefore, could lead to medico-legal problems. Furthermore, there is currently no standardization on the amount of drug to use or indications on the criteria to decide the right dose for the single patient. Finally, there may be doubts as to whether demonstrating an anatomical alteration *via* PDU can change the therapeutic decision in a patient in whom ED is confirmed by validated questionnaires and response to PDE5i and penile curvature is observable by self-photography of erection.

The reliance of PDU on operator knowledge and technical competence is one possible drawback. Specialized training is

necessary for the effective interpretation of ultrasonography results, as mistakes in image capture or analysis might result in incorrect diagnosis [12]. Moreover, there is a great deal of variety in the technique, as revealed in the responses to an online questionnaire addressed to members of the International Society for Sexual Medicine. For example, they described the use of more than ten distinct pharmaceutical mixes to achieve an erection. Divergences also existed in PDU diagnostic cut-off points [13].

Despite its non-invasive nature, PDU may not be universally well-tolerated by all patients. Factors such as discomfort, embarrassment and anxiety associated with the procedure may deter individuals from undergoing or completing the examination, thereby impeding the diagnostic process. Shamloul explained that younger men can have erroneously low PSV values on the PDU because of underlying psychological disturbances, anxiety related to penile injections and sympathetic overtone in medical offices [14].

Furthermore, healthcare economics regarding the cost-effectiveness of PDU should be discussed. A 1986 article demonstrated that an ED evaluation involving medical history, sexual function questionnaires, physical examination and blood tests typically cost between \$250 and \$450; the average cost of PDU alone was a further \$450 [15]. More research is needed to compare the current cost-benefit of routine PDU screening versus other diagnostic modalities or empirical treatment.

Jung *et al.* [10] pointed out that a positive response after PDE5i validates adequate venous occlusion and arterial input, hence lowering the need for PDU confirmation. This remark is supported by most professionals who were asked to complete the questionnaire. Regardless of the patients' age or comorbidities, there was a certain consensus among them not to perform any second-level study on PDE5i-responsive patients.

## 5. Conclusions

PDU is a diagnostic tool that can be used during the workup of ED. Although PDU may determine the etiology of ED, the efficacy of PDU in changing or determining management remains unclear. In recent literature, there is little clinical utility of using PDU; however, it may prove useful in special populations such as in younger patients or in patients with anatomical abnormalities. The opinion leader has shown not a real agreement in which patients it is useful or not to perform PDU instead of an ICI test or no second-level analysis at all. Therefore, there is a need for high-quality up-to-date studies investigating the use of PDU and its effect on ED management decision-making.

### AVAILABILITY OF DATA AND MATERIALS

The data are contained within this article.

### AUTHOR CONTRIBUTIONS

AC and MF—designed the research study. AC—performed the research. DR, NC, DO, CB, RD, GA and JRO—provided help and advice. LL, JIMS, JRO, PE, IMI, GH, PP and FA—analyzed the data. HJP, LR, AK, ERC, KVR, RJV, SKW, NT, MC, MP and MLR—wrote the manuscript. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript.

### ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

### ACKNOWLEDGMENT

Not applicable.

### FUNDING

This research received no external funding.

### CONFLICT OF INTEREST

The authors declare no conflict of interest.

## REFERENCES

- [1] Yafi FA, Jenkins L, Albersen M, Corona G, Isidori AM, Goldfarb S, *et al.* Erectile dysfunction. *Nature Reviews Disease Primers*. 2016; 2: 16003.
- [2] Gratzke C, Angulo J, Chitale K, Dai Y, Kim NN, Paick J, *et al.* Anatomy, physiology, and pathophysiology of erectile dysfunction. *The Journal of Sexual Medicine*. 2010; 7: 445–475.
- [3] EAU Guidelines Office. EAU guidelines on sexual and reproductive-health 2023. 2023. Available at: <https://uroweb.org/guidelines/sexual-and-reproductive-health/chapter/citation-information> (Accessed: 10 May 2024).
- [4] Hatzichristou DG, Hatzimouratidis K, Apostolidis A, Ioannidis E, Yannakoyorgos K, Kalinderis A. Hemodynamic characterization of a functional erection. Arterial and corporeal veno-occlusive function in patients with a positive intracavernosal injection test. *European Urology*. 1999; 36: 60.
- [5] Aversa A, Crafa A, Greco EA, Chiefari E, Brunetti A, La Vignera S. The penile duplex ultrasound: how and when to perform it? *Andrology*. 2021; 9: 1457–1466.
- [6] Aversa A, Bruzziches R, Pili M, Spera G. Phosphodiesterase type 5 inhibitor drugs in the treatment of erectile dysfunction. *Current Pharmaceutical Design*. 2006; 12: 3467–3484.
- [7] Mulhall J, Barnas J, Aviv N, Anderson M, Parker M. Sildenafil citrate response correlates with the nature and the severity of penile vascular insufficiency. *The Journal of Sexual Medicine*. 2005; 2: 104–108.
- [8] Capogrosso P, Frey A, Jensen CFS, Rastrelli G, Russo GI, Torremade J, *et al.* Low intensity shock wave therapy in sexual medicine—clinical recommendations from the European Society of Sexual Medicine (ESSM). *The Journal of Sexual Medicine*. 2019; 16: 1490–1505.
- [9] Kirby M, Jackson G, Betteridge J, Friedli K. Is erectile dysfunction a marker for cardiovascular disease? *International Journal of Clinical Practice*. 2001; 55: 614–618.
- [10] Jung DC, Park SY, Lee JY. Penile Doppler ultrasonography revisited. *Ultrasonography*. 2018; 37: 16–24.
- [11] Erdogru T, Savas M, Yilmaz N, Faruk Usta M, Koksali T, Ates M, *et al.* Evaluation of penile hemodynamic status and adjustment of treatment alternatives in Peyronie's disease. *Asian Journal of Andrology*. 2002; 4: 187–190.
- [12] Morgado A, Diniz P, Silva CM. Is there a point to performing a penile duplex ultrasound? *The Journal of Sexual Medicine*. 2019; 16: 1574–1580.
- [13] Butaney M, Thirumavalavan N, Hockenberry MS, Kirby EW, Pastuszak AW, Lipshultz LI. Variability in penile duplex ultrasound international practice patterns, technique, and interpretation: an anonymous survey of ISSM members. *International Journal of Impotence Research*. 2018; 30: 237–242.
- [14] Shamloul R. Original research—erectile dysfunction: peak systolic velocities may be falsely low in young patients with erectile dysfunction. *The Journal of Sexual Medicine*. 2006; 3: 138–143.
- [15] Maatman TJ, Montague DK, Martin LM. Cost-effective evaluation of impotence. *Urology*. 1986; 27: 132–135.

**How to cite this article:** Andrea Cocci, Marta Pezzoli, Mattia Lo Re, David Ralph, Nim Christopher, Daniar Osmonov, *et al.* The efficacy of penile duplex ultrasound in erectile dysfunction management decision-making: facing the opinion leader. *Journal of Men's Health*. 2024; 20(6): 8-11. doi: 10.22514/jomh.2024.084.