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Research article

Results of ultrasound dopplerography of the penis in patients before and after transurethral enucleation of benign prostatic hyperplasia

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BACKGROUND: The development of modern technologies for the surgical treatment of urological diseases poses new questions for urologists. One of them is to evaluate the effect of transurethral enucleation of benign prostatic hyperplasia on the erectile function of patients.

AIM: The aim of the study was to assess the state of erectile function in patients before and after transurethral enucleation of benign prostatic hyperplasia using Doppler ultrasound of the vessels of the penis.

MATERIALS AND METHODS: The study included 102 patients with benign prostatic hyperplasia aged 50 to 80 years (average 65 years) with complaints of erectile dysfunction and urinary disorders. All patients underwent transurethral enucleation of benign prostatic hyperplasia: 55 patients with the laser method (HoLEP, group 1) and 47 patients – with the bipolar method (TUEB, group 2). The severity of ED was assessed using the IIEF-5 questionnaire (International Index of Erectile Function). To assess the state of blood flow in the penis, ultrasound dopplerography of the vessels of the penis was performed using a vasoactive erection stimulator. The studies were carried out before surgery and 24 weeks after it.

RESULTS: The results of ultrasound dopplerography of the vessels of the penis before surgery revealed the arteriogenic type of ED in 18 (17.6%) patients, the venous type – in 45 (44.2%) patients, the mixed arteriovenogenic type – in 22 (21.6%) patients. In 17 (16.7%) patients ED was regarded as psychogenic. 24 weeks after the operation in patients of both the 1st and 2nd groups, according to the data of the IIEF-5 questionnaire, positive dynamics of the severity of erectile function was noted, regardless of the type of ED. For patients with vasculogenic types of ED, similar trends were noted regardless of the type of surgery. Thus, in patients with arteriogenic and arteriovenogenic ED a significant increase in the maximum systolic blood flow velocity (V_{max}) in the cavernous arteries was recorded, while the values of the resistance index (*RI*) did not change significantly. At the same time, the V_{max} values in these patients were initially low before the operation, and after the operation did not reach the reference values. In patients with venogenic ED, there was no significant improvement in penile blood flow, as evidenced by the absence of significant differences in V_{max} and *RI* values. At the same time, the *RI* in these patients before the operation was reduced, and the V_{max} values were in the range of normal values.

CONCLUSIONS: The erectile function of patients after transurethral enucleation of benign prostatic hyperplasia improves regardless of the type of operation and the type of erectile dysfunction. Ultrasound dopplerography of the vessels of the penis is a minimally invasive and highly informative diagnostic method that makes it possible to detect circulatory disorders in the penis and assess its state in dynamics during treatment.

Keywords: Doppler ultrasound of the penis; erectile dysfunction; benign prostatic hyperplasia; transurethral laser enucleation of the prostate; transurethral bipolar enucleation of the prostate.

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Научная статья

Результаты ультразвуковой доплерографии полового члена пациентов до и после трансуретральной энуклеации доброкачественной гиперплазии предстательной железы

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Актуальность. Развитие современных технологий оперативного лечения урологических заболеваний ставит перед урологами новые вопросы. Один из них — оценка влияния трансуретральной энуклеации доброкачественной гиперплазии предстательной железы на эректильную функцию больных.

Цель. Оценить состояние эректильной функции и кровотока в половом члене у пациентов до и после трансуретральной энуклеации доброкачественной гиперплазии предстательной железы.

Материалы и методы. В исследование включены 102 пациента с доброкачественной гиперплазией предстательной железы в возрасте от 50 до 80 лет (в среднем 65 лет) с жалобами на нарушение эрекции и расстройство мочеиспускания. Всем больным выполняли трансуретральную энуклеацию: 55 пациентам лазерным методом (HoLEP, 1-я группа) и 47 — биполярным методом (TUEB, 2-я группа). Степень тяжести эректильной дисфункции оценивали с помощью опросника МИЭФ-5 (Международный индекс эректильной функции). Для оценки состояния кровотока в половом члене выполняли ультразвуковую доплерографию сосудов полового члена с использованием вазоактивного стимулятора эрекции. Исследования проводили до операции и через 24 нед. после нее.

Результаты. Результаты ультразвуковой доплерографии сосудов полового члена до оперативного вмешательства позволили выявить артериогенный тип эректильной дисфункции у 18 (17,6 %) пациентов, веногенный тип — у 45 (44,2 %), смешанный артерио-веногенный тип — у 22 (21,6 %). У 17 (16,7 %) пациентов эректильная дисфункция была расценена как психогенная. Через 24 нед. после операции у больных обеих групп по данным опросника МИЭФ-5 отмечена положительная динамика выраженности эректильной функции независимо от типа эректильной дисфункции. Для больных васкулогенными типами эректильной дисфункции отмечены сходные тенденции независимо от вида операции. Так, у пациентов с артериогенным и артерио-веногенным типом зарегистрировано достоверное увеличение максимальной систолической скорости кровотока (V_{max}) в кавернозных артериях, в то время как значения индекса резистентности (*RI*) достоверно не изменились. При этом значения V_{max} у этих больных были исходно низкими до операции, а после операции не достигли референсных значений. У пациентов с веногенным типом не отмечено значимого улучшения кровотока в половом члене, о чем свидетельствовало отсутствие достоверных различий в значениях V_{max} и *RI*, при этом *RI* до операции был снижен, а значения V_{max} находились в диапазоне нормальных значений.

Заключение. Эректильная функция пациентов после трансуретральной энуклеации доброкачественной гиперплазии предстательной железы улучшается независимо от вида операции и типа эректильной дисфункции. Ультразвуковая доплерография сосудов полового члена — малоинвазивный и высокоинформативный диагностический метод, позволяющий выявить нарушение кровообращения в половом члене и оценить его состояние в динамике в процессе лечения.

Ключевые слова: ультразвуковая доплерография полового члена; эректильная дисфункция; доброкачественная гиперплазия предстательной железы; трансуретральная лазерная энуклеация простаты; трансуретральная биполярная энуклеация простаты.

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BACKGROUND

Benign prostatic hyperplasia (BPH) is a common disease in middle-aged, elderly, and senile men, manifested by urination disorders and reduced quality of life, often leading to serious complications [1]. In a significant number of BPH patients, lower urinary tract symptoms (LUTS) are associated with erectile dysfunction (ED).

The term "ED" refers to the inability to achieve or maintain an erection sufficient for satisfactory sexual activity [2]. The results of an extensive epidemiological study have shown that the incidence of LUTS in men with ED is 72.2% and only 37.7% in men with normal erectile function [3]. A relationship has also been found between the severity of urination disorders and the severity of ED [4]. Given its high prevalence, ED is a significant medical and social problem [5]. Even in the past 20 years, psychogenic factors were considered the main cause of ED. However, at present, almost 80% of ED cases are due to natural causes. ED is considered as a polyetiological condition caused by various cardiovascular, endocrine, neurological, and penile diseases and a number of other factors. Erection is a neurovascular phenomenon under hormonal control, which includes arterial dilatation, relaxation of trabecular smooth muscles, and activation of the corporal veno-occlusive mechanism [6]. Endothelial dysfunction and a decrease in the production of nitric oxide (NO) play an important role in the ED mechanism, leading to impaired blood filling of the vessels of the penis [7]. In 70%–80% of patients, ED is associated with certain vascular (arteriogenic, venogenic, or arterio-venogenic) disorders [8]. The penile arteries are known to have a narrow lumen, and occlusion caused by atherosclerotic lesions occurs earlier in such arteries than in other larger arteries, such as coronary arteries, in which the lumen is wider. Therefore, in clinical practice, vasculogenic ED is considered as an early manifestation of a generalized lesion of the cardiovascular system [9]. At present, at least four common pathophysiological mechanisms for the development of ED and LUTS have been identified; in addition to a decrease in the synthesis of NO, they include hyperactivity of the sympathetic nervous system, an increase in the activity of the Rho-kinase enzyme, and widespread atherosclerosis [10]. The degree of blood flow deterioration in the bladder and penis correlates with the severity of urinary disorders and erectile function, respectively [10–12]. Therefore, phosphodiesterase type 5 inhibitors (PDE-5) will be effective in both cases [10, 13].

Given the association between the severity of clinical manifestations of BPH and ED, the effect of surgical treatment, particularly minimally invasive transurethral interventions on the prostate gland, on the sexual function of patients is worthy of study [14]. The incidence of ED after various transurethral methods in patients with BPH ranges from approximately 4% to 40% [15]. Factors leading to ED after prostate surgery include perforation of the prostate capsule with damage to the cavernous nerves, fibrosis and thrombosis of the cavernous arteries, thermal or electrical effects on the prostatic neurovascular bundles, and psychological causes associated with the planned surgery or the surgical history [16, 17]. Despite the large number of potential causes of ED, the mechanism of the development of ED after prostate surgery remains unclear. Most authors note that regardless of the method of transurethral intervention, including laser surgery, a significant number of patients in the postoperative period experience retrograde enucleation, the frequency of which varies from 30% to 97% [18, 19]. Damage to the muscle fibers of the bladder neck is considered as a possible cause of its occurrence [20, 21].

The common methods for diagnosing vasculogenic ED include computed tomography, magnetic resonance imaging-cavernosography with intracavernous contrast enhancement, and ultrasound using dopplerography of the penile vessels [22, 23]. When performing these studies, pharmacological erection stimulants, namely, PDE-5 inhibitors or prostaglandins, are used [24]. Dynamic cavernosography with the administration of a radiopaque medium is used to detect accelerated venous outflow from the vessels of the penis [23]. In addition, a number of experts recommend computed cavernosography to improve the efficiency of dynamic cavernosography in mixed ED [25]. Magnetic resonance imaging of the penis can identify the anatomical structures of the penis and detect veno-occlusive disorders, but it is rarely used because of its invasiveness and high cost [26]. Ultrasound examination with Doppler imaging (USDI) of the penile vessels has become widespread in clinical practice owing to its high sensitivity, specificity, availability, and non-invasiveness, which can assess the blood flow in the penis over time during treatment [8, 27–29].

Ultrasonic Doppler techniques can identify prognostic dopplerographic signs of impaired blood flow in the penile vessels in patients before surgery and are used to assess erectile function in the postoperative period. Despite the significant diagnostic potential of this research method in BPH patients, only few scientific publications on this issue are found.

Therefore, *this study aimed* to analyze the results of USDI of the penile vessels before and after transurethral enucleation of BPH and assess the state of erectile function and blood flow in the penis in patients before and after transurethral enucleation of BPH.

MATERIALS AND METHODS

A total of 102 BPH patients, aged 50 to 80 years (mean age 65 years), who complained of urination disorders and impaired erection, were examined and treated from March 2019 to May 2021 in the consultative and diagnostic center and urological clinic of the Mechnikov North Western State Medical University, at the Alexandrovsky Hospital. All patients signed informed consent to participate in the study. The inclusion criteria for the study were as follows: age ⩾50 years, severe urination disorders (total IPSS score >19), disease duration >1 year, prostate volume >40 cm^3, maximum urine flow rate <10 mL/s, residual volume urine >50 mL, blood serum level of prostate-specific antigen <4 ng/mL, and patient's desire to be sexually active. The exclusion criteria were as follows: acute and active phases of chronic inflammatory diseases of the genital organs and urinary tract, neurogenic disorders of urination, Peyronie's disease, history or presence of malignant tumors of the urinary and genital organs, stones of the bladder and ureter, urethral strictures, cardiovascular insufficiency in stages of decompensation, unstable angina pectoris, chronic alcoholism, chronic renal and hepatic insufficiency, decompensated diabetes mellitus, and mental illness.

Among comorbidities, 27 (26.5%) patients were diagnosed with hypertension, and 24 (23.5%) patients had coronary heart disease in the compensation stage.

All patients under monitoring underwent transurethral enucleation of BPH. For example, the laser method (HoLEP, group 1) was used for 55 patients, and the bipolar method (TUEB, group 2) was applied in 47 cases.

The severity of ED was assessed using the International Index of Erectile Function (IIEF-5) questionnaire. This questionnaire includes five questions, the answers to which are evaluated from 1 to 5 points. The sum of points 5–10 corresponds to severe ED, 11–15 indicates moderate dysfunction, 16–20 corresponds to mild dysfunction, and 21–25 indicates its absence. All patients underwent USDI of the penile vessels. The study was performed on a Mindray DC-7 ultrasound device (China) using a Mindray 3C5A convex probe, a V10-4 intracavitary probe, and a 7L4A linear probe. During the study, the state of the anatomical structures of the penis, its echostructure, cavernous (right and left) dorsal arteries, and deep dorsal vein were assessed. Studies were performed in the resting phase before intracavernous administration of the vasoactive substance alprostadil at a dose of 10 μg, and then the tumescence and erection phases were assessed using color Doppler mapping in a pulsed mode. Anomalies in the structure of blood vessels, including blood filling of the cavernous bodies, were assessed, and their lumen was examined for the presence of plaques. Moreover, the spectrum of blood flow in the arteries of the penis was analyzed. The sensor was placed at the base of the penis at 45°.

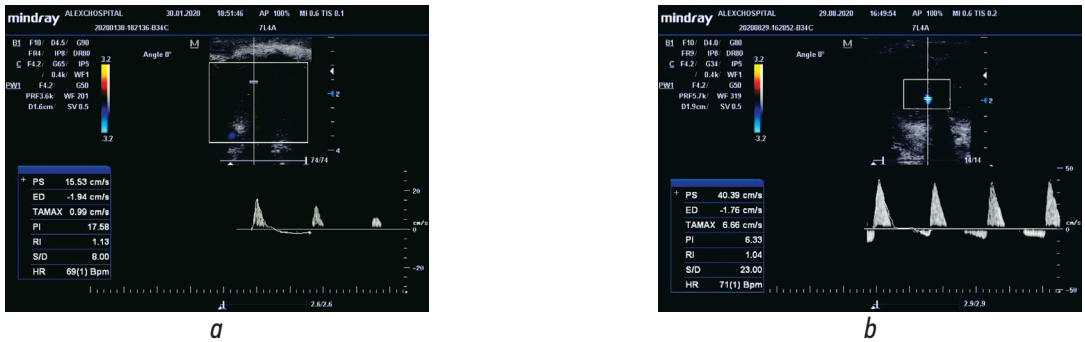
Questioning using the IIEF 5 questionnaire and USDI of the vessels of the penis were performed before surgery and 24 weeks after surgery.

The study results were processed using the SPSS 12.0 applied statistics software package, and statistical hypotheses were tested using Student's *t*-test and χ^2 test.

RESULTS

The results of USDI of the penile vessels before surgery revealed an arteriogenic type of ED in 18 (17.6%) patients, venogenic type in 45 (44.2%) patients, and mixed arterio-venogenic type in 22 (21.6%) patients. In 17 (16.7%) patients, ED was regarded as psychogenic. Based on the results of USDI of the cavernous and dorsal arteries of the penis using the "grayscale" mode and color Doppler mapping, no abnormalities in their structure, occlusions, or fibrous changes were detected in any of the patients.

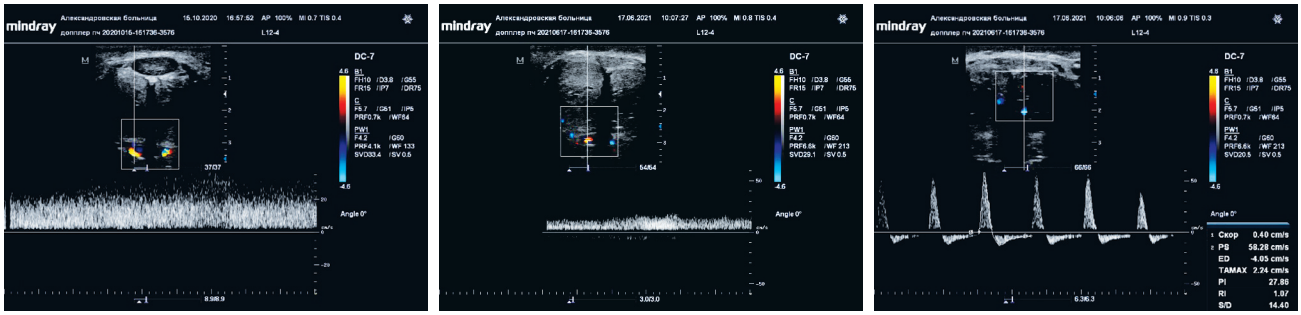
Table 1 shows that all 102 BPH patients of groups 1 and 2 before surgical treatment had a decrease in score of below 21 points based on the IIEF-5 questionnaire. The clinical features of psychogenic ED included the sudden onset of the disease with preservation of nocturnal erections, the presence of problems in relation to an intimate partner, and worsening of erection under certain life circumstances. Vasculogenic ED was characterized by a decrease in erection, libido, the absence of nocturnal erections under any circumstances, and gradual development of clinical manifestations. In patients with psychogenic ED, optimal peak linear velocities (V_{max}) and resistance indices (*RI*) were achieved in the cavernous arteries in the tumescence phase, that is, 10–15 min after the intracavernous test; these patients had a fast, long, and good-quality erection, with normal penile arteries and veins. Arteriogenic ED was diagnosed in 10 (18.2%) patients in group 1 and 8 (17%) patients in group 2. In these patients, V_{max} values were reduced, and the *RI* value was consistent with that shown in previous studies (Fig. 1). Venogenic ED was detected in 24 (44.3%) patients in group 1 and 21 (44.7%) patients in group 2. Based on the result of USDI, tumescence rapidly disappeared, whereas the dorsal vein did not collapse, and the caval blood flow (biphasic) was determined during the entire study. In addition, the Valsalva test remained positive with accelerated antegrade blood flow (Fig. 2). In these patients, the peak linear velocities (V_{max}) in the tumescence phase reached the reference values (38.9 ± 9.7 cm/s in group 1 and 37.7 ± 9.7 cm/s in group 2), and the *RI* values remained low (0.67 ± 0.13 in group 1 and 0.65 ± 0.11 in group 2), indicating insufficient venous occlusion. In arterio-venogenic ED, 10 (21.8%) patients in group 1 and 10 (21.3%) patients in group 2 had



a *b*

Fig. 1. Doppler ultrasound of the vessels of the penis of patient V., 62 years old, BPH and arteriogenic erectile dysfunction. *a* – Before surgery: in the tumescence phase V_{max} (maximum systolic blood flow velocity) 15.5 cm/s, *RI* (resistance index) 1.13; IIEF-5 13 points; *b* – 24 weeks after laser enucleation of the prostate (HoLEP), in the tumescence phase V_{max} 40,4 cm/s, *RI* 1.04; IIEF-5 20 points

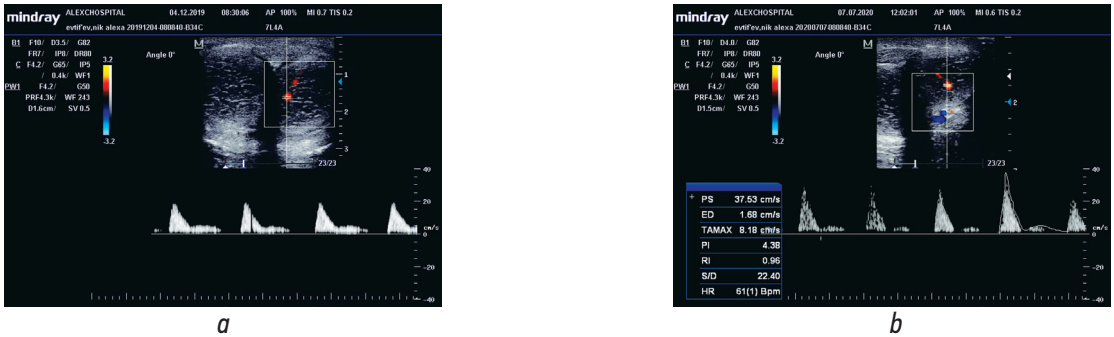
Рис. 1. Ультразвуковая доплерография сосудов полового члена пациента В., 62 года, доброкачественная гиперплазия предстательной железы и артериогенная эректильная дисфункция. *a* — До операции: в фазе тумесценции V_{max} (максимальная систолическая скорость кровотока) 15,5 см/с, *RI* (индекс резистентности) 1,13; МИЭФ-5 13 баллов; *b* — через 24 нед. после лазерной энуклеации предстательной железы (HoLEP), в фазе тумесценции V_{max} 40,4 см/с, *RI* 1,04; МИЭФ-5 20 баллов



a *b* *c*

Fig. 2. Doppler ultrasound of the vessels of the penis of patient E., 66 years old, BPH and venogenic erectile dysfunction. *a* – Before surgery: in the tumescence phase V_{max} 37.7 cm/s, *RI* 0.65; IIEF-5 before surgery 14 points, Valsalva's test is positive, the dorsal cavernous vein did not collapse and the blood flow through it was 20.5 ml/min; *b* – after bipolar enucleation of the prostate (TUEB): in the tumescence phase V_{max} 41.1 cm/s, the discharge of blood through the dorsal cavernous vein decreased to 11.4 ml/min; *c* – after bipolar enucleation of the prostate: in the erection phase V_{max} 58 cm/s, *RI* 1.07; IIEF-5 after surgery 20 points

Рис. 2. Ультразвуковая доплерография сосудов полового члена пациента Е., 66 лет, доброкачественная гиперплазия предстательной железы и веногенная эректильная дисфункция. *a* — До операции: в фазе тумесценции V_{max} 37,7 см/с, *RI* 0,65; МИЭФ-5 14 баллов, проба Вальсальвы положительная, дорзальная кавернозная вена не спалась и кровоток по ней 20,5 мл/мин; *b* — после биполярной энуклеации простаты (TUEB): в фазе тумесценции V_{max} 41,1 см/с, сброс крови по дорсальной кавернозной вене снизился до 11,4 мл/мин; *c* — после биполярной энуклеации простаты: в фазе эрекции V_{max} 58 см/с, *RI* 1,07; МИЭФ-5 20 баллов



a *b*

Fig. 3. Doppler ultrasound of the vessels of the penis of patient B., 59 years old, BPH and arteriovenogenic erectile dysfunction. *a* – Before the operation: in the tumescence phase V_{max} 21.3 cm/s, *RI* 0.79, Valsalva's test is positive, the dorsal cavernous vein did not collapse, the blood flow through it was 23 ml/min; IIEF-5 before surgery 13 points; *b* – after laser enucleation of the prostate (HoLEP): in the tumescence phase V_{max} 37.5 cm / s, *RI* 0.96; IIEF-5 after surgery 21 points

Рис. 3. Ультразвуковая доплерография сосудов полового члена пациента Б., 59 лет, доброкачественная гиперплазия предстательной железы и артерио-веногенная эректильная дисфункция. *a* — До операции: в фазе тумесценции V_{max} 21,3 см/с, *RI* 0,79, проба Вальсальвы положительная, дорсальная кавернозная вена не спалась, кровоток по ней 23 мл/мин; МИЭФ-5 до операции 13 баллов; *b* — после лазерной энуклеации простаты (HoLEP): в фазе тумесценции V_{max} 37,5 см/с, *RI* 0,96; МИЭФ-5 после операции 21 балл

Table. Clinical and Doppler indices of patients in groups 1 and 2 before and after surgical treatment, $M \pm m$ (n = 102)

Таблица. Клинические и доплерографические показатели пациентов 1-й и 2-й групп до и после хирургического лечения, $M \pm m$ (n = 102)

Group, *n*	Type of erectile dysfunction	Indicator	Before surgery	24 weeks after surgery	*p*
Group 1, *n* = 55	Psychogenic (*n* = 9, 16.4%)	IIEF-5, scores	14.8 ± 3.8	23.3 ± 2.5	<0.001
		V_{max}, cm/s	28.9 ± 4.8	38.1 ± 5.4	<0.001
		RI	0.99 ± 0.06	1.05 ± 0.08	0.009
	Arteriogenic (*n* = 10, 18.2%)	IIEF-5, scores	13.4 ± 3.7	20.6 ± 2.9	<0.001
		V_{max}, cm/s	18.9 ± 3.6	21.8 ± 5.0	0.048
		RI	0.9 ± 0.06	0.94 ± 0.08	0.074
	Venogenic (*n* = 24, 44.3%)	IIEF-5, scores	14.4 ± 4.2	20.7 ± 3.1	<0.001
		V_{max}, cm/s	38.2 ± 9.7	42.8 ± 9.2	0.134
		RI	0.67 ± 0.13	0.71 ± 0.15	0.437
	Arterio-venogenic (*n* = 12, 21.8%)	IIEF-5, scores	13.9 ± 3.7	21.6 ± 3.0	<0.001
		V_{max}, cm/s	20.6 ± 3.1	24.0 ± 3.5	0.0029
		RI	0.72 ± 0.12	0.76 ± 0.12	0.277
Group 2, *n* = 47	Psychogenic (*n* = 8, 17%)	IIEF-5, scores	14.2 ± 3.7	22.9 ± 1.7	<0.001
		V_{max}, cm/s	27.7 ± 4.8	36.6 ± 5.4	<0.001
		RI	0.97 ± 0.04	1.03 ± 0.06	0.002
	Arteriogenic (*n* = 8, 17%)	IIEF-5, scores	13.7 ± 4.1	19.8 ± 2.7	<0.001
		V_{max}, cm/s	17.8 ± 3.7	20.8 ± 5.1	0.038
		RI	0.91 ± 0.05	0.93 ± 0.06	0.4
	Venogenic (*n* = 21, 44.7%)	IIEF-5, scores	14.3 ± 4.4	20.1 ± 2.6	<0.001
		V_{max}, cm/s	37.7 ± 9.7	41 ± 8	0.251
		RI	0.65 ± 0.11	0.69 ± 0.15	0.426
	Arterio-venogenic (*n* = 10, 21.3%)	IIEF-5, scores	13.5 ± 3.7	20.3 ± 3.5	<0.001
		V_{max}, cm/s	20.6 ± 3.4	23.1 ± 2.8	0.015
		RI	0.73 ± 0.1	0.74 ± 0.12	0.657

Note. IIEF-5, International Index of Erectile Function; V_{max}, maximum systolic blood flow velocity in the cavernous arteries in the tumescence phase; *RI*, resistance index in cavernous arteries in the tumescence phase.

reduced mean values of V_{max} and *RI* in the tumescence phase (Fig. 3). The results of the examination of patients 24 weeks after surgical treatment of BPH are presented in Table 1; in groups 1 and 2, an impairment of erectile function, regardless of the type of ED, was found. For patients with vasculogenic types of ED, similar tendencies were noted regardless of the type of surgery. Thus, with arteriogenic and arterio-venogenic ED, a significant increase in V_{max} values in cavernous arteries was registered, whereas *RI* values did not change significantly. Moreover, the V_{max} values in these patients were initially low before the surgery, and after the intervention, they did not reach the reference values. In patients with venogenic ED, no significant improvement in blood flow in the penis was observed, as evidenced by the absence of significant differences in V_{max} and *RI* values. Notably, if *RI* in these patients was reduced before surgery, then the V_{max} values were within the normal range.

DISCUSSION

The present study included BPH patients who wanted to improve their erectile function; however, the only subject of conversation between the doctor and the patient before surgical treatment and in the postoperative period is LUTS, which can adversely affect sexual function in general. In our opinion, in addition to LUTS, sleep disturbance, social problems, and general dissatisfaction with their health play a significant role in the development and progression of ED, and most patients are not satisfied with the quality of life before surgical treatment and psychosocial recovery after surgery. Various methods of surgical treatment used in patients with BPH are not always justified, which reduces the efficiency of treatment and increases the number and severity of postoperative complications.

This work is characterized by the assessment of the value of USDI of the penile vessels before surgical treatment to identify the cause of ED. Despite the use of pharmacological erection stimulants, this diagnostic procedure was well tolerated by the patients, and priapism did not occur to any of the patients. In the postoperative period, regardless of the type of surgical intervention, we noted an improvement in the quality of erection, particularly in patients with psychogenic ED. Improved erection in patients under follow-up was accompanied by an improvement in blood flow in the penile vessels, which suggested a negative effect of prostatic hyperplasia on hemodynamics not only in the pelvic organs but also in the penis. USDI of the penile vessels before prostate surgery can predict the quality of the erectile function of patients in the postoperative period and, if necessary, prescribe treatment in a timely manner. The least pronounced vascular disorders were noted in the group of patients with venogenic ED. When comparing erectile function after different methods of transurethral enucleation of BPH, fast recovery of sexual function and improved blood flow parameters in the penis were noted after laser enucleation, which may be associated with less trauma and a faster enucleation rate. When performing laser enucleation, the mechanical effect on the prostate capsule is minimized, tissue separation occurs pointwise because of the micro-explosion of cavitation bubble without displacement of the prostate and surrounding tissues, and electrical damage to the cavernous nerves and paraprostatic vessels is prevented. In addition, after laser enucleation, the duration of bladder catheterization and the length of hospital stay are shorter. This circumstance has a positive effect on the emotional state of the patient, and psychosocial recovery accelerates the return to preoperative and higher levels of sexual satisfaction.

CONCLUSION

In the postoperative period, regardless of the type of transurethral enucleation of the prostate and the type of ED, patients had improved erectile function, accompanied by restoration of blood flow in the vessels of the penis.

Ultrasonic dopplerography of the penile vessels is a minimally invasive and highly informative diagnostic method that is used to identify circulatory disorders in the penis and assess its condition in dynamics during treatment.

ADDITIONAL INFORMATION

Author contributions. All authors confirm that their authorship complies with the international ICMJE criteria (all authors have made a significant contribution to the development of the concept, research, and preparation of the article; they read and approved the final version before its publication).

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