

DOI: <https://doi.org/10.34921/amj.2024.4.009>**DİSTANSİON ZƏRBƏ-DALĞA LİTOTRİPSİYASININ PROQNOZLAŞDIRILMASI
ASPEKTİNDƏ SİDİK AXARLARININ ELİMİNASİON FUNKSİYASININ DOPLER
VASİTƏSİLƏ QIYMƏTLƏNDİRİLMƏSİ****S.M.Kolupayev^{1,2}, V.N.Lesovoy^{1,2}, N.M.Andonyeva^{1,2}, M.A.Lesovaya³, V.V.Qargin^{3,4}**¹Xarkov Tibb Universitetinin Urologiya, nefrologiya və andrologiya kafedrası,²V.Şapoval ad. Vilayət Tibbi-Klinik Urologiya və Nefrologiya Mərkəzi,³Xarkov Beynəlxalq Tibb Universiteti Peşə yönümlü Fənlər kafedrası,⁴Xarkov Milli Tibb Universiteti Patoloji anatomiya kafedrası, Xarkov, Ukrayna

Ekstrakorporal zərbə-dalğa litotripsiyasından (EZDL) sonrakı uzun müddət ərzində kongrementlərin soyudulması fonunda sidik axarlarının eliminasion qabiliyyətini öyrənmək məqsədilə tədqiqat aparılmışdır. Tədqiqata böyrək kasasında qeyri-obstruktiv daş olduğuna görə EZDL-ə məruz qalmış 134 xəstə cəlb edilmişdir. Onlardan EZDDL-dən sonra 14 gün müşahidə altında olan 105 nəfər (78,4%) birinci qrupa, daşların xaric olması daha uzun müddət çəkən 29 nəfər (21,6%) pasiyent isə ikinci qrupa daxil edilmişdir. İkinci qrupun xəstələrində sidik daşı fraqmentləri müşahidənin 28-ci gününə qədər xaric olmamışdır. Sidik çıxarı yolların eliminasion qabiliyyəti zədəli tərəfin sidik axarlarının peristaltik funksiyasının Dopler vasitəsilə müşahidəsi yolu ilə öyrənilmişdir. Dopler spektrinin forması, sidik axarının atımının müddəti (T), yüksək (YS) və orta (OS) sürəti öyrənilmişdir.

Tədqiqat zamanı sidik axarında atımın təkfazlı, ikifazlı, üçfazlı və uzun sürən tipləri müşahidə edilmişdir. 2-ci qrup pasiyentlərdə Dopler spektri daha çox üstün sürən tipi və daha aşağı orta sürət (OS) müşahidə edilmişdir; sidik atımının orta sürəti 10 sm/san-dən az olanlarla bu göstəricidən çox olanlar arasında daşların xaric olması müddətinin şanslarına nisbəti 5,3-ə bərabər olmuşdur. Bu, nefroliti az olan xəstələrdə sidik axarının eliminasion qabiliyyəti peristaltik aktivlikdən asılıdır. Dopler spektrinin uzun sürən tipini, həmçinin sidik axarında axım sürətinin 10 sm/san-dan az olmasını onun eliminasion qabiliyyətinin zəifliyinin marker hesab etmək olar.

Açar sözlər: sidikdaşı xəstəliyi, sidik axarları, doplerografiya, peristaltik aktivlik

Ключевые слова: мочекаменная болезнь, мочеточники, доплерография, перистальтическая активность

Key words: urolithiasis, ureteric jets, dopplerography, peristaltic activity

**DOPPLER EVALUATION OF THE ELIMINATION CAPACITY OF THE URETER
IN THE ASPECT OF PREDICTING THE RESULTS OF EXTRACORPOREAL SHOCK
WAVE LITHOTRIPSY****S.M.Kolupayev^{1,2}, V.M.Lisovyi^{1,2}, N.M.Andoniev^{1,2}, M.A.Lisova³, V.V.Gargin^{3,4}**

¹Department of Urology, Nephrology and Andrology named after A.Podrez, Kharkiv National Medical University, Kharkiv, Ukraine; ²Regional Medical Clinical Center of Urology and Nephrology named after V. Shapoval, Kharkiv, Ukraine; ³Department of Professionally Oriented Disciplines, Kharkiv International Medical University, Kharkiv, Ukraine; ⁴Department of Pathological Anatomy, Kharkiv National Medical University, Kharkiv, Ukraine

The work is dedicated to the study of the elimination ability of the ureter in patients with non-obstructive nephrolithiasis, in the aspect of predicting the duration of the period of stone discharge after extracorporeal shock wave lithotripsy (ESWL). The study included 134 patients with non-obstructive renal pelvis stones who underwent ESWL. All studied patients were divided into 2 groups: the first group consisted of 105 (78.4%) patients in whom this status was stated within 14 days after ESWL; the second group was represented by 29

(21.6%) patients with longer periods of achieving this condition or the presence of residual stone fragments on the 28th day of observation. The elimination capacity of the urinary tract was determined on the basis of an assessment of the peristaltic activity of the ureter on the side of the lesion, by studying the Doppler parameters of the ureteral jets. The shape of the Doppler spectrum, duration (T), peak and average velocity of ureteral jets were evaluated. In the studied patients, monophasic, biphasic, triphasic and continuous types of ureteral emissions were found. According to the results of the study, a significantly larger number of patients in the 2nd group of patients had continuous type of Doppler spectrum and a significantly lower average value. The odds ratio to have a longer period of stone passage in patients with $CC < 10$ cm/sec compared to patients with values of this indicator ≥ 10 cm/sec was 5.3. The results of the study suggest that the elimination ability of the ureter in patients with nephrolithiasis is determined by its peristaltic activity, a non-invasive method for assessing which is Doppler investigation of ureteral jets. Markers of low elimination ability of the ureter should be considered an continuous type of Doppler spectrum, as well as an average ureteral jet's velocity of less than 10 cm/sec.

Introduction. Last decade is characterized significant improvement of imaging methods of diagnostics in different medical fields [1, 2] with especial peculiarity in pandemic time and development of non-invasive technology [3, 4] analysis of medical images [5]. Partly it's resulted in increasing frequency of detection of urinary tract pathology [6, 7] stones formation detection [8, 9] and non-obstructive urolithiasis [10, 11]. Modern protocols for the treatment of this pathology involve the use of minimally invasive methods, among which extracorporeal shock wave lithotripsy (ESWL) is considered as the first choice method in patients with stone sizes less than 2 cm [12]. The effectiveness of this method is determined by the physical and chemical parameters of the stone, as well as the condition of the upper urinary tract, in particular, the peristaltic activity of the ureter, which ensures the elimination of stone fragments [13]. In order to study the electrical and mechanical parameters of urinary tract peristalsis, various authors used electromyographic techniques, in particular, impedance measurement and measurement of intraluminal pressure in the ureter, which, due to their invasiveness associated with endoscopic or laparoscopic insertion of electrodes, have limited application in clinical practice [14].

This method can be a useful tool for non-invasive assessment of the functional state of the ureter in the aspect of predicting the duration of the stone fragment elimination period after ESWL.

The purpose of the study: to determine the elimination capacity of the upper urinary tract in patients with non-obstructive nephron-

lithiasis based on the assessment of Doppler parameters of ureteral jets.

Materials and methods. The study included 134 patients (men – 74, women – 60) with non-obstructive stones of the renal pelvis, who were being treated at Regional Medical Clinical Center of Urology and Nephrology named after V.I.Shapoval" (Kharkiv, Ukraine). All patients underwent a clinical and laboratory examination, which included an assessment of general blood and urine analysis indicators, blood biochemical indicators (urea, creatinine), multispiral computed tomography with contrast on a Toshiba Aquilion 16 X-ray computed tomography scanner. Patients were included in the study with non-obstructive kidney stones having similar tomographic parameters: maximum linear size of 10-15 mm, X-ray density of 1000-1500 HU.

The elimination capacity of the urinary tract was determined based on the assessment of peristaltic activity of the ureter on the side of the lesion by studying the Doppler parameters of the ureteral jets. Before the study, patients were asked to empty their bladder, followed by hydration, which involved drinking 700 mL of water (approximately 20-30 mL/kg) divided into three doses 5 minutes apart. Ultrasound examination of the ureteral output began approximately 10 minutes after the last dose. In order to visualize the ureter emissions, the ultrasound sensor was placed in the suprapubic area in such a way that the scanning plane passed through the ureters. The Doppler angle was set within $30^\circ - 60^\circ$. The following Doppler parameters of the ureteric jets were evaluated: the shape of the Doppler spectrum, duration (T), peak (PV) and average (AV) velocity.

All patients underwent ESWL on a Dornier Delta device (Germany). The average duration of the procedure was from 30 to 50 minutes. The number of shock waves ranged from 1000 to

3000, on average 2297 ± 378 per procedure at a pulse frequency of 90/min.

The results of ESWL were evaluated by performing an ultrasound examination on days 7, 14, and 28 after the procedure. When visualizing stone fragments 5 mm or more in size, a repeated ESWL session was performed. Absence of stone fragments and signs of obstruction of the urinary tract during ultrasound examination were indications for control computer tomography without contrast. The "stone free" state was established in the absence of stone fragments in the projection of the kidneys and urinary tract on computer tomograms.

Statistical processing of the data obtained in the research process was carried out using Microsoft Office Excel 2016 spreadsheets (Microsoft, USA) and the Statistica 10.0 program (StatSoft, USA). Quantitative data are presented as mean and standard deviation ($M \pm SD$). The obtained digital experimental data were processed by the method of variational statistics using the Student's t-test. Qualitative data are presented in the form of absolute or relative (%) values. Comparison of qualitative features in two groups was carried out using the Pearson chi-square test. To assess the risk of symptoms, the odds ratio was calculated with a 95% confidence interval (CI). Differences were determined at the level of

significance $p < 0.05$.

The research protocol was approved by the ethics committee of the Regional Medical Clinical Center of Urology and Nephrology named after KNPHOR. V.I. Shapovalova". Before the start of the study, all patients were informed about the aims, tasks and method of the study, after which they voluntarily signed the informed consent.

Results. In this study, an analysis of the peristaltic activity of the ureter was performed, which can determine its ability to eliminate stone fragments. Stone-free status on day 28 after ESWL was achieved in 123 (91.8%) patients. 11 (8.2%) patients had residual stone fragments in the lower group of cups at the end of the observation period. Depending on the time of onset of "stone free" status, all studied patients were divided into 2 groups: the first group consisted of 105 (78.4%) patients in whom this status was ascertained within 14 days after ESWL; the second group was represented by 29 (21.6%) patients with longer periods of reaching this state or had residual stone fragments on the 28th day of observation. Both groups were comparable in terms of sex, age, side of stone localization (Table 1).

Table 1. Comparative characteristics of the studied groups of patients by sex, age, side of stone localization

Indicators	1 group (n=105)	2nd group (n=29)	P
Sex			
- men	59 (56.2%)	17 (58.6%)	0.82
- women	46 (43.8%)	12 (41.4%)	
Age	37.6 ± 7.8	41.5 ± 6.4	0.5
The side of stone localization			
- right kidney	49 (46.7%)	13 (44.8%)	0.86
- left kidney	56 (53.3%)	16 (55.2%)	

The elimination capacity of the ureter was assessed based on the analysis of dopplerograms of ureteric emissions. Among the types of Doppler spectra described in previous

works [15, 17], the following were found in the studied patients: monophasic, biphasic, triphasic, extended (Fig. 1).

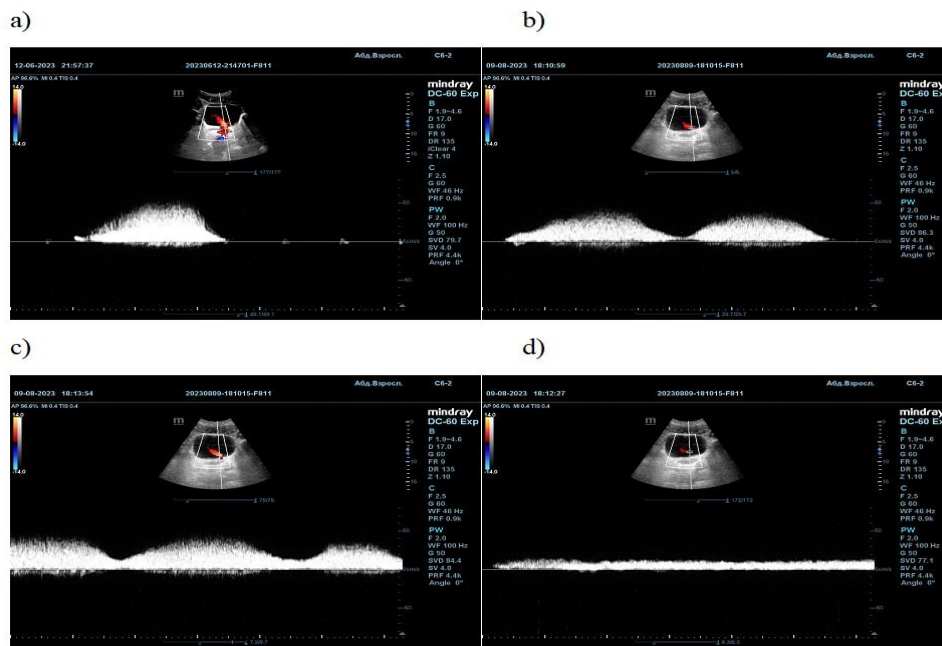


Fig. 1. Types of Doppler spectra of ureteric jets in patients with non-obstructive nephrolithiasis: monophasic (a), biphasic (b), triphasic (c), extended (d)

The quantitative presence of the first three types of dopplerograms in patients of the studied groups did not differ. An extended type of Doppler spectrum was observed in significantly more cases in patients of group 2. The rate of AV was significantly higher in patients of group 1. There was no significant difference in the parameters of PV and T in the patients of the studied groups (Table 2).

The obtained results allow us to consider the type of Doppler spectrum, as well as the average velocity of ureteral outflow as Doppler criteria for assessing peristaltic activity of the ureter, which determine its elimination capacity, in patients with nephrolithiasis.

In order to analyze the relationship between the AV indicator and the length of the stone fragment elimination period, the odds ratio

(OR) was calculated. The median values of the average velocity of the ureteral jets in patients of groups 1 and 2 were 12.7 cm/sec and 9.9 cm/sec, respectively. For the calculation of AV, a AV value of 10 cm/sec was chosen as the threshold value (cut off value) of reduced peristaltic activity of the ureter. $SS \leq 10$ cm/sec was observed in 31 (29.52%) patients of the first group and 20 (68.96%) patients of the second group ($p < 0.001$). When comparing groups of patients with $AV \leq 10$ cm/sec ($n = 51$) and $LV > 10$ cm/sec ($n = 83$), the odds ratio was 5.3 (95 % AV: 2.1751 – 12.9368; $p = 0.0002$), indicating that patients with a Doppler mean ureteric jet velocity ≤ 10 cm/sec have 5.3 times greater odds of a prolonged (more than 14 days) stone passage period after ESWL.

Table 2. Comparative characteristics of the studied groups according to dopplerographic indicators of ureteric jets

Indicator	1 group, (n=105)	2nd group, (n=29)	P
Type of Doppler spectrum			
- monophasic	34 (32.4%)	8 (27.6%)	0.62
- biphasic	30 (28.6%)	6 (20.7%)	0.40
- three-phase	25 (23.8%)	4 (13.8%)	0.25
- extended	16 (15.2%)	11 (37.9%)	0.007
PV, cm/sec	52±4.6	61±7.2	0.1
AV, cm/sec	13.6±2.4	9.8±1.2	0.03
T, sec	4.3±0.7	4.1±0.5	0.8

Discussion. Urolithiasis is widespread in the modern population [15]. The modern trend in the treatment of this disease is the use of a wide range of non-invasive and minimally invasive methods, among which, during the last decades, one of the first places is stably occupied by ESWL [16]. An indicator of the effectiveness of ESWL, as well as other alternative methods used in patients with nephrolithiasis, is the “stone free” state, as well as the terms of its achievement [17], which, in the case of ESWL, are determined by a number of factors, one of which is functional condition of the upper urinary tract [13, 17].

The result of conducting peristaltic waves along the upper urinary tract is the appearance of the ultrasonic phenomenon of ureteral jets from the ureteral orifice [18]. Previous studies have demonstrated the possibility of using ultrasound dopplerography of ureteral emissions in the diagnosis of upper urinary tract obstruction [19], vesicoureteral reflux disease in children [20], differentiation of

obstructive and physiological dilatation of the urinary tract during pregnancy [21].

Results of our work are going with accordance of previously published work about Doppler examination with good sensitivity and specificity for the diagnosis of symptomatic ureteral stones [22]. The twinkling artifact is useful for the early detection of the calculi, especially in the middle tract of the ureter, usually the most difficult place in sonographic diagnosis. It also seems helpful for the detection of smaller stones. The use of color Doppler does not increase the exploration time.

Conclusions. The elimination capacity of the ureter in patients with nephrolithiasis is determined by its peristaltic activity, a non-invasive method of assessment of which is dopplerography of ureteric jets. Markers of low elimination capacity of the ureter should be considered an extended type of Doppler spectrum, as well as an average velocity of the ureteral jet ≤ 10 cm/sec.

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ДОПЛЕРОВСКАЯ ОЦЕНКА ЭЛИМИНАЦИОННОЙ СПОСОБНОСТИ МОЧЕТОЧНИКА В АСПЕКТЕ ПРОГНОЗИРОВАНИЯ РЕЗУЛЬТАТОВ ДИСТАНЦИОННОЙ УДАРНО- ВОЛНОВОЙ ЛИТОТРИПСИИ

С.М.Колупаев^{1,2}, В.Н.Лесовой^{1,2}, Н.М.Андоньева^{1,2}, М.А.Лесовая³, В.В.Гаргин^{3,4}

¹*Кафедра урологии, нефрологии и андрологии имени проф. А.Г.Подреца Харьковского национального медицинского университета, Харьков, Украина;* ²*Областной медицинский клинический центр урологии и нефрологии им. В.Шаповала, Харьков, Украина;* ³*кафедра профессионально-ориентированных дисциплин, Харьковский международный медицинский университет, Харьков, Украина;* ⁴*Кафедра патологической анатомии Харьковского национального медицинского университета, Харьков, Украина*

Резюме. Работа посвящена исследованию элиминационной способности мочеточника у пациентов с необструктивным нефролитиазом, в аспекте прогнозирования продолжительности периода отхождения конкрементов после экстракорпоральной ударно-волновой литотрипсии (ЭУВЛ). В исследование было включено 134 пациента с необструктивными камнями почечной лоханки, которыми была проведена ЭУВЛ. Все исследуемые больные были разделены на 2 группы: первую группу составили 105 (78,4%) больных, у которых этот статус был констатирован в течение 14 дней после ЭУВЛ; вторая группа была представлена 29 (21,6%) пациентами с более длительными сроками достижения этого состояния или наличием резидуальных фрагментов камня на 28 день наблюдения. Элиминационная способность мочевыводящих путей определялась на основании оценки перистальтической активности мочеточника на стороне поражения, путем изучения доплеровских параметров мочеточ-

ников. Были оценены форма доплеровского спектра, длительность (Т), пиковая и средняя (СС) скорость мочеточниковых выбросов. У исследуемых пациентов были обнаружены монофазный, двухфазный, трехфазный и продолженный типы мочеточниковых выбросов. По результатам исследования у достоверно большего количества пациентов 2 группы пациентов наблюдался удлинённый тип доплеровского спектра и достоверно более низкий показатель СС. Отношение шансов иметь более длительный период отхождения камней у больных с уровнем $CC < 10$ см/сек по сравнению с пациентами со значениями данного показателя ≥ 10 см/сек составляло 5,3. Результаты исследования позволяют утверждать, что элиминационная способность мочеточника у пациентов с нефролитиазом определяется его перистальтической активностью. Маркерами низкой элиминационной способности мочеточника следует рассматривать продленный тип доплеровского спектра, а также среднюю скорость мочеточникового выброса менее 10 см/сек.

Автор для корреспонденции:

Гаргин Виталий Витальевич, профессор кафедры патологической анатомии Харьковского национального медицинского университета, Харьков, Украина

E-mail: vitgarg@ukr.net

Author for correspondence:

Gargin Vitaliy, Professor of the Department of Pathological Anatomy, Kharkiv National Medical University, Kharkiv, Ukraine

E-mail: vitgarg@ukr.net