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A NEW TOOL FOR PREDICTING THE EFFICIENCY OF MINI-PERCUTANEOUS NEPHROLITHOTOMY

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Introduction. Currently, percutaneous nephrolithotomy (PCNL) is a first-line treatment method for large and staghorn kidney stones. Predicting the efficiency of the performed surgical procedure is relevant at the stage of preoperative counseling of patients.
Aim. To develop a universal nomogram for predicting the efficiency of mini-PCNL taking into account the baseline characteristics and features of the patient.
Materials and methods. A total of 251 patients with kidney stones who underwent mini-PCNL in the prone position according to the standard method through a single access were included in the study. The preoperative characteristics of patients and their impact on the outcome were evaluated. An achievement of the stone-free rate (SFR) was assessed by the computed tomography (CT).
Results. The analysis revealed factors significantly influencing the achievement of the SFR, such as stone volume >1.39 cm3 (p=0.001), stone area >189.03 mm2 (p=0.001), distance from the lowest point of the Th12 to the lower part of the lower pole calyx (T12-LP) <85.81 mm (p=0.050), distances from the lower calyx to the most cranial part of the iliac crest (ICLP) >49.1 mm (p=0.029), stone size >18.2 mm (p=0.001), number of involved calyxes >3 (p=0.001), number of involved calyxes for staghorn stones >4 (p=0.001), and staghorn stone (p=0.001). Correlation, logistic regression, and ROC analysis were performed for these factors. The area under the curve (AUC) was 0.897. A nomogram has been developed. The sensitivity of the model is 94.4%, specificity is 59.2%, and overall accuracy is 84.4%. A certificate of state registration of a computer program in the IBM SPSS Statistics syntax language "A model for predicting the SFR of mini-PCNL in patients with kidney stones" was obtained.
Conclusion. The nomogram developed on the basis of our data showed a high predictive ability in relation to the SFR with sensitivity of 94%. This nomogram is easy to use and interpret, which makes it convenient for routine practice, however, external validation is necessary to objectify the predictive ability.

K e y w o r d s: *urolithiasis, surgical treatment, mini-percutaneous nephrolithotomy, stone-free rate prediction.*

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Introduction. Currently, percutaneous nephrolithotomy (PCNL) is a widely used surgical method for treating urolithiasis, especially for large kidney stones (including staghorn calculi) [1, 2]. It is known that the inability to completely remove stones leads to patient dissatisfaction and disappointment with the treatment, so having a method to predict the efficiency of stone removal before performing PCNL is a good option for planning the procedure [3].

In urological practice, there are nomograms that have been commonly used and are currently actively employed when planning surgical treatment. In particular, for predicting stone-free status when performing PCNL, a number of studies have been published [3-8]. According to an international study carried out among endourologists in 2016, only 15% of specialists used nomograms in routine practice, and 13% denied their efficiency. Approximately 25% of respondents believed that a higher level of evidence was needed for using nomograms [9]. Each of the previously proposed nomograms has its advantages and disadvantages. Taking this into account, there is a need to develop a more universal method for predicting the efficiency of PCNL for simplicity and wider application in the clinical practice.

Aim. To develop a universal tool for predicting the efficiency of mini-PCNL, taking into account preoperative features and patient characteristics.

Materials and methods. The study was carried out at Pirogov City Clinical Hospital No. 1 in Moscow and included 251 patients who underwent mini-PCNL. At the preoperative stage, all patients had clinical and laboratory examination, as well as computed tomography of the urinary tract (CT-urography). All patients underwent mini-mini-PCNL in the prone position according to the standard technique through one access. Stone-free status was assessed based on CT results in the postoperative period, and was defined as the complete absence of stones in the collecting system or the presence of residual

stones no larger than 4 mm. The influence of factors on achieving stone-free status was evaluated, such as stone volume, stone area, distance from the lowest point of the 12th thoracic vertebra to the lower part of the lower calyx (T12LP), vertical distance between the lower part of the lower calyx and the most cranial part of the iliac crest (ICLP), stone size, stone density, presence of multiple stones, number of calyces affected by the stone, number of branches of staghorn calculi, presence of staghorn stone, body mass index (BMI), presence of hydronephrosis, history of endoscopic procedures for urolithiasis or open procedures. Quantitative parameters were evaluated based on CT-urography using the Vidar Dicom Viewer program (Russia), while qualitative characteristics were assessed based on history taking and medical records. Demographic and clinical characteristics of patients, as well as morphometric characteristics of kidney stones, are presented in *Table 1*.

Statistical analysis. The database was created using Excel from the Office 365 package by Microsoft (USA), and for statistical analysis, StatTech v. 3.1.8 (developed by Stattech LLC, Russia) and IBM SPSS Statistics (version 27) were used. The distribution of quantitative indicators was determined using the Shapiro-Wilk and Kolmogorov-Smirnov tests. To compare percentages, Pearson's chi-square test and the z-test for equality of proportions were used when analyzing relationships based on contingency tables. The odds ratio (OR) was calculated. The method of correlation analysis of variables, the logistic regression for modeling the dependence of binary characteristics on quantitative and qualitative features, and ROC analysis were applied.

Results. Based on the analysis of relationships between the dependent variable (stone-free status) and clinical and morphometric preoperative features, factors were identified that significantly influence the success of mini-PCNL and achievement of stone-free status. For all categorical original and transformed variables with two categories, relative risk indicators of unsuccessful mini-PCNL were calculated, including odds ratios and their confidence intervals.

The analysis allowed to identify factors that significantly affect the achievement of stone-free rate status, including stone volume >1.39 cm^3, stone area >189.03 mm^2, T12LP <85.81 mm, ICLP >49.1 mm, stone size >18.2 mm, number of calyces affected by the stone >3, number of branches of staghorn calculi >4, presence of staghorn stine. The results of the analysis are presented in *Table 2*.

Correlation analysis of the original clinical and morphometric characteristics showed their influence not only on the dependent variable, such as stone-free status, but also strong correlations between the factors themselves. The results of the correlation analysis are presented in *Table 3*.

At the next stage, a component analysis to solve the problem of multicollinearity was done. After that, two main components were identified (physical characteristics of the stone and the kidney anatomic location), whose values were greater than 1 (*Table 4*).

After carrying the component analysis on the new aggregated indicators (main components), which are linear combinations of the original seven characteristics, a regression analysis was performed. A mathematical model of logistic regression was used. As a result of the stepwise construction of the logistic regression model, only the

Table 1

Characteristics of patients

Parameter		M±SD / Me (Q1–Q3) / N (%)
Age, years		60,00 (48,00–68,00)
Gender	Женский	141 (56.2%)
	Мужской	110 (43.8%)
Side of stone	Right	123 (49.0%)
	Left	128 (51.0%)
Hydronephrosis	Yes	64 (25.8%)
	No	184 (74.2%)
Past endoscopic treatment of urolithiasis	Yes	75 (29.9%)
	No	176 (70.1%)
Past open procedures for urolithiasis	Yes	20 (8%)
	No	231 (92%)
Multiple stones	Yes	59 (23.5%)
	No	192 (76.5%)
Staghorn stone	Yes	82 (32.7%)
	No	169 (67.3%)
BMI, kg/m^2		28,70 (25,30–33,05)
Number of calyces affected by the stone		2,00 (1,00–3,00)
Number of branches of staghorn stone		3,00 (2,00–4,50)
Stone volume, cc		1,38 (0,75–3,40)
Stone area, mm^2		189.23 (111.35–355.19)
T12LP, mm		84.01±18.95
ICLP, mm		46.80 (36.95–57.75)
Stone size, mm		18.00 (13.25–25.80)
Max. stone density, HU		1372.00 (1005.00–1534.00)

Table 2

Assessment of risk factors affecting the achievement of stone-free status

Factor	Value	OR [95% CI]	*p* (value)
Stone volume, cc	<1.38 >1.39	9.6 [4.7; 19.5]	0.001
Stone area, mm²	<189.02 >189.03	7.4 [3.789; 14.611]	0.001
T12LP, mm	>85.80 <85.81	1.9 [0.986; 3.765]	0.050
ICLP, mm	<49.0 >49.1	0.5 [0.242; 0.935]	0.029
Stone size, mm	<18.1 >18.2	6.2 [3.274; 11.898]	0.001
Max. stone density, HU	<1372.0 >1372.1	1.1 [0.805; 1.445	1.445
Multiple stones	Да Нет	1.6 [0.863; 3.011]	0.132
Number of calyces affected by the stone	<2 >3	10.7 [5.198; 21.974]	0.001
Number of branches of staghorn stone	<3 >4	8.3 [2.568; 26.955]	0.001
Staghorn stone	Да Нет	10.5 [5.586; 19.866]	0.001
BMI, kg/m²	<28.7 >28.8	1.2 [0.718; 2.160]	0.435
Hydronephrosis	Да Нет	0.6 [0.325; 1.245]	0.185
Past endoscopic treatment of urolithiasis	Да Нет	0.1 [0.533; 1.774]	0.927
Past open procedures for urolithiasis	Да Нет	1.4 [0.533; 3.659]	0.495

Table 3

Correlation analysis of initial clinical and morphometric characteristics

	Number of branches of staghorn stone	Number of calyces affected by the stone	Stone volume	Stone area	T12LP	ICLP	Stone size
Number of branches of staghorn stone	1	0.893*	0.699*	0.696*	0.026	0.016	0.606*
Number of calyces affected by the stone		1	0.731*	0.730*	-0.003	0.035	0.618*
Stone volume			1	0.904	0.042	0.007	0.761
Stone area				1	0.020	0.053	0.807*
T12LP					1	-0.664*	0.016
ICLP						1	0.019
Stone size							1

Note: * – correlations are significant at the level of $p<0.001$.

Table 4

Values of the selected components before and after rotation

Components	Initial values			Values of principal components after rotation		
	Values	Percentage of Explained Variance	Total Percentage of Variance	Values	Percentage of Explained Variance	Total Percentage of Variance
1	4.18	59.77	59.77	4.18	59.77	59.77
2	1.56	22.28	82.05	1.56	22.28	82.05
3	0.45	6.47	88.52			
4	0.34	5.68	94.21			
5	0.20	2.96	97.17			
6	0.12	1.69	98.86			
7	0.08	1.14	100.00			

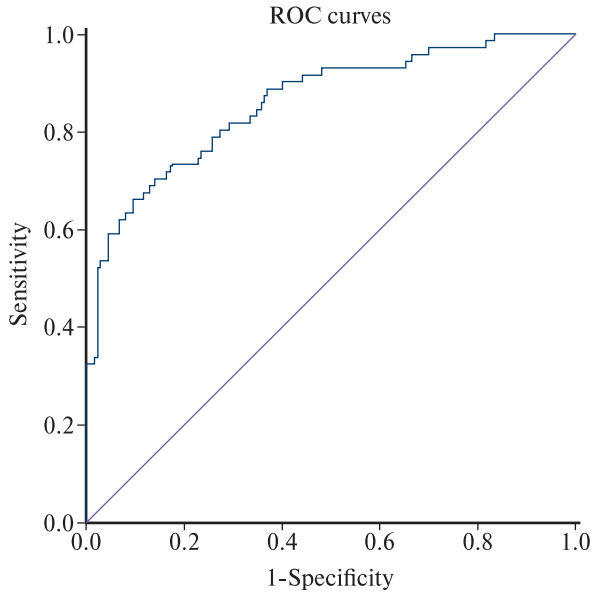


Fig. 1. Plot of specificity and sensitivity of the multivariate model

first main component was included (p=0.001). Thus, an equation was obtained for the probability of achieving stone-free status:

p_i=1/(1+e^(-(-1,060+1,952·F_1i))),

where F1i=0,220*X1+0,216* X2 + 0,216*X3+0,221* X4 +0,12*X5 +0,009*X6 +0,219*X7,

where Xj are standardized values of the original independent variables.

Based on the results of this equation, the model predicts 84.4% of successfully performed mini-PCNL for kidney stones (*Table 5*).

The sensitivity of the model was 94.4%, and the specificity was 59.2%. The overall accuracy was 84.4%. After constructing the logistic regression to analyze the quality of the classification and overall predictive power, ROC analysis was carried out and the area under curve (AUC) was analyzed (*Fig. 1*). AUC was 0.897 with a 95% confidence interval from 0.81 to 0.91, which corresponds to a good quality of the predictive model. The Gini index was 0.72. Based on the predictive model, a program was written, namely a model for predicting the successful performance of mini-PCNL in patients with kidney stones. The

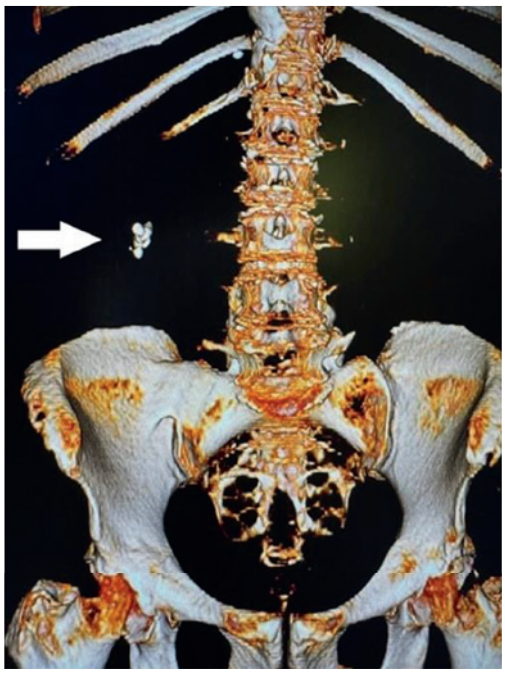


Fig. 2. 3D reconstruction of CT-urography (coronal plane), the arrow indicates a staghorn stone

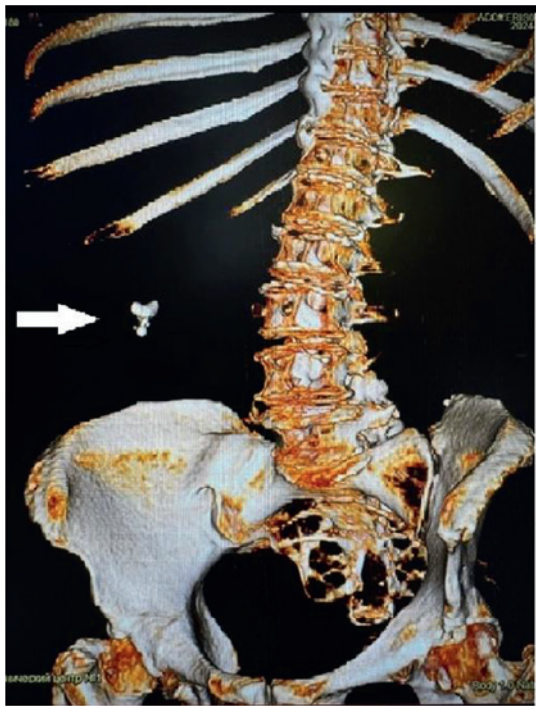


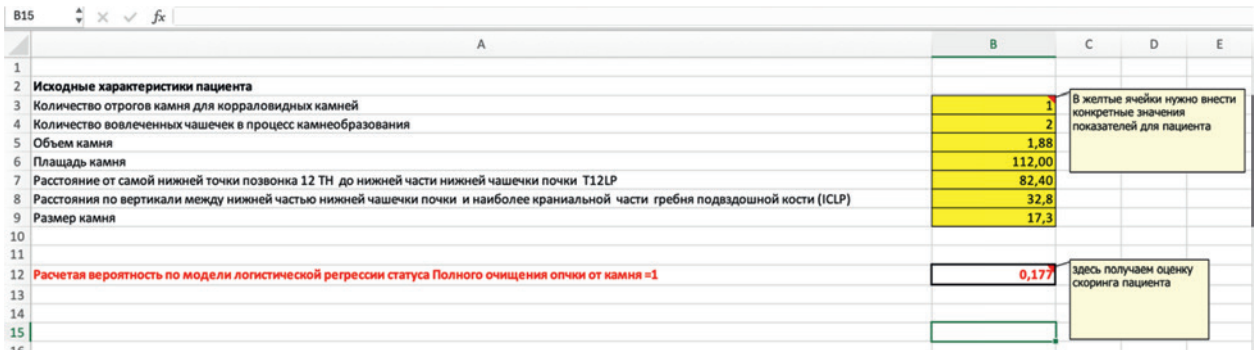
Fig. 3. 3D reconstruction of CT-urography (sagittal plane), the arrow indicates a staghorn stone

Table 5

Classification ability of the constructed model

Was stone-free status observed?	Model prediction		
	Stone-free status predicted		Proportion of correct predictions, %
	да	нет	
Yes	169	10	94.4
No	29	42	59.2
Total			84.4

Note: at cutoff probability threshold of 0.5.



	A	B	C	D	E
1					
2	Исходные характеристики пациента				
3	Количество отрогов камня для корраловидных камней	1	В желтые ячейки нужно внести конкретные значения показателей для пациента		
4	Количество вовлеченных чашечек в процесс камнеобразования	2			
5	Объем камня	1,88			
6	Плащадь камня	112,00			
7	Расстояние от самой нижней точки позвонка 12 TH до нижней части нижней чашечки почки T12LP	82,40			
8	Расстояния по вертикали между нижней частью нижней чашечки почки и наиболее краниальной части гребня подвздошной кости (ICLP)	32,8			
9	Размер камня	17,3			
10					
11					
12	Расчетая вероятность по модели логистической регрессии статуса Полного очищения опчки от камня =1	0,177	здесь получаем оценку скоринга пациента		
13					
14					
15					

Note: if the obtained value is 1, the probability of achieving stone-free status is 0%, if the value is 0, the probability of achieving stone-free status is 100%, the intermediate value is calculated by ((1-X)*100%).

Fig. 4. Results of mini-PNLT success calculation in the developed program

program contains code in the IBM SPSS Statistics syntax language for calculations of the obtained model, the original sample for training, and a patient scoring calculator in MS Excel based on the model. Computer type: PC. Language: IBM SPSS Statistics 26.0 syntax, MS Excel OS: Windows 7\8\10\11. For this program, a certificate of state registration of a computer program was obtained: "Model for predicting the successful performance of mini-percutaneous nephrolithotomy in patients with kidney stones."

Clinical example of using of the predictive tool:

Patient K. with a staghorn stone in the right kidney (K1 according to N. A. Lopatkin's classification) (*Fig. 2, 3*). According to preoperative parameters, the patient was prepared for mini-PCNL.



Fig. 5. 3D reconstruction of CT-urography after surgical treatment (coronal plane)

Based on the results of preoperative CT-urography, the necessary parameters were calculated. The stone size was 17.3 mm, stone volume of 1.88 cc, stone area of 112 mm, T12LP of 82.4 mm, ICLP of 32.8 mm, number of calyces affected by stone of 2, number of branches for the staghorn stone of 3. According to the model, the probability of achieving stone-free status was 82.3% (*Fig. 4*). It should be noted that this value was obtained by transforming the value of 0.177 (the difference of one and the obtained value, and the product of the difference by 100%), ((1-0.177)*100%=82.3%).

According to the results of CT-urography in the postoperative period, no residual stones were detected (*Fig. 5*).

Discussion. Stone-free status is one of the main criteria for evaluating the efficiency of surgical treatment of urolithiasis and implies the absence of clinically significant stones according to postoperative imaging studies [10]. It is well known that successful PCNL positively affects patient satisfaction with the surgical treatment [11]. Up to 37% of clinically insignificant residual stones can grow and lead to clinical manifestations, such as inflammation or urinary tract obstruction. Residual stones larger than 4 mm significantly increase the number of additional diagnostic studies, surgical interventions, and hospitalizations [12-14]. However, it is not always possible to achieve stone-free status. Predicting successful PCNL using nomograms allows objectively assessing the complexity of the upcoming procedure, planning the use of combined endoscopic treatment or creating multi-access when performing PCNL, which will allow counseling patients at the preoperative stage about the features of surgical treatment of kidney stones and possible multiple sessions of treatment.

Previously proposed tools (scales, nomograms) for predicting stone-free status have currently undergone external validation, and some of them have demonstrated their high predictive ability. However, these tools have not found widespread application in routine practice, which is due to the complexity of evaluating the necessary parameters, the interpreting the obtained result, and the low predictive ability [15, 16, 17]. Our predictive tool seems to be attractive in application, as it is based on quantitative parameters evaluated using a computer program, which reduces the likelihood of underestimating the complexity of the upcoming procedure and achieving

stone-free status. Also, this predictive tool includes the kidney anatomic location, which can affect all stages of PCNL.

Conclusion. Our predictive tool covers not only the morphometric parameters of stones but also the constitutional features of the patient. The simplicity of its application and interpretation is its advantage, however, it is necessary to carry out external validation on other cohorts of patients to objectify the predictive ability of the nomogram.

REFERENCES

1. *Mamaev I.E., Akhmedov K.K., Dolomanov K.A., Saipulaev G.Sh., Manuilova O.O., Stepanenko K.V., Savkina K.V., Kotov S.V.* Mini-subcutaneous nephrolithotomy without ureter catheterization. Comparison with the standard methodology. Eksperimentalnaya i klinicheskaya urologiya, 2021;14(2):58-63; https://doi.org/10.29188/2222-8543-2021-14-2-58-63. Russian (Мамаев И.Э., Ахмедов К.К., Доломанов К.А., Сайпулаев Г.Ш., Мануйлова О.О., Степаненко К.В., Савкина К.В., Котов С.В. Мини-перкутанная нефролитотомия без катетеризации мочеточника. Сравнение со стандартной методикой. Экспериментальная и клиническая урология. 2021;14(2):58–63. https://doi.org/10.29188/2222-8543-2021-14-2-58-63).
2. *Kotov S.V., Belomyttsev S.V., Mamaev I.E., Perov R.A., Pulbere S.A., Surenkov D.N.* The evolution of approaches in the treatment of urolithiasis. Multicenter analysis of the work of 5 urological departments of multidisciplinary hospitals in Moscow. Eksperimentalnaya i klinicheskaya urologiya 2020;13(5):51-58, https://doi.org/10.29188/2222-8543-2020-13-5-51-58. Russian (Котов С.В., Беломытцев С.В., Мамаев И.Э., Перов Р.А., Пульбере С.А., Суренков Д.Н. Эволюция подходов в лечении мочекаменной болезни. Мультицентровой анализ работы 5 урологических отделений многопрофильных стационаров г. Москвы. Экспериментальная и клиническая урология. 2020;13(5):51-58. https://doi.org/10.29188/2222-8543-2020-13-5-51-58).
3. *Gadzhiev N.K., Grigorev V.E., Mazurenko D.A., Malhasyan V.A., Obidnyak V.M., Pisarev A.V., Tagirov N.S., Popov S.V., Petrov S.B.* The ACS system or a new method for predicting the effectiveness of percutaneous nephrolithotomy. Eksperimentalnaya i klinicheskaya urologiya 2016;3:52–56. Russian (Гаджиев Н.К., Григорьев В.Е., Мазуренко Д.А., Малхасян В.А., Обидняк В.М., Писарев А.В., Тагиров Н.С., Попов С.В., Петров С.Б. Система ACS или новый способ прогнозирования эффективности перкутанной нефролитотомии. Экспериментальная и клиническая урология. 2016;3:52–56).
4. *Smith A., Averch T.D., Shahrour K., Opondo D., Daels F.P.J., Labate G. et al.* A nephrolithometric nomogram to predict treatment success of percutaneous nephrolithotomy. J Urol 2013;190(1):149–56.
5. *Okhunov Z., Friedlander J.I., George A.K., Duty B.D., Moreira D.M., Srinivasan A.K. et al.* S.T.O.N.E. nephrolithometry: novel surgical classification system for kidney calculi. Urology 2013;81(6):1154–1159.
6. *Mishra S., Sabnis R.B., Desai M.* Staghorn morphometry: a new tool for clinical classification and prediction model for percutaneous nephrolithotomy monotherapy. J Endourol. 2012;26(1):6–14.
7. *Thomas K., Smith N.C., Hegarty N., Glass J.M.* Guy's stone score-grading the complexity of percutaneous nephrolithotomy procedures. Urology. 2011;78(2):277–81.
8. *Jeong C.W., Jung J.-W., Cha W.H., Lee B.K., Lee S. et al.* Seoul National University Renal Stone Complexity Score for Predicting Stone-Free Rate after Percutaneous Nephrolithotomy. PLoS ONE. 2013; 8(6): e65888. doi:10.1371/journal.pone.0065888
9. *Elkoushy M.A., Metwally A.H., Noureldin Y.A.* Implications of different nephrolithometry scoring systems on clinical practice of endourologists: an international web-based survey. Arab J Urol. 2016;14:216–222.
10. *Gorelov D.S., Gadzhiev N.K., Akopyan G.N., Ivanov A.O., Schukin V.L., Talyshinskiy A.V., Petrov S.B.* Residual stones after PNL: problems of diagnosis and treatments (literature review) Eksperimentalnaya i klinicheskaya urologiya. 2019;1:57–63. doi:10.29188/2222-8543-2019-11-1-57-62. Russian (Горелов Д.С., Гаджиев Н.К., Акопян Г.Н., Иванов А.О., Щукин В.Л., Талышинский А.В., Петров С.Б. Резидуальные камни после ПНЛ: проблемы диагностики и лечения (обзор литературы) Экспериментальная и клиническая урология. 2019;1:57–63 doi:10.29188/2222-8543-2019-11-1-57-62).
11. *Panferov A.S., Kotov S.V., Safiullin R.I.* Analysis of changes in the quality of life of patients with bilateral nephrolithiasis after simultaneous and staged bilateral mini-percutaneous nephrolithotomy. Experimental and clinical urology. 2019;1:64–69. Doi: 10.29188/2222-8543-2019-11-1-64-69. Russian (Панферов А.С., Котов С.В., Сафиуллин Р.И. Анализ изменения качества жизни пациентов с двусторонним нефролитиазом после одномоментной и этапной билатеральной мини-перкутанной нефролитотомии. Экспериментальная и клиническая урология. 2019;1:64–69. Doi: 10.29188/2222-8543-2019-11-1-64-69).
12. *Emmott A.S., Brotherhood H.L., Paterson R.F., Lange D., Chew B.H.* Complications, re-intervention rates, and natural history of residual stone fragments after percutaneous nephrolithotomy J Endourol. 2018;32(1):28–32. doi: 10.1089/end.2017.0618.
13. *Delvecchio F.C., Preminger G.M.* Management of residual stones. Urol Clin North Am. 2000;27(2):347–354.
14. *Raman J.D., Bagrodia A, Gupta A, Bensalah K, Cadeddu J.A., Lotan Y.* Natural history of residual fragments following percutaneous nephrostolithotomy. J Urol. 2009;181(3):1163–68. doi: 10.1016/j.juro.2008.10.162.
15. *Bibi M., Sellami A., Chaker K., Ouanes Y., Kheiredine M.D., Ben Chehida M.A., Ben Rhouma S., Nouira Y.* Les scores radiologiques peuvent-t-ils prédire le succès de la NLPC ? Étude comparative du Guy's stone score, du STONE score, du CROES nomogram, et du S-ReSc score [Do the nephrolithometry scoring systems predict the success of percutaneous nephrolithotomy. Comparison of 4 scores: The Guy's stone score, STONE Score, CROES nomogram and S-ReSC score]. Prog Urol. 2019;29(8-9):432–439.. doi: 10.1016/j.purol.2019.05.007. Epub 2019 Jun 11. PMID: 31196827
16. *Al Adl A.M., Mohey A., Abdel Aal A., Abu-Elnasr H.A.F., El Karamany T., Noureldin Y.A.* Percutaneous Nephrolithotomy Outcomes Based on S.T.O.N.E., GUY, CROES, and S-ReSC Scoring Systems: The First Prospective Study. J Endourol. 2020;34(12):1223–1228. doi: 10.1089/end.2019.0856. Epub 2020 Mar 23. PMID: 32098495
17. *Biswas K., Gupta S.K., Tak G.R., Ganpule A.P., Sabnis R.B., Desai M.R.* Comparison of STONE score, Guy's stone score and Clinical Research Office of the Endourological Society (CROES) score as predictive tools for percutaneous nephrolithotomy outcome: a prospective study. BJU Int. 2020;126(4):494–501. doi: 10.1111/bju.15130. Epub 2020 Aug 4. PMID: 32506712.

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