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## Experience of percutaneous nephrolithotripsy of large kidney stones

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### SUMMARY

Topicality. Kidney stone disease is referred to wide spread diseases. According to the literature data its prevalence is 732,8 cases per 100 000 of Ukrainian population. During the last years the usage of minimally invasive techniques, such as: extracorporeal shock-wave lithotripsy (ESWL) and ureteroscopy with contact lithotripsy has significantly increased, but percutaneous lithotripsy (PNL) remains as a technique of choice among basic methods of treatment of large size kidney stones.

The purpose of the work. To evaluate the effectiveness of the percutaneous shockwave lithotripsy (PNL) in treatment of kidney stones larger than 50 mm.

Materials and methods. Twenty-eight patients, among them twenty-five (89,28%) male patients and three (10,71%) female patients, with large > 50 mm kidney stones treated in NMMCC from April 2016 to March 2020 were included to the research. Stone-free rate and complications rates were examined.

Results. In thirteen cases (46,42%) the stones were located in the right kidney, in fifteen cases (53,57%) the stones were located in the left kidney. The nineteen patients (67,85%) did not have any residual stones, and nine patients (32,14%) had residual stones. The extracorporeal shock-wave lithotripsy had been performed in 4 patients (14%), in 5 (17%) cases – contact lithotripsy of residual stones, which migrated to the lower third part of the ureter. After repeated intervention in 5 cases (17,86%) stone-free status was obtained. Stone-free rate index was 85,71%. Average duration of operation was  $115 \pm 24,64$  min. Hemoglobin level before and after operative intervention was 142 (117–159) g/l and 119 (94–132) g/l respectively ( $p < 0,005$ ). Length of hospital stay was 5,07 (4–9) days. Complications were observed in six patients (21,5%). Stone-free status was defined as absence of any residual stones during radioscopy at 1 day after the operation or during computer tomography after 3 months. Residual stones  $d \leq 4$  mm and  $> 4$  mm were considered as insignificant and significant respectfully.

Conclusions. Percutaneous nephrolithotripsy is an effective and reliable method of treatment and should be a method of choice in treatment of staghorn stones and large size stones of the kidneys.

## INTRODUCTION

### Вступ

Kidney stone disease is referred to wide spread diseases [10]. According to the literature data its prevalence is 732,8 cases per 100 000 of Ukrainian population [11].

The size, the location of the concretion, the presence of concomitant pathology and related complications determine the degree of negative impacts on kidney function. In case of large kidney stones, insensitive to treatment, the risk of impaired renal function or life-threatening complications increases significantly over time. The high rate of stone-free rate reduces the recurrence rate of urolithiasis without taking into account the size of the concretion [2].

The percutaneous lithotripsy (PNL) has taken its place in the treatment of urolithiasis due to its effectiveness and low frequency of complications [3]. During the last years the usage of minimally invasive techniques, such as: extracorporeal shock-wave lithotripsy (ESWL) and ureteroscopy with contact lithotripsy has significantly increased. However, percutaneous lithotripsy (PNL) remains as a technique of choice among basic methods of treatment of large kidney stones.

Percutaneous nephrolithotripsy was first performed by Fernstrom in 1976 [5]. At present, PNL is ahead of open operations in the treatment of kidney stones. Indications for retrograde intrarenal interventions have significantly expanded, they are considered to be a standard treatment for stones larger than 2 cm.

Due to the fact that often staghorn stones cannot be removed completely, they have a higher frequency of recurrence [6]. Due to their larger size, they require more accesses, which are often accompanied by complications and worse stone-free rates. In the study by Akman et al [4], PNL for staghorn stones was performed on 272 patients, and the average stone-free rate after one intervention was 76.5%. More than one access was performed in 102 (37.5%) cases, a single access was performed in 170 (62.5%) cases. In the studies of El Nahas et al [7] (n=241) and Desai et al [8] (n=1466) it was reported about significant success rates (56.6 and 56.9%, respectively) in the first attempt at PNL performed on staghorn stones.

The presence of concretion branches at all the major calyces or the presence of multiple

concretions in the calyces requires both additional access and repeated surgery. According to the data of measurements, localization of residual concretions, repeated PNL, ESWL or ureteroscopy can be performed. In the study of Akman et al., ESWL was performed on 29 patients after PNL, 3 patients underwent repeated PNL, and 6 patients underwent ureterorenoscopy [4]. El Nahas et al. performed repeated PNL in 30%, EUHL in 17% and stenting of the ureters with a double-J stent, ureteroscopy and open surgery in 10.4% of patients [7]. As the size of the concretions increases, so does the number of accesses depending on the location of the concretions. While increasing the amount of accesses, the frequency of complications also increases, especially the risk of bleeding [4]. According to the literature data, during last years, it has become possible to reduce the frequency of complications due to the use of smaller diameter of nephroscopes.

The most common complications of PNL are fever, bleeding, leakage of urine and the presence of residual stones [1]. In the study of Akman et al. [4] 64 patients had 77 complications. The most common complication was bleeding. Two of the 47 patients underwent selective embolization of the renal arteries because of pseudoaneurysm and arteriovenous fistula. In a group of 119 patients, Netto et al. [9] the complications were observed in 28.5% of patients, which included bleeding and required blood transfusion (n=25), pneumo-hydrothorax (n=2), urosepsis (n=2), intestinal obstruction (n=2) and prolonged leakage of urine (n=2). In our research, the complications were observed after Clavien-Dindo 1 (fever) in 4 patients and after Clavien-Dindo 2 (bleeding requiring blood transfusion) in 2 patients. The overall incidence of complications was 21.5%.

## MATERIALS AND METHODS

### Матеріали і методи дослідження

The treatment cases of 28 patients, who underwent PNL for concretions in the urology clinic of the National Military Medical Clinical Center from April 2016 to March 2020 were retrospectively analyzed. In our study, we evaluated the results and PNL complications in the patients with large stones  $\geq 50$  mm, which were localized in a pelvis and several calyces.

All the patients underwent a standard preoperative examination, which included medical history,

objective examination, general blood test, general urine test, bacteriological urine test if necessary, biochemical blood test to determine the level of urea and creatinine, inspective and excretory urography, computer tomography (CT) (table 1). The control of X-ray time and duration of a surgery were intraoperatively monitored. The frequency and severity of postoperative complications were recorded according to the Clavien-Dindo classification. Postoperatively, urea and creatinine levels were monitored, and radioscopy and CT scans were performed 3 months after the procedure. In addition, the duration of hospitalization and the duration of incapacity for work were recorded. The duration of the operation was defined as the time spent for inserting the cystoscope into the bladder, catheterizing of the ureter, changing the position of the patient's body "on the abdomen", access to the renal collecting system using a needle by a percutaneous method, dilatation and PNL using a

nephroscope. The patients with bacteriuria in the tests were preoperatively treated with antimicrobial therapy until sterile urine was obtained. All the patients underwent intraoperative antibiotic prophylaxis with the use of second-generation cephalosporins or fluoroquinolones. The condition free of concretions was defined as the absence of any residual concretions on radioscopy on the first day after a surgery and on CT in 3 months. Residual concretions of  $\leq 4$  mm and  $>4$  mm were considered insignificant and significant, respectively.

## RESULTS AND DISCUSSION

### Результати та їх обговорення

Twenty-five (89.28%) sick men and three (10.71%) women were included in the study. The average age was  $50.14 \pm 7.38$  (21–79) years. Before the surgery, none of the patients had clinical symptoms of urinary tract infections. In 16

**TABLE 1.** General characteristics of the patients and postoperative complications

Localization of concretions	
Right	13 (46,42%)
Left	15 (53,57%)
The position of the stone	
Pelvis	8 (28,57%)
Upper calyx	3 (10,71%)
Lower calyx	4 (14,28%)
Staghorn	6 (21,42%)
Pelvis + lower calyx	5 (17,85%)
Upper and lower calyces	2 (7,14%)
Irradiation time (min)	$18,4 \pm 4,6$
Operative time (min)	$115 \pm 24,64$
Complications	
Clavien 1	4 (14,3%)
Clavien 2	2 (7,2%)
Clavien 3a	0
Clavien 3b	0
Percentage of complications	21,50%
Stone-free rate for the first day after surgery	
Stone-free rate	19 (67,85%)
Slight residual stones	0
Significant residual stones	9 (32,14%)
Stone-free rate in 3 months after surgery	
Stone-free rate	24 (85,71%)
Slight residual stones	4 (14,28%)
Significant residual stones	0
Hospital stay	5,07 (4–9)
Complete recovery	9 (8–24)

(57.14%) patients before the surgery bacteriuria was detected according to the bacterial cultures data and antimicrobial therapy was prescribed. The average diameter of the concretion was  $56.42 \pm 8.14$  (50–100) mm. The concretions were localized in the right kidney in 13 (46.42%) and in the left kidney in 15 (53.57%) patients. All the patients underwent PNL. The patients were operated on through a single access (n=28). The average time of X-ray irradiation and the average time of a surgery were  $18.4 \pm 4.6$  and  $115 \pm 24.64$  minutes. Hyperthermia (Clavien–Dindo 1, n=4) was observed in 4 patients after the surgery, and bleeding requiring blood transfusion (Clavien–Dindo 2, n=2) was observed in 2 patients. The incidence of complications was 21.5%. At the end of the surgery, all the patients had a double-J stent (table 2).

Pre- and postoperative levels of hemoglobin, urea and blood creatinine are shown in table 2. The average (and limiting) indexes of hospitalization and incapacity for work were 5.07 (4–9) and 9 (8–24) days, respectively.

On the first postoperative day, 19 (67.85%) patients were free of stones, 9 patients (32.14%) had significant residual stones. Then 9 (32%)

patients underwent repeated intervention: ESWL (n=4). In 3 months after repeated intervention 5 (17.86%) patients were staying free of stones; insignificant residual concretions were observed in 4 (14.28%) patients.

On the first postoperative day, 6 patients with staghorn stones were either free of stones (n=5; 83.3%) or had significant residual fragments (n=1; 16.67%). Afterwards one of the patient with significant residual concretion was performed ESWL, in 3 months there was a condition free of concretions. 14 (63.63%) out of 22 (78%) patients with multiple concretions were free of concretions on the first postoperative day, while 8 (36.36%) of them had significant residual concretions. Later on, these 8 patients underwent ESWL (n=3) or urethroscopy (n=5). In three months after re-intervention, 4 (50%) patients were free of concretions, while 4 (50%) patients still had slight residual concretions. The stone-free rate in the patients with staghorn stones and in those, who had staghorn and multiple calyces stones was 83.3% and 63.63% ( $p < 0.05$ ), respectively; while after 3 months these figures were 100 and 81.81%, respectively ( $p > 0.08$ ) (table 3).

**TABLE 2.** Blood parameters before and after surgery and X-ray examination

	Preoperative	Postoperative	p*
Hb (g/l)	142 (117–159)	119 (94–132)	<0,005
Urea (mmol/l)	7,23 (5,13–11,4)	7,36 (5,97–10,2)	>0,05
Creatinine ( $\mu$ mol/l)	89 (74–138)	93 (87–152)	>0,05
Inspective intravenous urography	28 patients	19 patients (stone free index 67.85%)	<0,005
CT	28 patients	4 patients (stone free index 85.71%)	<0,005

**TABLE 3.** PNL results for staghorn concretions and multiple concretions of calyces

	Staghorn concretion	Multiple concretions of calyces
Number of patients	6	22
Stone-free rate		
Stone-free rate on the first try	5 (83,3%)	14 (63,63%)
Stone-free rate in general	6 (100%)	18 (81,81%)
Slight residual stones	0	0
Significant residual stones	1 (16,67%)	8 (36,36%)
Additional treatment		
Urethroscopy with contact lithotripsy	0	5 (22,72%)
Extracorporeal shock wave lithotripsy	1 (16,67%)	3 (13,63%)
Percutaneous nephrolithotripsy	0	0
Complications		
Clavien 1	1 (16,67%)	3 (13,63%)
Clavien 2	0	2 (9,09%)
Clavien 3a	0	0
Clavien 3b	0	0

No difference was found between the duration of hospitalization, the duration of incapacity for work, the frequency of complications, the duration of surgery and X-rays.

However, in our study, the initial success rate was 85.71% and subsequently it decreased to 63.63% with multiple calyces stones. The general average stone-free rate after the first intervention in our study was 67.85%. In our study, we performed ESWL in 4 (14%) cases and ureteroscopy in 5 (17%) cases for the patients with residual stones. In 3 months during the control examination after re-intervention, 5 (17.85%) patients got free of concretions, while 4 (14.28%) patients had insignificant residual concretions (less than 3 mm). The general stone-free rate was 85.71%. Even with the concretions larger than 50 mm, where there was a low success rate, additional interventions allowed to improve progress. Thanks to this approach, it became possible to reduce the frequency of complications. While dealing with single concretions, PNL is more effective in comparison with multiple concretions of calyces, however the frequency of complications does not differ essentially.

## CONCLUSIONS

### Висновки

When performing PNL, the frequency of complications increases with the increasing number of interventions. In the cases of large kidney stones, the use of repeated staged PNL or additional methods such as ESWL, and ureteroscopy with contact lithotripsy allows to achieve a state free of stones with a low frequency of complications.

The limitation of this research is related to the small group of the patients and the retrospective nature of the study. Despite the implementation of a technique without drainage, we offer to use a double-J stent in combination with nephrostomy in all the cases, taking into account the large size of the concretion.

In spite of the need of multiple accesses, the necessity for additional techniques usage and the increasing frequency of complications, PNL remains an effective and reliable method of treatment of kidney stones  $\geq 50$  mm in size. With the improvement of PNL technique, and the implementation of a technique without drainage, the frequency rate of the condition free of concretions increases, the duration of hospitalization and days of incapacity for work gradually decreases. PNL allows to achieve the best frequency of a condition free of concretions in the treatment of staghorn concretions and large kidney stones in comparison with multiple concretions of calyces.

Informed Consent: All the patients included in this study signed an informed consent.

Perspectives for further researches – further increasing of the number of surgical interventions and studying of the effectiveness in the treatment of urolithiasis are planned.

There is no conflict of interest.

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## РЕФЕРАТ

### Досвід перкутанної нефролітотрипсії каменів нирок великих розмірів

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Актуальність. Сечокам'яна хвороба належить до розповсюджених захворювань. Згідно з даними літератури, в Україні її частота становить 732,8 на 100 000 населення. За останні роки значно збільшилось застосування мінімально інвазивних методик, таких як екстракорпоральна ударно-хвильова літотрипсія (ЕУХЛ) та уретероскопія з контактною літотрипсією; однак ПНЛ залишається операцією вибору серед основних методик лікування конкрементів великих розмірів.

Мета: Оцінити ефективність перкутанної нефролітотрипсії (ПНЛ) каменів нирок розмірами більше 50 мм.

Матеріали і методи: в дослідження увійшли 28 (двадцять вісім) хворих, із них двадцять п'ять (89,28%) чоловіків та три (10,71%) жінки, з наявністю конкрементів нирок розмірами >50 мм, які лікувались в НВМКЦ з квітня 2016 по березень 2020 року. Досліджувались показники stone-free rate (стан, вільний від конкрементів) та частота ускладнень.

Результати: У тринадцяти (46,42%) випадках конкременти знаходились у правій нирці та у п'ятнадцяти (53,57%) у лівій нирці. У дев'ятнадцяти (67,85%) хворих не залишалось резидуальних конкрементів, а у дев'яти (32,14%) мали місце резидуальні конкременти. У 4 пацієнтів (14%) була проведена екстракорпоральна ударно-хвильова літотрипсія, у 5 (17%) випадках – контактна літотрипсія резидуальних конкрементів, що мігрували в нижню третину сечоводу. Після повторного втручання у 5 випадках (17,86%) спостерігався стан, вільний від конкрементів. Показник stone-free rate становив 85,71%. Середня тривалість оперативного втручання складала  $115 \pm 24,64$  хв. Рівень гемоглобіну до - та після оперативного втручання становив 142 (117–159) г/л та 119 (94–132) г/л відповідно ( $p < 0,005$ ). Тривалість госпіталізації склала 5,07 (4–9) днів. Ускладнення спостерігались у шести хворих (21,5%). Стан, вільний від конкрементів, визначався як відсутність будь-яких резидуальних конкрементів при рентгеноскопії на 1-й день після операції та при КТ через 3 місяці. Резидуальні конкременти розміром  $\leq 4$  мм та  $> 4$  мм вважались несуттєвими та суттєвими відповідно.

Висновок. Перкутанна нефролітотрипсія є ефективним та надійним методом лікування та повинна бути методом вибору у лікуванні коралоподібних конкрементів нирок та конкрементів нирок великих розмірів.

**Ключові слова:** перкутанна нефролітотрипсія, сечокам'яна хвороба, коралоподібні конкременти.