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**D.M. Ivashchenko, M.O. Dudchenko, M.I. Kravtsiv, M.P. Shevchuk, H.O. Ivanova**
**Poltava State Medical University, Poltava**

## RETROGRADE INTRARENAL SURGERY AS A METHOD OF IMPROVING THE ENDOSCOPIC MANAGEMENT OF OCCLUSIVE CONCREMENTS OF THE UPPER PARTS OF THE URETER

e-mail: d.ivashchenko@pdmu.edu.ua

The paper presents upper ureter stone treatment with use of retrograde intrarenal surgery. This is the latest method, which has advantages in treatment of complex cases of nephrolithiasis, stone translocations and residual cases. We analyzed treatment of patients with ureteral stones. Two representative groups were formed and underwent surgical interventions. Patients of first group underwent contact lithotripsy with semi-rigid ureteroscope, in patients of group 2 used flexible ureteroscope. We compare total operation time, average size and density of stones, presence of residual fragments, surgical and postoperative complications. Performing lithotripsy using a retrograde intrarenal surgery provides higher frequency of achieving "stone-free state", which is the ultimate goal of intervention. Also, this is a method that has fewer intraoperative complications, but has a slightly longer duration of surgical intervention. The use of combination of retrograde intrarenal surgery and semi-flexible ureteroscopy should facilitate operations, speed up patient recovery and minimize complications.

**Key words:** ureteral stones, retrograde intrarenal surgery, lithotripsy, flexible ureteroscopy.

**Д.М. Іващенко, М.О. Дудченко, М.І. Кравців, М.П. Шевчук, Г.О. Іванова**

## РЕТРОГРАДНА ІНТРАРЕНАЛЬНА ХІРУРГІЯ ЯК МЕТОД ПОЛІПШЕННЯ ЕНДОСКОПІЧНОГО МЕНЕДЖМЕНТУ ОКЛЮЗУЮЧИХ КОНКРЕМЕНТІВ ВЕРХНІХ ВІДДІЛІВ СЕЧОВОДУ

У роботі представлено аналіз результатів лікування конкрементів верхніх відділів сечоводу за допомогою ретроградної інтраренальної хірургії. Це новітній метод, який має переваги в лікуванні складних випадків нефролітіазу, особливо при транслокації конкрементів і резидуальних формах нефролітіазу. Проведено аналіз лікування пацієнтів із конкрементами сечоводу. Пацієнтам першої групи проводили контактну літотрипсію напівжорстким уретероскопом, у хворих другої групи використовували гнучкий уретероскоп. Визначали загальну тривалість операції, середній розмір і щільність конкрементів, наявність залишкових фрагментів, виникнення інтраопераційних і післяопераційних ускладнень. Проаналізувавши дані, виявили, що виконання літотрипсії методом ретроградної інтраренальної хірургії забезпечує більш високу частоту досягнення стану «stone-free», що є метою оперативного втручання. Також це метод, який має менше інтраопераційних ускладнень, але є технічно складнішим для освоєння та має трохи більшу тривалість оперативного втручання. Вірний напрямок на майбутнє – поєднання ретроградної інтраренальної хірургії та напівгнучкої уретероскопії, що має полегшити операції, прискорити одужання пацієнтів та мінімізувати ризики ускладнень.

**Ключові слова:** конкременти сечоводу, ретроградна інтраренальна хірургія, літотрипсія, гнучка уретероскопія.

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At this stage of development of medicine, the tactics for removing kidney stones and stones of the ureteropelvic segment are described in sufficient details in modern recommendations. Depending on the characteristics and location of the stones, the constitutional characteristics of the patient, and concomitant diseases, one or another treatment method is used – distant lithotripsy, laparoscopic operations, retrograde or percutaneous lithotripsy.

Ureteroscopy is a method originally developed as an addition to cystoscopy, but at the moment it is leading in the treatment and diagnosis of urolithiasis. It is generally accepted that the first ureteroscopy was performed in 1912, using a rigid cystoscope. The first ureteroscope used in clinical practice was invented by Richard Wolf company. And in 1980, the first ureterolithoextraction was performed.

One of the turning points in the history of ureteroscopy was the development and introduction into practice of fiber optic technologies, which led to the development of flexible ureteroscopes. In 1964, Marshall described the first performance of flexible ureteroscopy. In 1971, Takagi described the use of the first flexible ureteroscope, and in 1987, Bagley, Huffman and Lyon introduced the flexible ureterorenoscope as it is known today. In 1992, the last necessary condition for performing operations appeared – a holmium laser, which ensured safe and effective crushing of stones in all parts of the urinary tract [11]. This has allowed flexible ureterorenoscopy to take a leading place in the treatment of patients with kidney and ureteral stones [10].

It is important to consider the issue of using retrograde flexible interventions when there are contraindications for percutaneous operations, such as taking anticoagulants, anatomical features, and small size of stones. Although there are a number of publications describing the results of effective surgical treatment of patients with renal stones larger than 2 cm using retrograde intrarenal surgery (RIRS), although in some situations multiple procedures were required to achieve stone-free condition [2, 15]. The percutaneous method is often impossible to use for stones combinated with elongated narrow calyx necks, postoperative cicatricial changes in the kidneys, and skeletal deformities. In this regard, we have to look for new ways to remove “problem” stones, combining the use of tools and techniques.

In most cases, treatment of kidney stones and ureteropelvic stones is carried out through a retrograde or percutaneous approach using rigid instruments. But often access to some areas of the collecting system is possible only with the help of flexible instruments. This is especially necessary for coral-shaped forms of nephrolithiasis – fragmentations, extractions of spurs, stones and fragments of the upper third of the ureter, in patients with kidney anomalies.

An effective method for treating stones of the ureteropelvic segment and the upper third of the ureter is a one-stage combination of semi-rigid and flexible endoscopic approaches, which is what we wanted to show and explore in our work. Combining accesses and techniques is a promising direction and a very pressing issue that is currently being actively discussed.

**The purpose** of the study was to establish the efficacy of retrograde intrarenal surgery using a flexible endoscope in the treatment of patients with occluding stones of the upper compartments of the ureter.

**Materials and methods.** The work analysis was carried out based on the results of surgical interventions carried out in years 2021–2023 at the clinical bases of the department in the CE “2-nd City Clinical Hospital” and CE “3-rd City Clinical Hospital” in patients with the development of kidney obstruction, the clinical picture of renal colic and the presence of inflammatory changes in the kidney on the background of occlusion.

The first group consisted of 22 patients (9 men and 13 women, with an age distribution of 29–68 years). The average duration of illness before hospital admission was 5±3.1 days. In 14 patients (63.6 %), signs of pyelonephritis were detected, such as an increase in temperature to febrile levels (more than 38 degrees Celsius), a positive “tapping” symptom and the presence of signs of nephritis on ultrasound examination and computed tomography (thickening of the parenchyma, presence of perinephric effusion) [12, 13].

The second group consisted of 20 patients (8 men and 12 women with an age distribution of 31–73 years). The average duration of illness before hospital admission was 4±2.8 days. 11 patients (55 %) showed signs of pyelonephritis.

Patients in both groups underwent surgical interventions in two stages. The 1st stage included pyelovesical stenting, performed under local anesthesia “Katejel” in women, and under intravenous sedation in men. Rush stents were used, most of them with a size of 6 Fr; in 8 cases (19 %) out of 42, due to technical necessity and difficulties of implementation, stents with a size of 4.8 Fr were used. For accurate control of stent installation, ultrasound diagnostics with primary control of the position of the nitinol string in the renal cup and subsequent control of the stent position were sufficient in all cases. This made it possible not to use a C-arch at this stage and not to additionally irradiate patients [7].

The 2-nd stage of surgery was performed within 14–20 days from the first stage. This was due to the need to heal an inflammatory process, according to well-known clinical protocols for the treatment of pyelonephritis, and the need to relax the ureter to ensure the ability to pass the ureteroscope into the renal pelvis and be able to work in the obstruction zone.

Patients of the first group underwent contact laser lithotripsy using a MultiPuls 30W holmium laser. (fiber diameter 400 μm.), using semi-rigid ureteroscopes R.Wolf and Olympus, diameter 9.0 Fr. For patients in the second group, the 2-nd stage was performed using a flexible ureteroscope from Innovex, size 8.5 Fr (laser fiber diameter 200 μm). To do this, a 12/14 Fr amplatz was first installed into the ureter up to the upper third [4]. Contact lithotripsy in both groups was performed in the dusting mode, but if fragments larger than 3–4 mm were formed, they were evacuated with forceps or a Dormea basket.

To evaluate the effectiveness of the methods used, the total operation time, the average size and density of stones, the presence of residual fragments, and surgical and postoperative complications were determined.

Results of the study were statistically processed by using the Microsoft Excel package and Statistika 8.0. package with the calculation of the student's criterion. Specificity, sensitivity and accuracy of the study were calculated using generally accepted formulas.

**Results of the study and their discussion.** Based on the results of the investigation, the current data can be assessed. The density of stones, size and location were determined based on the results of computer tomography of the abdomen in native mode. The size of the stones in group 1 was 1.2±0.64 cm, in group 2 was 1.12±0.73 cm. The localization of stones in 28 patients (66.6 %) was the upper third of the ureter, no stones beyond the lower pole of the kidney. The localisation was the ureteropelvic segment in 14 patients (33.4 %). More details are shown in Table 1.

Table 1

**Characteristics and localization of stones**

| Index | Group 1 (n=22) | Group 2 (n=20) |
|---|---|---|
| Average size of stones (cm) | 1.2±0.64 см | 1.12±0.73 |
| Hardness of stones (HU) | 1208±223 | 1156±289 |
| Localization of stones in the upper third | 14 (63.6 %) | 14 (70 %) |
| Localization of stones in the ureteropelvic segment | 8 (36.4 %) | 6 (30 %) |
| Migration into the pelvic system during stenting | 7 (31.8 %) | 8 (40 %) |

When performing the first stage (stenting) in patients with stones of the upper third, migration of the stone into the renal pelvic system was observed in 5 patients (17.8 %), in other cases – 23 patients (82.2 %) the stones remained in their location. Among patients with stones of the ureteropelvic segment, migration was observed in 10 patients (71.4 %), and only in 4 cases (28.6 %) the stone did not change its position. The explanation for this is in the structure and appearance and size of the stone. Small stones and those with a smooth surface are more susceptible to migration. In cases where an attack of colic occurred for more than 5–6 days, such stones practically did not migrate into the renal pelvic system, due to their fixation in the wall of the ureter in the presence of edema. In the same cases, it was sometimes impossible to perform stenting with a 6 Fr stent, and it was necessary to use a 4.8 Fr size, since it passes more easily into the site of penetration of the nitinol wire. In these groups, we did not observe cases of total occlusion, which would not allow the string to be inserted and would require nephrostomy as the first stage of medical care.

At the 2-nd stage of the surgical intervention, which was performed on all patients under spinal anesthesia (this made it possible to perform operations at a decompensation of cardiac and pulmonary diseases and, in general, to reduce the number of contraindications to radical intervention), the stents was first removed with forceps using a ureteroscope.

Next, in group I, ureteroscopy was performed with a semi-rigid ureteroscope, the purpose of which was to visualize the stone. In 19 cases this was possible; the calculus was either at the site of its original location or was in the renal pelvis. In 3 cases (13.6 %) of 22 patients, during ureteroscopy, the ureter and renal cups were inspected along the ureteroscope and the possibility of its mobility, but no calculus was found. In such cases, the first step was to reposition the patient on the operating table so that the pelvis was the lowest point of the kidney, and secondly, the pelvis system was washed with sterile saline solution under pressure so that the calculus migrated with a flow of water into the “reach zone”. In 2 (9 %) patients this had an effect and the stone became accessible, but in 1 case (4.5 %) the manipulations were not successful and the fact of a residual stone of the lower cup was stated. Crushing of stones was carried out in the “dusting” mode, with fiber with a diameter of 400 microns, power 20 W, frequency 15 Hz. This mode allows you to carefully, moving from the edge of the stone, crush it into small sand-like slices less than 1 mm, and at the same time should minimize the risks of pushing stones into cups and crushing them into fragments ahead of time. The mean duration of surgery was 96±28 minutes. Moreover, in 8 cases during lithotripsy (with most stones of lower density), fragments of 4–6 mm in size arose, which migrated into the renal calyces. After completion of fragmentation of the main part of the stone, these fragments

required further location and extraction, which delayed the operation time, and in 3 patients (13.6 %) we noted residual fragments in the lower calyces in the postoperative period.

In 2-nd group, the operation after stent removal continued with the installation of 12/14 Fr amplatz into the ureter up to the upper third under X-ray control on the C-arch. After this, a flexible ureteroscope was inserted into the calculus of the upper third of ureter or into the pelvis of the kidney along a string. In this group, the localization of stones had no practical significance for lithotripsy, because by rotating and bending the flexible instrument, we gradually visualized all the calyces of the kidney and found the stone in 100 % of cases. In this group, a 200 μm fiber was used for lithotripsy (the fiber size is limited by the instrumental channel) with the same power parameters, but due to the half the diameter, the lithotripsy force was slightly reduced and more time was spent on the stone crushing stage (Fig 1).

The mean duration of surgery was 108±17 minutes. But at the same time, there was no problem of the presence and search of fragments, because any fragment of 4–5 mm could either be crushed separately in the cup where it was displaced, or pulled out through the amplatz using a Dormea basket. The operation time also increased slightly due to the need to get used to the flexible equipment and the features of its operation. This, in our experience, was observed during the first 9–11 operations; later – navigation did not cause any problems. At the end of the surgical intervention, patients in both groups received 6 Fr stents for a period of 2 weeks.

In the postoperative period, 4 cases of fever (18 %) were observed in group I, and 3 cases (15 %) in group 2. All these cases required antibacterial therapy and were resolved within 5 days without affecting the functioning of the renal parenchyma according to laboratory tests [6, 9].

Postoperative hematuria was not pronounced and resolved in all patients until the next day. Patients from both groups were discharged the next day after the control ultrasound, followed by a 5-day prescription for antibacterial prophylactic treatment. Only 7 patients (16.6 %) of the total were discharged more than after 1-st day, due to treating of a hyperthermic reaction. Operations outcomes are shown at the Fig 2.

Fig. 1. Stone lithotripsy with flexible ureteroscope in renal cup

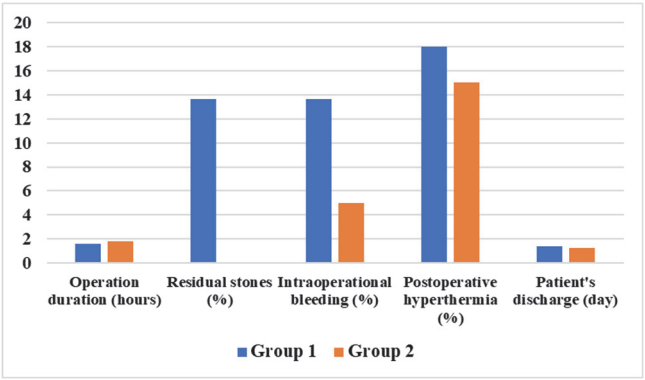


Fig. 2. Operations outcomes.

Analyzing the study, we can say with confidence that the use of the not yet widespread RIRS technology already has several serious advantages over the proven methods of semi-flexible and percutaneous lithotripsy [3, 14]. RIRS as a method is indicated for kidney stones up to 2 cm, because it allows you to avoid puncture of the skin and the risk of intra- and postoperative complications, and when compared with traditional lithotripsy, it allows you to avoid residual pieces after crushing and the risk of migration of stones into cups inaccessible for inspection [1, 5]. The disadvantage of this method is its high cost due to complex equipment. In this case, a combination of techniques looks promising, when the operation is performed with a semi-rigid ureteroscope, and if the need arises, at certain stages of the operation a flexible endoscope is used to finally achieve the “stone free” state.

Analyzing complications during operations and in the postoperative period, it was revealed that in group 1, bleeding from the renal pelvis was observed intraoperatively in 3 patients (13.6 %). We attribute this to the fact that when using a semi-rigid ureteroscope there are restrictions on the angles of its movement and sometimes damage to the inner layer of the kidney is possible. In all cases, the bleeding continued for up to 10 minutes; a blood clot formed inside the pelvis, which we then washed away using a syringe through the ureteroscope. In conclusion, these events had no impact on the operation result, although they did complicate visualization during subsequent lithotripsy. In group 2, such complication occurred in 1 patient (5 %), and was most likely associated with laser work in the cup and direct damage to the vessel. The severity of the bleeding was not significant and did not affect the course of the operation, except for visualization [8].

## Conclusions

1. Performing lithotripsy using the method of retrograde intrarenal surgery provides a higher frequency of achieving the stone-free state, which is the ultimate goal of surgical intervention.

2. According to our data, retrograde intrarenal surgery is a method that has fewer intraoperative complications, but is technically more difficult to master and has a slightly longer duration of surgical intervention.

3. The combination of retrograde intrarenal surgery and semi-flexible ureteroscopy should facilitate operations, speed up patient recovery and minimize the risks of complications.

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