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Original Article

# The Role of Retrograde Intrarenal Surgery in Kidney Stones of Upper Urinary System Anomalies

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## Abstract

**Introduction:** Fusion, pelvic, and duplicated urinary tract anomalies of the kidney are rarely seen. There might be some difficulties in the stone treatment, in the administration of extracorporeal shockwave lithotripsy (ESWL), retrograde intrarenal surgery (RIRS), percutaneous nephrolithotomy (PCNL), and laparoscopic pyelolithotomy procedures in these patients due to the anatomical variations in kidneys with anomalies.

**Aim:** To evaluate RIRS results on patients with upper urinary tract anomalies.

**Materials and methods:** Data of 35 patients with horseshoe kidney, pelvic ectopic kidney, and double urinary system in two referral centers were reviewed retrospectively. Demographic data, stone characteristics, and postoperative characteristics of the patients were evaluated.

**Results:** The mean age of patients (n=35, 6 women and 29 men) was 50 years. Thirty-nine stones were detected. The total mean stone surface area in all anomaly groups was found to be 140 mm$^2$, and the mean operative time was 54.7±24.7 minutes. The rate of using ureteral access sheath (UAS) was very low (5/35). Eight patients needed auxiliary treatment after the operation. The residual rate, which was 33.3% in the first 15 days, decreased to 22.6% in the third month follow-ups. Four patients had minor complications. In patients with horseshoe kidney and duplicated ureteral systems, it was observed that the risk factor increasing the presence of residual stones was the total stone volume.

**Conclusions:** RIRS for kidneys with low and medium stone volume anomalies is an effective treatment method with high stone-free and low complication rates.

## Keywords

horseshoe kidney, kidney stones, pelvic kidney, ureteroscopy, ureteral duplication

## INTRODUCTION

Congenital anomalies of the urinary tract are seen in approximately 3.3% to 11.1% of the population. Horseshoe kidney (HSK) is the most common renal anomaly with an incidence of 1/400. After impaired drainage of the kidney, urinary tract infections and kidney stone disease are more common in HSK anomaly than in people with normal kidneys.[1] Although urinary stasis is thought to be the main cause of kidney stone formation in HSK, metabolic anomalies in 30% of patients in one study[2], and infection in 41% of patients in another[3], were observed. It is noticed that stone formation is not only dependent on malformation. The incidence of ectopic kidney is approximately 1:3000. One of the most common causes of ureteropelvic junction obstruction in patients with ectopic pelvic kidney is nephrolithiasis.[4] The most common renal congenital anomaly of the upper urinary tract is duplication of the renal collecting system, with an incidence of 0.3%–0.8%. The incidence of stone disease in the duplex system is 3%–8%.[5]

It is difficult to reach stone localizations with endourological procedures due to the anomaly. High placement of the uretero-pelvic junction due to the parenchyma of the isthmus region, decreased deflection capability of the flexible ureteroscope due to insufficient space in the renal pelvis, inaccessibility to the calices of the lower and isthmus region due to angular disadvantage, difficulty in managing the flexible ureterorenoscope device due to short ureter in ectopic kidneys are some of the anatomical obstacles. Treatment methods such as extracorporeal shock wave lithotripsy (ESWL) and percutaneous nephrolithotomy (PCNL) are well defined in kidneys with anomalies, but there may be lower success rates or higher complication rates than normal kidneys due to technical difficulties.[6,7] The indications of flexible ureterorenoscopes (FURS) have expanded with advancements in technology and techniques. With the development of fine-caliber endoscopes with high deflection capabilities combined with Holmium:YAG laser technology, fiber lasers, and nitinol stone baskets, there is a chance for endoscopic lithotripsy in the treatment of urinary tract anomalies.[8,9]

## AIM

The aim of this study was to evaluate the retrograde intrarenal surgery (RIRS) results in patients with upper urinary tract anomalies. It appeared to be very difficult to conduct randomized studies with a high level of evidence due to the low incidence of abnormal kidneys. Most of published studies are retrospective. Therefore, in this study, we aim to contribute to the scientific knowledge by presenting our two-center RIRS experiences of stone disease treatments in anomalous kidneys.

## MATERIALS AND METHODS

Following the Helsinki Declaration and waiver of informed consent, we retrospectively reviewed the records of patients who underwent RIRS treatment of kidney stone disease with upper urinary system anomalies in two referral centers between January 2013 and December 2020. We included patients with horseshoe kidneys, ectopic kidneys, and duplicated collecting system. Patients with rotation and other kidney anomalies and pediatric patients were not included in the study. Preoperative demographic data, intraoperative and postoperative variables, treatment success, complications, stone characteristics, and predictive risk factors for residual stones were evaluated. During the preoperative period, urinalysis, urine culture-antibiogram, extensive biochemical tests including blood creatinine values and imaging tests including x-ray, urinary system ultrasonography, non-contrast computerized tomography (NCCT) **(Fig. 1)**, and/or intravenous pyelography (IVP) were performed in all patients. Patients with pathogenic bacterial agents underwent surgery when the urine was cleared of microbial agents after appropriate antibiotic therapy. In this study, the stone size was given as the stone surface area (mm$^2$) by calculating the width and length of the stone. Complications were classified according to the modified Clavien classification system. Patients were invited to the outpatient clinic follow-ups in the first week, first month, and three months postoperatively. X-ray and USG imagings were used in the first follow-up. However, NCCT imaging was definitely performed at the first month and 3rd-month follow-ups **(Fig. 2)**. The establishment of complete stone-free status was taken as the basis for determining the presence of residue.

### RIRS procedure

The patients were placed in the dorsal lithotomy position after general anesthesia. The surgical site disinfection was performed by opening the leg on the contra side of the involved kidney wider downwards and laterally. Areas outside the surgical field were covered with surgical sterile drapes. Then, the surgical field was entered from the external urethral meatus with a 7.5 semi-rigid ureterorenoscope (Richard Wolf, Germany) under endovision. After

**Figure 1.** Preoperative CT scan of horseshoe kidney stone.



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**Figure 2.** CT scan of horseshoe kidney stone at three months.

**Figure 3.** Fluoroscopic view of flexible ureterorenoscope and kidney stone.

detecting the related ureter in the bladder, a 0.038-inch guide hydrophilic wire was advanced proximally in the direction of the kidney under fluoroscopy. With a semi-rigid ureteroscope, ureter dilatation was performed by entering the lower end of the ureter over the guidewire, and diagnostic-ureterorenoscopy was performed at the lower end of the ureter. After dilation, an attempt was made to advance a 9.5/10.5 fr or 11/13 fr ureteral accessory sheath (UAS) (Boston Scientific, USA) over the guidewire under fluoroscopy view. A flexible ureterorenoscope (Flex-X2; STORZ, Tuttlingen, Germany) was advanced over the guidewire in patients in whom the UAS could not be advanced from the lower ureteral end **(Figs 3, 4)**. When the endoscope reached the stone, stone fragmentation was performed with the Holmium:YAG laser (Boston Scientific, USA) in dusting lithotripsy and/or hard stones lithotripsy mode at 8-15 Hz and 1-1.5 joule energy range **(Fig. 5)**. Large particles >4 mm were extracted with a nitinol basket catheter (Karl Storz, Tuttlingen, Germany). After lithotripsy, stone-free status was observed with fluoroscopy and endovision follow-up. DJ stent was placed for drainage in most of the patients after the procedure. One-night 5f ureteric catheter drainage was used for some patients, with a small stone burden and no laceration in the ureter. The patients came for follow-up in the first week, at 1 month, and at 3 months after operation. Patients who were found to have residual stones were again benefited from auxiliary methods such as RIRS, ESWL, and laparoscopic pyelolithotomy.

**Figure 4.** Retrograde pyelography of horseshoe kidney under fluoroscopy.

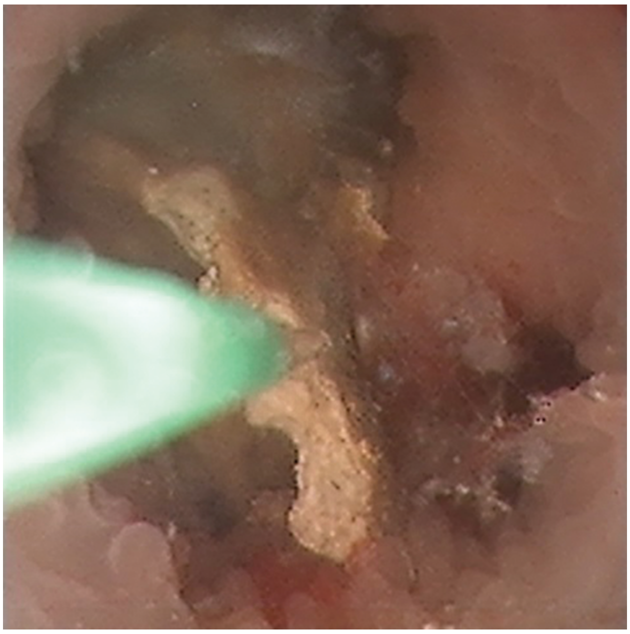

**Figure 5.** Stone fragmentation with Holmium:YAG laser.

## Statistical analysis

All data were loaded into the SPSS 22.0 statistical program. Continuous data were presented with mean ± standard deviation values after descriptive analysis, and categorical data were presented as percentages and numbers. Binary logistic regression analysis was performed to detect effective predictive factors in the presence of residual stones in kidneys with anomalies. Results below $p<0.05$ were considered significant after univariate and multivariate analyses. Possible predictive factors and $p$ values of the exact predictive factor, odds ratio, and 95% confidence intervals were given.

# RESULTS

A total of 35 patients, 18 with horseshoes, 7 with pelvic ectopic, and 10 with duplicate collecting system, were included in the study. Although the highest mean age was in the duplicate system patient group, the overall mean age was 50 (23-70) years. The majority of our patients were male (6 women, 29 men), with a mean body mass index (BMI) of 27.2 (18-41). Twenty-one (60%) of the stones were in the left kidney and 14 (40%) were in the right kidney. There were 39 stones in total, 20 stones in 18 patients in the horseshoe kidney group, 9 stones in 7 patients in the ectopic kidney group, and 10 stones in 10 patients in the double collecting system patient group. The mean stone size was higher in the pelvic kidney group than in the other groups, and the total mean stone surface area was 140 (48-266) $mm^2$ in all anomaly groups **(Table 1)**.

**Table 1.** Demographic and stone classifications

| | Horseshoe | Ectopic | Duplicated | Total |
|---|---|---|---|---|
| Patient No, n (%) | 18 (51%) | 7 (20%) | 10 (29%) | 35 |
| Age, mean ± SD | 48.5±12.8 | 48.7±14.5 | 55.6±6.5 | 50 (23-70) |
| Gender, n (%) | | | | |
| – Female | 3 (17%) | 0 | 3 (30%) | 6 (17%) |
| – Male | 15 (83%) | 7 | 7 (70%) | 29 (83%) |
| BMI, mean±SD | 27.3±6.1 | 27.8±3.1 | 26.4±3.2 | 27.2±4.2 |
| Stone side, n (%) | | | | |
| – Right kidney | 11 (61%) | 1 (14%) | 2 (20%) | 14 (40%) |
| – Left kidney | 7 (29%) | 6 (86%) | 8 (80%) | 21 (60%) |
| Stone number, n (%) | | | | |
| – Upper calyx | 2 (10%) | 0 | 3 (30%) | 5 (13%) |
| – Middle calyx | 3 (15%) | 1 (11%) | 0 | 4 (10%) |
| – Lower calyx | 9 (45%) | 3 (33%) | 4 (40%) | 16 (41%) |
| – Renal pelvis | 6 (30%) | 4 (44%) | 0 | 10 (26%) |
| – UPJ | 0 | 1 (11%) | 3 (30%) | 4 (10%) |
| – Total | 20 | 9 | 10 | 39 |
| Stone size, ($mm^2$), mean (min-max) | | | | |
| – Upper calyx | 91.5 (78-105) | - | 212 | 131 (79-212) |
| – UPJ | - | 50 | - | 64 (50-78) |
| – Middle calyx | 114 (92-118) | 79 | 79 | 100 (78-118) |
| – Lower calyx | 126.5 (79-192) | 99.6 (79-126) | - | 119 (50-192) |
| – Pelvis | 121.7 (22-197) | 178 (142-236) | 93 (48-141) | 131 (22-236) |

The mean total operative time was higher in the group with the doubled system, the mean operative time in all groups was found to be 54.7±24.7 minutes. Again, in the duplicate system, the fluoroscopy time was higher, and the total mean fluoroscopy time was 0.89±0.24 seconds. Postoperatively, DJ stent was used for drainage in 32 patients (91.4%). The rate of using UAS was very low (5/35), and UAS was not used in any of the patients in the pelvic ectopia group. The mean hospital stay was 32 (18-52) hours. The mean visual analog scale (VAS) score on postoperative day 1 was 4.2 (3-8). In the morning of the first postoperative day, all patients were relieved of the urethral tube. Eight patients needed auxiliary treatment after the operation. RIRS was the most preferred auxiliary treatment. We performed laparoscopic pyelolithotomy for residual stones in 1 patient from the horseshoe kidney anomaly group and in 2 patients from the pelvic ectopic group. Our residual rate, which was 33.3% in the first 15 days, decreased to 22.6% during the 3rd month follow-ups. At the end of 3 months, our total stone-free rate was calculated as 77.4%. There were no major complications in the peri- and postoperative period. We detected minor complications in 3 patients in the horseshoe group. Intravenous antibiotic therapy was administered for the patients with postoperative fever (grade 1 and 2) **(Table 2)**.

A logistic regression model was created to evaluate the independent risks of different variables affecting the presence of residual stones in the abnormal upper urinary tract. The correlations between the variables were evaluated. Age, gender, BMI, stone side, lower calyx stones, total stone volume, operation time, DJ stent use, UAS use, and anomaly type are the variables included in the model. Total stone volume was a predictive factor for stone free ratio (SFR) in univariate and multivariate analyses of horseshoe and duplicated ureter subgroups [multivariate analysis, odds ratio results, respectively; ORs, 95% CI and p: 2.2 (0.8-3.7) and 1.4 (0.8-3.1)] **(Table 3)**.

## DISCUSSION

Due to vascular abnormalities, different anatomical relationships with adjacent organs, ureter and renal pelvis anomalies, stone free, and complication rates may be different from normal anatomical kidneys after ESWL, PCNL, and RIRS. For instance, the success of ESWL may be accounted to the localization of the stones and the increase in the skin-stone distance due to the overlying bone structures and interposed intestinal gases. Even though stone fragmentation is successfully performed, impaired renal drainage makes the passage of fragments difficult and may decrease stone-free rates.[11,12]

Likewise, due to vascular and calyceal abnormalities and different anatomical proximity to the organs adjacent to the kidney, an increased risk of complications during PCNL, and a longer access tract requirement may be observed as

**Table 2.** Operative and postoperative classifications

| | Horseshoe kidney | Ectopic kidney | Duplicated ureter | Total |
|---|---|---|---|---|
| Operation time, mean±SD | 50.0±14.9 | 57.2±35.3 | 63.6±32.3 | 54.7±24.7 |
| Insertion of DJ stent, n (%) | 16 (89%) | 6 (86%) | 10 (100%) | 32 (91.4%) |
| Use of UAS, n (%) | 3 (17%) | 0 | 2 (20%) | 5 (14%) |
| Fluoroscopy time, mean±SD | 0.74±0.32 | 0.90±0.22 | 1.05±0.18 | 0.89±0.24 |
| Hospital stay, hours, mean (min-max) | 30 (22-44) | 34 (20-54) | 28 (18-52) | 32 (18-52) |
| VAS score, mean (min-max) | 4.2 (3-7) | 3.7 (3-6) | 4.5 (4-8) | 4.2 (3-8) |
| Auxiliary treatment, n (%) | | | | |
| – ESWL | 1 (25%) | - | - | 1 (12.5%) |
| – RIRS | 2 (50%) | 1 (33%) | 1 (100%) | 4 (50%) |
| – PNL | - | - | - | - |
| – Pyelolithotomy | 1 (25%) | 2 (77%) | - | 3 (37.5%) |
| – Total | 4 | 3 | 1 | 8 |
| Residual stone, n (%) | | | | |
| – First month | 5 (27.8%) | 4 (57%) | 1 (14.3%) | 10 (32.3%) |
| – Third month | 4 (23.5%) | 2 (28.5%) | 1 (14.3%) | 7 (22.6%) |
| Complications, total n (%) | 3 (17%) | 0 | 1 (10%) | 4 (11%) |
| Modified Clavien Classifications | | | | |
| – Stage 1 | Pyrexia (2) | | - | 2 |
| – Stage 2 | Pyrexia+Antibiotic (1) | | Pyrexia+Antibiotic (1) | 2 |

UAS: ureteral access sheath; VAS: visual analog scale

**Table 3.** Logistic regression analyses

| | Univariate | | Multivariate | | |
|---|---|---|---|---|---|
| | OR (95% CI), *p* | | | | |
| | Horseshoe kidney | | Ectopic kidney | Duplicated ureter | |
| Age | 0.6 (0.3-1.3), 0.45 | | 0.9 (0.3-2.3), 0.8 | 1.7 (0.6-4.4), 0.2 | |
| Gender | 1.2 (0.4-8.1), 0.8 | | 1.4 (0.5-1.2), 0.6 | 0.9 (0.5-2.1), 0.4 | |
| BMI | 0.5 (0.2-1.1), 0.4 | | 1.2 (0.9-4.3), 0.9 | 1.3 (0.7-3.2), 0.8 | |
| Stone side | 1.4 (0.5-4.4), 0.9 | | 0.9 (0.4-6.5), 0.3 | 1.6 (0.9-5.7), 0.5 | |
| Lower calyx | 0.7 (0.2-3.2), 0.6 | | 1.5 (0.4-4.5), 0.9 | 2.2 (1.4-7.6), 0.3 | |
| Total stone volume | 1.4 (0.5-2.8), <0.01 | 2.2 (0.8-3.7), <0.01 | 0.9 (0.5-3.2), 0.1 | 1.1 (0.3-4.5), <0.01 | 1.4(0.8-3.1), <0.01 |
| Operation time | 0.7 (0.3-2.7), 0.7 | | 1.2 (0.5-3.3), 0.7 | 2.1 (1.3-3.9), 0.7 | |
| Insertion of DJ stent | 0.3 (0.1-1.4), 0.4 | | 2.2 (1.1-3.7), 0.4 | 0.8 (0.4-3.9), 0.5 | |
| UAS | 1.6 (0.4-3.3), 0.6 | | 1.30.7-6.7), 0.7 | 1.2 (0.9-1.5), 0.6 | |

BMI: body mass index; UAS: ureteral access sheath

compared to normally formed kidneys.[13] The success of PCNL in the treatment of horseshoe kidneys with stones larger than 20 mm is 80%-90%. The reason for the lower rate success is the anterior location of the pelvis.[14]

Thanks to its deflection capacity (up to 270 degrees) and high image quality in new flexible ureterorenoscope with very thin fiber laser and nitinol stone basket catheters, high stone-free rate can be achieved in stones with an average size of <2 cm, by coping with the anatomical and technical difficulties in stones located in the lower calyx or in the hard-to-reach calyces and even in kidneys with anomalies.[15] It has been reported that FURS combined with holmium laser lithotripsy and nitinol basket is effective and safe, offering high stone-free rates and low complication rates in patients with an average stone size of less than 30 mm.[16] It was reported in the Clinical Research Office of the Endourological Society's (CROES) URS global study that patients with horseshoe kidneys achieved 77% stone-free status in RIRS with FURS.[17] Ergin et al.[10] obtained 72.2% stone-free status with FURS in their high-series study. Similarly, it has been reported that 75% success was achieved in studies with a mean stone diameter of 12.2 mm with FURS.[18] Molimard et al.[9] achieved 88.2% total stone-free status with FURS in 7 patients with a mean stone size of 16 mm. Abdeldaeim et al.[19] and Bansal et al.[20] reported that they achieved 60%-67.7% and 70%-90% stone-free rates with FURS after the first and second sessions of RIRS, respectively. In studies with a mean stone diameter of >2 cm or more, 87.5% total stone-free rates were reported with FURS.[21] Even in studies involving very large stones with an average stone surface area of 321 $mm^2$ or an average stone diameter of 29 mm, it is reported that FURS can achieve stone-free status in the first session of 62.5% and a total of 87.5%.[16] In the study in which RIRS and PCNL were compared in stones with a mean size >2 cm, it was reported that the stone-free rates were statistically similar (stone-free rates for RIRS; 71.4% and 81%) in the first and in the final session accordingly.[22] Although the rates of retreatment are high, it is reported that the RIRS procedure can be preferred for large-sized stones to avoid PNL-related complications in the HSK anomaly, with minimal morbidity, low complication rate, and minor character of complications, and similar stone-free rates.[22] In this study, which includes an average of 140 $mm^2$ stone surface area, we consider that 77% total stone-free rates, which we obtained in patients with horseshoe kidneys and moderate stones size, are comparable to data in the literature.

In horseshoe kidneys, even if the flexible endoscope has 270 degrees of deflection, full deflection of FURS is not possible due to malposition of the ureteropelvic junction (UPJ), malrotation of the renal pelvis, flat renal pelvis, intrapelvic space tightness, and infundibulopelvic angle.[22,23] For these reasons, we could only perform partial lithotripsy in 2 patients with large renal pelvis stones. We had to perform laparoscopic pyelolithotomy as an auxiliary procedure in those patients.

In pelvic ectopia, the kidney cannot rise to its normal lumbar position, and the renal pelvis is located more anteriorly due to rotational anomalies. In these patients, drainage may be impaired due to the high insertion of both the UPJ and the ureter for these anatomical reasons. Infection, stasis, hydronephrosis, and kidney stone formation are more common in these patients due to drainage disorders. Even if stone fragmentation can be achieved in ESWL, the stone-free rate remains low due to drainage disorder as in horseshoe kidneys. PCNL and/or laparoscopy-guided PCNL is a very successful method in these kidney stones. However, the techniques are not easy and carry a higher risk of complications than normal kidneys.[24] Thanks to technological advances, RIRS stands out as a very successful alternative surgery method with very thin and flexible endoscopes, thin fiber lasers, and nitinol basket catheters. Bozkurt et al.[25] reported that they achieved 84.7% success with stone relocation and dusting lithotripsy mode in patients with pelvic ectopic kidney. Weizer et al.[8] reported a success rate of 75% with one session of URS, and Ugurlu et al.[26] reported a success rate of 66.6%. Ergin et al.[10] compared FURS with laparoscopic pyelolithotomy in patients with ectopic kidney stones. They reported that the laparoscopic pyelolithotomy group was more successful than FURS in terms of stone-free rates (FURS/Laparoscopic Pyelolithotomy; 83.6%/100%). However, although the stone volumes in the laparoscopy group were larger, all stones were more easily located in the renal pelvis. In the CROES URS Global study[17], the postoperative stone-free rate was reported as 20% in patients with ectopic pelvic kidney with an average stone volume of 120 mm$^2$. In this study, our total stone-free rate of 71% in patients with pelvic ectopic kidneys seems comparable to data reported in the literature. It is obvious that UAS placement is technically difficult due to the ureteral kink in an ectopic kidney. Ugurlu et al.[26] and Alkan et al.[21] talk about this challenge in their work, and Alkan et al.[21] report that high-quality UAS can help with this problem.

When we take a look at the few studies available on this subject, we see that the total stone-free and complication rates we obtained in this study are consistent with the literature.[27,28] Alkan et al.[21] were able to achieve 100% stone-free status with additional treatments in 8 patients with an average of 15.6 mm stones in 9 renal units. In their comparative study, Chertack et al.[29] reported that stone-free and complication rates were quite good in patients with normal and duplex ureters, but the operation time was longer than in patients with normal kidneys. Another advantage of RIRS was found out in patients with large stones in both collecting systems of the duplex system. In these patients, two separate accesses are required for PCNL. On the other hand, it is known that complication rates in PCNL increase with the number of accesses, especially bleeding. However, it is possible to save patients with duplex collecting system with appropriately sized stone volume from this risk with RIRS.

There are studies recommending the use of UAS[8] because it makes a tortuous ureter a straight line during surgery, facilitates the extraction of stone fragments by allowing easy re-entry and exit, and provides low intrarenal pressure during surgery, protecting the endoscope by reducing the deflection time, and increasing the stone-free rate, as well as relocation of stones in the kidney.[16] In addition, there are studies reporting that the total stone-free rate is increased by extracting stone fragmentations.[9,15] In this study, UAS usage rate was quite low. The main reason for this was that we thought it increased the risk of ureteral stenosis. At the same time, we did not prefer preoperative DJ stent for passive dilatation because it increases the number of surgical sessions. Moreover, we performed lithotripsy by moving the stones in the localizations that will cause excessive defecation of the endoscope, especially the lower calix stones, to more advantageous localizations. However, we could not perform fragmented stone extraction in most of our patients, due to low usage rate.

Some known factors such as stone size, stone number, anatomical features of the kidney, and/or hydronephrosis degree have emerged as predictive values in the success of RIRS in kidneys with normal anatomical structure and position. In fact, some preoperative scoring methods have been developed, and postoperative stone-free rates have been tried to be predicted. However, we see that these predictive values have not been adequately studied in renal stone diseases with anomalies due to the number of cases and the small number of studies. Atis et al.[15] reported that lower pole location of the kidney and large stones reduced the success of surgery in patients with horseshoe kidney stones. Similarly, CROES URS global study[17] reported that the stone-free rate decreased in patients with kidney stones with anomalies, whose stone volumes were more than 80 mm$^2$. In our study, inverse correlation was observed between the success of RIRS and the stone size. In the multivariate logistic regression analysis, stone size was a predictive factor for operative success in the horseshoe kidney and duplicated ureter subgroups. However, although we have findings that the size of the stone affects the success of the surgery, we cannot draw a definitive conclusion due to the small size.

Our total stone-free rate after the study is comparable with those found in appropriate publications. However, the cut-off figures for stone sizes, follow-up times, and stone-free assessment differ between studies.[8-10,12,15,17,18,20,23,25,30] Due to this heterogeneity, there may be differences in total stone-free rates. We obtained a full stone-free cut-off value in the NCCT taken 3 months later applying methods.

Anatomical variations in anomalous kidneys make the localization and transportation of stones difficult, and it is expected that complication rates may be higher when compared to normally formed kidneys. Bas et al.[31] reported that congenital renal anomalies were the only predictive factor determining complication rates in multivariate analysis. However, the complication rate and degree of complication we encountered in this study were similar to normal formed kidney RIRS surgeries with the same stone size.

There were some limitations that affects the results of our study such as retrospective design, isolated rotational anomalies, absence of crossed renal ectopia, and relatively small sampling. Obviously, there is a need for large multicenter clinical trial and meta-analysis studies on this subject.

# CONCLUSIONS

RIRS is an effective treatment method with high stone-free and low complication rates in calculous kidneys with low and medium stone volumes and upper urinary system anomalies. However, additional surgical treatment may be required for patients to obtain completely stone-free status.

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The authors have declared that no competing interests exist.

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# Роль ретроградной внутрипочечной хирургии при камнях в почках при аномалиях верхних отделов мочевыделительной системы

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## Резюме

**Введение:** Аномалии слияния, таза и удвоения мочевыводящих путей почки встречаются редко. Могут возникнуть некоторые трудности в лечении камней, проведении экстракорпоральной ударно-волновой литотрипсии (ESWL), ретроградной внутрипочечной хирургии (RIRS), чрескожной нефролитотомии (PCNL) и лапароскопической пиелолитотомии у этих пациентов из-за анатомических особенностей почек с аномалиями. .

**Цель:** Оценить результаты RIRS у пациентов с аномалиями верхних мочевыводящих путей.

**Материалы и методы:** Ретроспективно проанализированы данные 35 пациентов с подковообразной почкой, тазовой эктопией почки и удвоенной мочевой системой в двух специализированных центрах. Были оценены демографические данные, характеристики камней и послеоперационные характеристики пациентов.

**Результаты:** Средний возраст пациентов (n=35, 6 женщин и 29 мужчин) составил 50 лет. Было обнаружено 39 камней. Общая средняя площадь поверхности камня во всех группах аномалий составила 140 $mm^2$, а среднее время операции — 54.7±24.7 мин. Частота использования мочеточникового интродьюсера (UAS) была очень низкой (5/35). Восемь пациентов нуждались в вспомогательном лечении после операции. Остаточная частота, составлявшая 33.3% в первые 15 дней, снизилась до 22.6% на третьем месяце наблюдения. У четырёх пациентов наблюдались лёгкие осложнения. У пациентов с подковообразной почкой и удвоенной мочеточниковой системой было отмечено, что фактором риска, увеличивающим наличие резидуальных камней, был общий объём камней.

**Заключение:** RIRS почек с аномалиями малого и среднего объёма конкрементов является эффективным методом лечения с высоким уровнем полного отсутствия камней и низкой частотой осложнений.

## Ключевые слова

подковообразная почка, камни в почках, тазовая почка, уретероскопия, удвоение мочеточника