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Flexible Ureterorenoscopy for Management of Renal Stone in Anomalous Kidneys: A Single Centre Experience

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Abstract

Background and Objective: Flexible ureterorenoscopy is a well-established treatment for renal calculi in anatomically normal kidneys. our objective is to evaluate the efficacy and safety of retrograde intrarenal surgery for managing renal stones in patients with renal abnormalities.

Methods: A retrospective study was performed on 20 patients diagnosed with renal stones and kidney abnormalities who underwent primary retrograde intrarenal surgery, between October 2021 and October 2023 in Sulaymaniyah Teaching Hospital. The evaluation included demographic data, stone attributes, surgical specifics, and postoperative results. Success was defined as the complete removal of stones, confirmed by ultrasonography and x-rays at 1- and 3-months post-operation.

Results: The cohort included 7 patients (35%) with divergent collecting systems, 6 patients (30%) with horseshoe kidneys, 5 patients (25%) with ectopic kidneys, and 2 patients (10%) with renal malrotation. The mean age was 43.2 ± 13.8 years, the mean body mass index was 27.8 ± 3.6 kg/m², and the average stone size measured 13.7 ± 3.7 mm. After one session, 75% of patients achieved complete stone removal, and 100% after the second session. Stone size and using access sheaths correlated with the rate of stone-free outcomes ($P<0.5$). Five patients, representing 25% of the total, experienced minor postoperative complications, including fever in four and hematuria in one patient.

Conclusion: Despite the technical challenges associated with altered renal anatomy, Flexible ureterorenoscopy has demonstrated promising outcomes in managing renal calculi in abnormal kidneys, achieving satisfactory stone removal and acceptable complication rates.

Keywords: Anomalous kidney, Flexible ureterorenoscopy, Renal calculi, Stone clearance

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Introduction

The incidence of urolithiasis has steadily increased over the last thirty years and currently affects approximately 14% of the population over their whole lives. Various factors, such as socioeconomic status, lifestyle changes, and environmental conditions, play a role in the development of kidney stones. There is a notable correlation between the formation of kidney stones and certain medical conditions, including obesity, diabetes, and metabolic syndrome, which have also seen a rise in prevalence in recent years.[1,2] Renal anomalies, caused by abnormalities in the typical embryonic development, are somewhat uncommon. The most frequently observed abnormality among these is the horseshoe kidney, which occurs in 1 out of every 400 persons. The incidence of pelvic ectopic kidneys is 1 in 3,000 individuals, whereas crossed renal ectopia is seen in approximately 1 in 1,000 cases. The duplex collecting system is present in 7 out of every 1,000 individuals, and rotation abnormalities are exceptionally rare.[3,6] Impaired urine outflow and modified anatomical structure in patients with aberrant kidneys increase the chance of forming renal stones, thereby complicating the endourological care of these cases.[3] Therapeutic techniques such as extracorporeal shock wave lithotripsy (ESWL) and percutaneous nephrolithotomy (PCNL) are well recognized for their effectiveness in treating kidney stones in abnormal kidneys. Nevertheless, these methods may have reduced success rates or increased risks of complications when used in unaffected kidneys, mostly because of technical challenges.[4] Advancements in flexible endoscopic technology, such as enhancements in vision, size, and deflection, together with improved holmium laser production and the application of thulium fiber lasers, have significantly improved the effectiveness and speed of stone fragmentation. These advancements have made Retrograde Intrarenal Surgery (RIRS) a more favored option than PCNL and ESWL for treating renal stones less than 20 mm, providing better rates of stone-free outcomes with fewer problems.[5,6] This study presents our experience utilizing Retrograde Intrarenal Surgery (RIRS) for the treatment of renal stones in patients with various kidney abnormalities, including horseshoe kidneys, ectopic kidneys, malrotated kidneys, and duplicated collecting systems. Here in our study, we aim to evaluate the efficacy and safety of retrograde intrarenal surgery for managing renal stones in patients with renal abnormalities.

Patient and methods

A retrospective study was performed on a group of 20 patients who underwent RIRS to manage renal calculi in abnormal kidneys from October 2021 to October 2023. The study methodology was authorized by the local ethical council and all procedures were conducted by a single proficient endourologist at our institute. The patients were provided with comprehensive counseling on the treatment alternatives, potential problems, and the prospective requirement for supplementary or staged operations to optimize the removal of stones. The criteria for RIRS were stones measuring 2 cm or less, unsuccessful SWL, contraindications for PCNL, refusal of ESWL or PCNL by the patient, and the patient and surgeon's desire for RIRS. Descriptive data including age, gender, body mass index (BMI), type of renal abnormality, and the size and location of the stones were collected by reviewing patient medical records. The perioperative clinical data encompassed information on the administration of anesthesia, duration of the operation, usage of ureteral access sheath (UAS), placement of double-J stent, rates of stone-free outcomes, and perioperative complications. Prior to surgery, all patients

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had non-contrast-enhanced computed tomography (CT) imaging to assess the size, position, and density of the stones. The patient was positioned in lithotomy and anesthetized with either general or spinal anesthetic. All procedures commenced utilizing a semi-rigid ureteroscope (8–9.5F, Karl Storz Endoscopy, Tuttlingen, Germany) to facilitate passive dilation of the ureter and evaluate for the presence of ureteral stones or strictures. A Zebra™ nitinol guidewire, measuring 0.032 or 0.035 inches, was subsequently inserted into the renal pelvis, and a 10/12-Fr or 11/13-Fr UAS from Cook Medical, was placed over the guidewire utilizing tactile feedback and/or fluoroscopic guidance. The flexible ureteroscope was then introduced passing through the UAS. In cases where it was not possible to fully advance a ureteral access sheath (UAS) over the guidewire, a 7.5 Fr digital single-use flexible ureteroscope (HU32, Shenzhen Huge Med Medical Technical Development, China) was used in a monorail manner. The lithotripsy was conducted using a holmium laser (Cyber Ho 60, Quanta System, Milan, Italy), and the laser settings used were 0.5–1.2 J energy and 10–15 Hz frequency depending on the density and size of the stone. A 200–365-µm fiber was used for fragmentation. Following lithotripsy, a thorough endoscopic examination of the pelvicalyceal system was performed to detect residual stone fragments, supported by fluoroscopy to confirm stone absence. A double-J stent (4.7-6 fr) 22-28 cm, was implanted to enhance drainage, followed by Foley catheter insertion for 6-12 hours. Upon smooth recovery, patients received oral antibiotics the next day and were discharged. The first follow-up appointment was scheduled 3 to 4 weeks after the operation, during which a kidney-ureter-bladder (KUB) scan was performed. Complete clearance was defined as no residual stone fragment greater than 2 mm. If significant stones remained, a second-look surgery was planned within 2 to 4 weeks. If no issues were found, the DJ stent was removed. Three months later, renal ultrasound and KUB X-rays were used for further assessment. CT scans were excluded to reduce costs and limit radiation exposure. At the three-month follow-up, the SFR was calculated, classifying patients as either stone-free or having residual stones based on U/S and KUB X-ray findings. The raw data were systematically organized using Microsoft Excel (2019) and subsequently analyzed with the Statistical Package for the Social Sciences (SPSS), Version 22, created by IBM SPSS Statistics Inc., USA. The data was summarized by descriptive statistics, encompassing frequency estimates, percentages, ranges, means, and standard deviations. The investigation employed chi-square tests and independent samples T-tests to assess the significant connections between the SFR and other variables. A significance level of $p < 0.05$ was utilized to determine statistical significance. The study was approved by the ethical committee of the Kurdistan Higher Council of Medical Specialties (KHCMS).

Results

Of the 20 patients in this study, 7 (35%) exhibited duplicate collecting systems, 6 (30%) presented with horseshoe kidneys, 5 (25%) had ectopic kidneys, and 2 (10%) were diagnosed with malrotated kidneys. The participant pool predominantly consisted of males, with 17 males and 3 females, yielding a ratio of 5.6:1. The average age of the patients was 43.2 ± 13.8 years (ranging from 22 to 63 years), and their mean body mass index was 27.8 ± 3.6. The mean stone burden was 13.7 ± 3.7 millimeters. Out of the group, 11 patients (55%) presented with stones in their right kidneys, 7 (35%) had stones in their left kidneys, and 2 (10%) had stones in both kidneys. The lowest calyx had the greatest percentage of detectable stones,

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accounting for 40.7%. no preoperative stent insertion, Table (1).

Table (1): Baseline patient profiles and stone characteristics in individuals with anomalous kidneys.

Characteristic	Overall, N = 20[1]	Duplex system, N = 7[1]	orseshoe kidney, N = 6[1]	Ectopic kidney, N = 5[1]	lalrotated kidney, N = 2[1]
Age (years)	43.2 ± 13.8	52.9 ± 6.8	37.0 ± 12.8	29.8 ± 4.0	61.5 ± 2.1
Gender					
Male	17 (85.0%)	6 (85.7%)	6 (100.0%)	3 (60.0%)	2 (100.0%)
Female	3 (15.0%)	1 (14.3%)	0	2 (40.0%)	0
BMI (kg/m^2)	27.8 ± 3.6	28.1 ± 2.3	26.8 ± 3.5	27.3 ± 5.6	31.1 ± 1.9
Stone side					
Right	11 (55.0%)	2 (28.6%)	4 (66.7%)	3 (60.0%)	2 (100.0%)
Left	7 (35.0%)	5 (71.4%)	2 (33.3%)	0	0
Bilateral	2 (10.0%)	0	0	2 (40.0%)	0
Stone size (mm)	13.7 ± 3.7	10.0 ± 2.1	14.5 ± 2.1	16.1 ± 3.2	18.5 ± 0.7
Stone characteristics on Xray					
Radiopaque	18 (90.0%)	5 (71.4%)	6 (100.0%)	5 (100.0%)	2 (100.0%)
Radiolucent	2 (10.0%)	2 (28.6%)	0	0	0
Stone location and n %	27	12	7	6	2
Upper Calyx	5(18.5%)	3 (25%)	2 (28.5%)	0	0
Middle Calyx	3 (11.1%)	0	1 (14.3)	1 (16.7%)	1 (50.0%)
Lower Calyx	11 (40.7%)	6 (50%)	2 (28.5%)	2 (33.3%)	1 (50.0%)
Renal pelvis	5 (18.5%)	0	2 (28.5%)	3 (50%)	0
PUJ	3 (11.1%)	3 (25%)	0	0	0
[1]Mean ± SD; n (%)					

The surgeries of 18 patients (90%) were performed under spinal anesthesia, with an average surgical time of 52.8 ± 17.4 minutes. However, patients with ectopic kidneys had a longer mean operative time of 72.0 ± 16.4 minutes compared to the other groups due to difficult localization. The mean duration of lasing for all types of abnormalities was 27.3 ± 12.0 minutes, while the malrotated kidney group had the shortest average lasing time at 10.0 ± 0.0 minutes. Eight (40%) patients did not have ureteral access introduced, After the surgery, 18 patients (90%) had double-J stents inserted, which were thereafter removed 2–3 weeks post-procedure, Table (2).

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Table (2): The perioperative data and results of (RIRS) for individuals with anomalous kidneys.

Characteristic	Overall, N = 20[1]	Duplex system, N = 7[1]	Horseshoe kidney, N = 6[1]	Ectopic kidney, N = 5[1]	otated kidney, N = 2[1]
Type of anesthesia given					
Spinal	18 (90.0%)	7 (100.0%)	6 (100.0%)	3 (60.0%)	2 (100.0%)
General	2 (10.0%)	0	0	2 (40.0%)	0
Operative time (min)	52.8 ± 17.4	54.3 ± 10.6	39.2 ± 11.6	72.0 ± 16.4	40.0 ± 0.0
Use of fluoroscopy guidance	12 (60.0%)	4 (57.1%)	3 (50.0%)	5 (100.0%)	0 (0.0%)
l access	12 sheath (60.0%)	3 (42.9%)	3 (50.0%)	4 (80.0%)	2 (100.0%)
Insertion of DJ stent	18 (90.0%)	7 (100.0%)	6 (100.0%)	4 (80.0%)	1 (50.0%)
Post-op complications	4 (20.0%)	1 (14.3%)	0	2 (40.0%)	1 (50.0%)
Fever	4 (20.0%)	1 (14.3%)	0	2 (40.0%)	1 (50.0%)
Hematuria	1(5%)	1(5%)	0	0	0
Stone free rate	15 (75.0%)	4 (57.1%)	5 (83.3%)	4 (80.0%)	2 (100.0%)
Presence of Residual stone	7 (35.0%)	3 (42.9%)	3 (50.0%)	1 (20.0%)	0
After 1 month	7 (35.0%)	3 (42.9%)	3 (50.0%)	1 (20.0%)	0
After 3 months	5 (25.0%)	3 (42.9%)	1 (16.7%)	1 (20.0%)	0
Auxiliary treatment					
RIRS	5 (25.0%)	3 (42.9%)	1 (16.7%)	1 (20.0%)	0
[1]Mean ± SD; n (%)					

Four (20%) patients experienced temporary postoperative fevers below 38.5 degrees Celsius, which were controlled with antipyretics. A patient with a horseshoe kidney experienced acute postoperative hematuria, which resolved spontaneously within 1-2 days.All patients (100%), without exception, underwent Retrograde Intrarenal Surgery (RIRS) successfully. After one month, 65% of the patients, making 13 out of 20, were clear of stones. This percentage increased to 75% by the three-month mark. Following the initial treatment, five of the remaining patients had clinically significant residual pieces larger than 2 mm. After undergoing a second RIRS, all of these patients achieved a state of being completely free of stones. As a result, the overall success rate rose to 100%, Table (2). A logistic regression analysis was performed to assess the influence of multiple independent variables on the stone-free rate (SFR) after the initial RIRS session. The evaluated variables comprised age, gender, body mass

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index (BMI), stone location side, stone quantity, stone burden, operation duration, lasing duration, utilization of DJ stent, application of Ureteral Access Sheath (UAS), fluoroscopic guidance, and postoperative problems. Univariate analysis revealed that mean stone size and UAS usage are statistically significant predictors of the SFR, with odds ratios (OR), 95% confidence intervals (CI), and p-values < 0.05, Table (3).

Table (3): Univariate logistic regression for the prediction of stone-free rate.

Characteristic	OR[1]	95% CI[1]	p-value
Age (years)	1.03	0.96, 1.11	0.5
Gender			
Female	Reference	Reference	
Male	0.77	0.00, NA	>0.9
BMI (kg/m^2)	1.03	0.79, 1.37	0.8
Number of stone	1.27	0.30, 5.13	0.7
Stone size (mm)	1.29	1.14, 1.54	0.002
Stone side			
Bilateral	—	—	
Left	0.40	0.01, 13.6	0.6
Right	0.57	0.02, 17.2	0.7
Operative time (min)	0.98	0.92, 1.04	0.5
Lasing time (min)	1.02	0.94, 1.10	0.7
Use of fluoroscopy guidance	0.83	0.13, 5.77	0.8
Use of Ureteral access sheath	0.12	0.01, 0.86	0.046
Insertion of DJ stent	27,073,971	0.00, NA	>0.9
Presence of post-op complications	2.20	0.21, 23.2	0.5
[1]OR = Odds Ratio, CI = Confidence Interval			

Discussion

Urolithiasis is more common in kidneys with structural abnormalities of fusion, location, or rotation compared to kidneys that are normally positioned.[7] As a result of vascular abnormalities and varied anatomical relationships with adjacent organs, anomalies in the ureter and renal pelvis, the rates of stone elimination and complications after treatments like ESWL, PCNL, and RIRS may differ from those in normal kidneys due to impaired renal drainage result in lower stone-free rates.[8,9] The advent of advanced technology in flexible ureteroscopy has facilitated its broadening of application. The combination of high image quality, increased deflection capacity of up to 270 degrees, gradually reduced laser fiber diameters and the advancement of variable size and shape nitinol stone extractors have enabled the access and treatment of stones situated in lower or erratically-positioned calyces. As a result, stone-free rates ranging from 70 to 88.2% can be achieved.[10,15] When managing abnormal kidneys, the application of FURS differs technically from its application in orthotropic kidneys. Technical distinctions encompass a non-linear trajectory of the ureter, a possibly constricted pelvic ureteric junction (PUJ), and the difficulty of controlling an extended flexible ureteroscope beyond the urethra. Furthermore, it can be challenging to negotiate constricted angles at an infundibulopelvic junction, particularly when dealing with a very sharp angle in the inferior calyx. Pelvic ectopic kidney (PK) is characterised by a convoluted course of the ureter, whereas HSK is characterised by a high insertion of the ureter and MK is characterised by a somewhat anterior or posterior position of the pelvis. The presence of these variances can complicate the negotiation of the PUJ.[11] The Retrograde Intrarenal Surgery (RIRS) procedure was successfully performed on all patients included in the study. At the one-month follow-up, 65% of the patients (13 out of 20) achieved complete stone clearance, which improved to 75% (15 out of 20) at the three-month mark. Among the remaining five patients, who had clinically significant residual fragments larger than 5 mm, a secondary RIRS was carried out, resulting in complete stone clearance for all. Consequently, the final success rate, including the additional procedures, reached 100%. Our research, which determined an

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average stone burden of 13.7 ± 3.7, suggests that the total stone-free rate of 83.3% in patients with horseshoe kidneys is comparable to the 77% rate documented by the Clinical Research Office of the Endourological Society (CROES) in its global study.[11] Similarly, Molimard achieved an 88.2% stone-free rate using FURS in 7 patients with an average stone size of 16 mm. [12] Abdeldaeim, reported 80% SFR, while Bansal reported that they achieved 67.7% stone-free rates.[13,14] Even in studies involving stones larger than 2 cm, high stone-free rates ranging from 62% to 87.5% were observed.[15,16] Despite the increased likelihood of retreatment, RIRS remains the recommended approach for managing large stones in patients with horseshoe kidney anomalies. This method is preferred due to its association with low morbidity, a minimal complication rate, relatively mild aftereffects, and comparable stone-free outcomes.[17] Our findings demonstrate that the 80% stone-free rate in patients with ectopic kidneys aligns with the 84.7% reported by Bozkurt and 75% for a single session reported by Weizer et al. as well as the 66.6% rate reported by Ugurlu et al.[5,7,18] Patients diagnosed with duplex kidneys present with ureteral orifices that deviate from the typical anatomical location. According to the Weigert-Meyer rule, the ureter with a more medial and caudal opening drains the upper portion of the kidney, while the ureter with a more lateral and cephalad opening serves the lower portion. This anatomical variation complicates the identification of the ureteral openings during surgical interventions. However, Rana, successfully treated 12 patients with duplex kidneys, achieving a stone-free status in 11 of them. [19] In our series, seven patients with stones in duplex kidneys were treated using flexible ureteroscopy (F-URS). A single session rendered four patients (57.1%) stone-free, while three required an additional F-URS procedure. Postoperative complications occurred in five cases (25%), including fever in four patients (20%) and hematuria in one patient. No major complications were reported. A review of the literature suggests that the stone-free rates and complication outcomes in our study align with previously published findings.[20,21] Several studies support the use of UAS, due to its ability to straighten a tortuous ureter during surgery, facilitating the removal of stone fragments by easing re-entry and exit.[7] Additionally, UAS helps maintain low intrarenal pressure during surgery, protecting the endoscope by reducing deflection time and improving stone removal rates.[11] Research also suggests that the overall stone-free rate can be improved through the use of stone fragment extraction techniques.[12,22] Despite its benefits, UAS placement can be technically challenging, especially in ectopic kidneys where ureteral kinks are common. Ugurlu et al. And Alkan in our series, UAS placement was unsuccessful in 8 patients (40%). [5,15] The findings of our study highlight the potential of RIRS as a reliable and minimally invasive method for managing renal calculi in patients with complex anatomical variations. Our study had certain limitations, including its retrospective design and relatively small sample size. A larger, multicenter study would be necessary to confirm these findings.

Conclusion

Despite the technical challenges posed by altered renal anatomy, retrograde intrarenal surgery (RIRS) has shown promising results for treating renal calculi in patients with abnormal kidneys, achieving satisfactory stone clearance rates with acceptable complication rates.

Conflicts of interest

The authors declare no conflict of interest.

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