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Retrograde Intra Renal Surgery for Renal Calculi in Anomalous Kidneys

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Abstract

Objective: To share our experience in Retrograde Intrarenal Surgery (RIRS) for stones in anomalous kidneys in regard to its success rate and complications.

Material and Methods: Between 2019 and 2021, patients data were collected and reviewed retrospectively and 40 procedures were taken into consideration. There were 21 patients with Horseshoe Kidney (HSK), 9 with Ectopic Kidney (EK), 4 Malrotation (MR) and 6 with Calyceal diverticula (CD). Demographic, stone, intraoperative and postoperative data were collected. We analyzed these data in terms of stone free rate and complications.

Results: RIRS had good success rate. 36 patients out of 40 were stone. The average hospital stay was short and complications were minimal.

Coclusion: RIRS can be used in the management of anomalous kidney stone. It is an efficient and safe method.

Keywords: Rirs In Anamolous Kidney, Stones In Anamolous Kidney, Rirs, Anamolous Kidney

Introduction

Anomalous kidneys arise from different abnormalities in the embryological development [1]. These may relate to abnormal ascent, fusion, rotation, calyceal abnormalities, ectopic location, duplication or combination of these. The most common renal anomaly is Horseshoe Kidney (HSK) with an incidence of 1 in 400 while Ectopic kidneys (EK) are reported with an incidence of 1 in 3000 and the incidences of malrotation (MR) and calyceal diverticula (CD) are much lesser.

These anatomical anomalies compromise renal drainage and become one of the multiple factors for renal stone formation [2-4].

With the aid of the recent technological developments, there have been rapidly increasing options in the treatment of kidney stones. Kidney stones historically treated with open surgery, are often managed recently by shock wave lithotripsy (SWL) and endoscopic surgeries. ESWL has been used since 1980, and remains an important technique in the treatment of renal stones. Nowadays minimally invasive modalities such as SWL, antegrade (percutaneous nephrolithotripsy (PCNL) – conventional, mini, ultramini and micro), and retrograde endoscopic interventions [ureteroscopy (URS), retrograde intrarenal surgery (RIRS)] and laparoscopic surgeries are commonly used for the treatment of kidney stones.

The most important one of the various clinical parameters that can affect the success of stone treatment is the stone size [5]. It has been shown that SWL has a good stone-free rate (SFR) for the stones measuring up to 20 mm, and PCNL is considered as a primary treatment for the stones greater than 20 mm [6]. The negative factors affecting the SFR in SWL include the presence of lower pole calyx, acute infundibulopelvic angle (IPA), calyx neck longer than 10 mm, narrow infundibulum (≤5 mm), hard

stones, and obesity. Multiple sessions and additional treatments may be needed in case of these factors [7]. Even though PCNL has higher SFRs, hemorrhage, injury to colon, pleura and lungs, peri-operative decrease in hemoglobin and renal injury can occur if the renal parenchyma is penetrated.

These challenges increase to manifold when renal stones are associated with anomalous kidneys. Stone free rate in ESWL decreases as there is impaired urine drainage in anomalous kidneys while in PCNL there is more chances of renal and other organ injuries. Laparoscopic pyelolithotomy can be used but these have their own limitations.

Although SWL and PCNL are mentioned in the guidelines as gold standard treatment modalities for the management of kidney stones, Retrograde Intra-Renal Surgery (RIRS) is accepted as another treatment modality in the European Association of Urology (EAU) guidelines [8].

RIRS was first described and performed in the 1990s. Since then it has greatly improved. RIRS is more frequently used thanks to the digital improvements in flexible ureteroscopy (fURS) technology [9], in addition to the developments in deflection mechanism, mobility, ergonomics and durability of the equipments used. Meanwhile, with developments in auxiliary devices – such as miniaturized holmium laser fibers, nitinol baskets, guidewires and ureteral access sheath – and increase in surgical experience and compliance, higher success rates have been achieved with RIRS in the management of kidney stones. Accumulated evidence have demonstrated that RIRS can be performed evens for stones >2 cm.

Today, reaching the stone via a natural route and achieving a high success rate with a lower morbidity have led RIRS to become a commonly used and important treatment modality.

RIRS has proven to be an excellent alternative to PCNL in specific situations where PCNL becomes more challenging in regards to stone free rate and complications like patients with musculoskeletal deformities, morbid obesity, bleeding diathesis and occupations which require complete stone clearance.

Materials and Methods

This study is based on patients of age group 18-70 years who underwent RIRS in our institute from 2019 to 2021.

After selecting patients for the procedure, common blood count, serum biochemical values, bleeding and coagulation profile, urine analysis and urine culture were obtained for all patients preoperatively. All urine cultures were preoperative sterile. Different radiological methods were used like X-RAY kidney-ureter-bladder (KUB), ultrasonography (US), intravenous urography, and or computerized tomography. For non-opaque stones, the stone diameter was measured with the US or CT scan. In multiple stones, the sum of the longest diameters of each stone was defined as stone diameter.

We divided our 40 patients into groups.

First group included patients (21 out of 40) with Horseshoe kidney (HSK).

Second group included patients (9 out of 40) with Ectopic kidney (EK).

Third group included patients (4 out of 40) with Malrotation (MR).

Fourth group included patients (6 out of 40) with Calyceal Diverticula(CD).

Surgical Aspect

1. The procedure (RIRS) was done under general anesthesia in lithotomy position.
2. Intravenous antibiotic was given during induction.
3. Ureteroscopy was applied routinely in all cases using a 6 F semirigid ureteroscope prior to flexible ureteroscopy.
4. Then the hydrophilic guide wire was inserted into the ureter and pelvis under fluoroscopic control.
5. Ureteral access sheath was placed over the guidewire under fluoroscopic control. With UAS placed, flexible ureterorenoscope was guided over the guidewire.
6. And renal access was supplied. Lithotripsy was made with 360 micron Holmium:Yttrium Aluminum Garnet (Ho-YAG) laser .
7. Lithotripsy was performed with 5-15 Hertz frequency and 0.6-1.5 joule power. Dusting, fragmentation and popcorn methods were used according to surgeon's choice.

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8. All calyxes were visualized with flexible ureteroscope before the end of the operation.
9. Double-J (DJ) stent was placed in all patients.DJ stent was removed four weeks later.
10. X-RAY KUB was used for opaque stones and US was used for non-opaque stones after one month.
11. Being stone free or having less than 3 mm residual fragment one month after the procedure were described as successful. Unsuccessful stones were planned after a period of one month.
12. Complications were evaluated according to Clavien-Dindo classification.

Statistical Analysis

Data collected for individual patients were simultaneously entered into study performa and updated. The datas were analysed using SPSS software version 27. Statistical analysis for continuous data(age, stone size, duration of surgery and hospital stay) were expressed as mean and standard deviation and chi square test was applied as appropriate for comparison to nominal data. Nominal data analysis (sex, stone side, stone site, stone free rate and complications) were presented in numbers and percentage.

Results

The demographic characters of patients in our study is given in table 1 with 40% of patients were between 20-30 years of age. The anamolous kidney types in our study were Horseshoe kidney, Ectopic kidney, Malrotated kidney and Calyceal diverticulum. The majority of patients were Horseshoe kidney which is 50% of the study population as shown in table 2. The mean stone size and location of stone in each variant of anomalous kidney were given in table 3 and 4 respectively. The mean operation time was minimum in patients with Horseshoe kidney and maximum in patients with calyceal diverticulum 59.83±3.48. The overall mean stone free rate was more than 90% and with respect to each type of anomalous kidney is given table 5. The overall mean hospital stay in our study is 2.5 days. The common complications in our study were Fever and Hematuria as shown in table 6.

Table 1: Demography of study population.

Age in years	Males	Females	Total	Percent
20 - 30	9	7	16	40%
31 - 40	7	4	11	27.5%
41 - 50	4	0	04	10%
51 - 60	6	1	07	17.5%
61 - 70	1	1	02	5%
Total	27	13	40	100%

Table 2: Types of renal anomalies among study population.

Anomaly	Males	Females	Total	Percent
Horseshoe kidney	13	8	21	52.5%
Ectopic Kidney	6	3	9	22.5%
Malrotated kidney	4	0	4	10%
Calyceal Diverticulum	4	2	6	15%

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Table 3: Mean stone size in respective anomalies.

Types of Anomalies	Mean stone size(mm)
Horseshoe kidney	16.09±2.50
Ectopic Kidney	12.60±2.17
Malrotated kidney	12.75±3.59
Calyceal Diverticulum	15.00±2.89

Table 4: Stone localization in study population.

Types of Anomalies	Location of stones				Total
	Upper Calyx	Middle Calyx	Lower Calyx	Pelvis	
Horseshoe kidney	6	2	3	10	21
Ectopic Kidney	2	2	2	3	9
Malrotated kidney	2	1	0	1	4
Calyceal Diverticulum	4	2	0	0	6
Total	14	7	5	14	40

Table 5: Stone free rate.

Types of Anomalies	No. of patients	Complete Clearance	Stone Free Rate
Horseshoe kidney	21	19	90.4%
Ectopic Kidney	9	8	88.8%
Malrotated kidney	4	4	100%
Calyceal Diverticulum	6	5	83.3%

Table6: Complications associated with RIRS in our study.

Types of Anomalies	No. of patients	Bleeding	Fever	Mucosal injury
Horseshoe kidney	21	1	1	0
Ectopic Kidney	9	0	1	0
Malrotated kidney	4	0	0	0
Calyceal Diverticulum	6	1	2	1

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Total	40	2	4	1

Discussion

RIRS, PCNL and laparoscopy are the different endourological treatment modalities available for urinary stones in congenital abnormal kidneys such as HSK, Ectopic Kidney (EK), Malrotation (MR) and Calyceal Diverticula (CD). In recent years RIRS has become preferred modality for small and mid size renal stones in these patients and the results have been reported in literatures too.

We performed RIRS in 40 patients with renal anomalies, out of which 21 patients had HSK, 9 had EK, 4 had Malrotation and 6 had Calyceal Diverticlula. The mean age group of our study population was 37.4±12.05 years.

Horseshoe Kidney

Among all the renal anomalies HSK is the most common one with an incidence of 0.25 %. This anomaly constitutes the largest group in our study also. Renal stone formation occurs in approximately in 20 % of these patients. Although with PCNL there is satisfactory stone free rate but there is also high risk of complications like bleeding, sepsis and bowel injury. But with RIRS majority of these complications are limited.

In our study out of 21 HSK patients 13 were males and 8 were females. The average stone size in this group was 16.09±2.50 mm which is comparable to other studies.

In a study by Ergin et al, average stone size was 17.8 ± 4.5 mm while average stone size in the study conducted by Sercan Sari et al was 17.93mm.

In our study 6 patients had upper calyceal stone while 2 patients had middle calyceal stone, 3 patients had lower calyceal stone and 10 patients had pelvic stones.

The average operation time in our study was 48.90±5.30 minutes which is comparable to other studies. Sercan Sari et al reported an average operation time of 49 minutes while Ibrahim Ugurlu et al reported an average time of 38.33 ± 1.15 minutes with a mean stone size of 253± 103.69 mm².

Out of 21 patients, 19 patients were stone free when followed up after 1 month (90.4 %). Sercan Sari et al reported stone free rate of 83.33% in 12 patients, while Ergin et al achieved stone free rate of 72.2%.

In our study the two patients who were not stone free had residual fragments of size more than 3 mm. In both of these patients stones were located in lower calyx. Patients achieved complete clearance with redo RIRS after a gap of 1 month.

The mean duration of hospital stay in our study group was 2.47±0.60. Ergin et al reported mean duration of 1.4± 0.7 days.

Ectopic Kidney

The second most common anomaly in our group was Ectopic kidney. Out of total 40 patients, 9 patients had Ectopic kidney. Out of which 6 were males and 3 were females.

The average stone size for this group in our study was 12.60±2.17. Ergin et al in their study reported the average size of stone as 17± 5.1 mm while Gok et al reported average size as 16.3 ± 6.1 mm.

Among 9 patients in this Ectopic kidney group, 2 patients had upper calyceal, 2 had middle calyceal, 2 had lower calyceal and 3 had pelvic calculus. Ibrahim uruglu et al, in their study reported 6, 1, 4, and 6 patients with lower calyceal, mid calyceal, upper calyceal and pelvic calculus respectively.

The average operation time for this group in our study group was 50.55±5.02 minutes. Ibrahim Urugul et al reported an average time of 63.33± 22.65 minutes while Ergin et al reported an average operation time of 52.1± 27.7 minutes.

As far as stone free rate in this group is concerned 8 out of 9 patients were stone free (88.8%). The patient who had significant residual fragment had stone located in lower calyx. Ibrahim Urugul et al reported a stone free rate of 66.6% in 6 patients, Ergin et al reported stone free rate of 83.6% and Binbay et al reported stone free rate of 70.8%.

The mean duration of hospital stay in this group was 2.33±0.70 days, comparable to other studies.

Malrotation

Third common anomaly in our study was Malrotation of kidney which is a rare anomaly. Out of 40 patients,

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4 patients had malrotated kidney out of which all 4 were males. The average stone size in this group was 12.75±3.59 mm. 2 patients had calculus in upper calyx, 1 patient had calculus in mid calyx and 1 had calculus in pelvis.

Ergin et al reported an average size of stone as 13.4± 3.7 mm and Oguz et al reported average size of 13.5 mm.

The average operation time for this group in our study was 57.50±8.80 minutes. Ergin et al reported the mean time of 48.7± 14.4 minutes while Ibrahim Ugurlu et al reported average operation time of 38.5 ± 23.57 minutes.

All 4 patients with Malrotation kidney were stone free after the procedure. Ergin et al reported stone free rate of 75%, while Ugurlu et al reported stone free rate of 100%.

The average duration of stay in hospital for this group in our study was 2.50±0.57 days.

Calyceal Diverticula

The last group included patients with Calyceal Diverticula. Out of 40 patients 6 patients had Calyceal Diverticula . Out of 6 patients in this group 4 were males and 2 were females.

The average stone size for this group in our study was 15±2.89 mm. 4 patients had calculus in upper calyx and 2 had calculus in middle calyx. When the diverticular neck was not accessible, its neck was incised with laser and stones were fragmented. Sari et al reported an average size of 17.94 mm. Out of 6 patients, 5 patients were stone free (83.3 %). The patients who did not have stone free status, had 12 mm stone located in middle calyx and even after incising the neck of diverticula with laser, access to the stone was not satisfactory. Sari et al reported stone free rate of 72% while Koopman et al reported stone free rate of 90%.

The complications in our study were evaluated according to Clavien – Dindo classification. Out of 40 patients only 2 patients had bleeding. One patient had 11mm calculus in upper calyx with Calyceal Diverticula. Bleeding in this case was attributed to diverticular neck incision. While the other patient had 17 mm calculus in lower Calyx with HSK. In this patient we had difficulty in access due to high ureter insertion and this patient was also not stone free after the procedure. Both of these patients had mucosal injuries.

Sari et al also reported bleeding in 2 out of 47 patients while Ergin et al reported mild hematuria in some of his HSK patients and 2 out 32 patients with Malrotation had mild hematuria (6.3%). Since hematuria was mild, it was managed conservatively only and hematuria settled down after 24 hours.

Fever is usually seen post endourological procedures which may relate to bacterial endotoxin released during stone fragmentation and application of Double J stents which acts as foreign body. In our study only 4 patients developed fever post RIRS. 2 patients had HSK, 1 had Calyceal Diverticula and 1 patient had EK. In all these patients fever was mild and responded to usual intravenous antibiotic and paracetamol. Sari et al reported fever in 3 patients out of 47 anomalous kidney patients. Bozkurt et al reported minor complications in 3 out of 26 patients while Ergin et al reported minor complications in 12 out of 101 patients.

In our study none of the patients had perforation of PCS, Urosepsis and DJ stent migration.

The limitation of our study is the stone composition. The stone analysis of patients could affect the stone free rate. Relatively hard stone such as Cystine and Calcium Oxalate Monohydrate which are particulary SWL – resistant, may also affect the stone free rate of RIRS. But there is not enough data in the literature regarding the effect of stone composition on stone free rate in kidneys with abnormal anatomy. Further studies are necessary to elucidate this issue.

Conclusion

RIRS with laser lithotripsy has been proven to be a very effective therapy in dealing with urinary stones in anomalous kidneys due to its less invasive nature, ease of reoperation and acceptable complication rates. The delicacy and cost of the equipment are the major issues that should be overcome. Our study proves RIRS to be the choice of procedure in dealing renal stones in anomalous kidneys.

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