Original Article

Is retrograde intrarenal surgery the game changer in the management of upper tract calculi? A single-center single-surgeon experience of 131 cases

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Abstract

Introduction: Success of any modality for stone disease needs to be evaluated in terms of Stone Free Rates (SFR), auxiliary procedures needed; complications and follow up. SFR in RIRS is subject to parameters like stone burden, location, number, hardness, composition; calyceal and ureter anatomy; use of ureteric access sheath (UAS); surgeon experience etc.

Methods: The aim of this study is to evaluate the efficacy and safety of RIRS for managing upper tract stones. The objectives include evaluating SFR in RIRS in relation to stone burden, location and number. Other objectives include evaluating SFR after re RIRS in relation to stone burden, necessity of pre DJ stenting, use of UAS and post operative complication rate. 131 patients operated by single surgeon for single/multiple renal and/or upper ureteric stones were evaluated. Stone size > 3 mm on follow up CT KUB was considered as residual. Re RIRS was required for residual stones.

Results: The overall SFR was 76%. SFR were statistically lower with stone burden > 1.5 cm, lower calyceal stones and single stones with stone burden > 1.5 cm. SFR was 90% after 2nd RIRS and 98.5% after 3rd RIRS procedure. No significant difference in SFR was noted between single v/s multiple stones, single calyx v/s multiple calyx stones and renal v/s upper ureteric stones. No major complication was noted.

Conclusion: Larger stone burden and lower calyceal location are important factors deciding SFR in RIRS. With auxiliary procedure, RIRS is safe and effective compared to PCNL.

Keywords: Flexible ureterorenoscopy, percutaneous nephrolithotripsy, retrograde intrarenal surgery, stone-free rates

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INTRODUCTION

Urolithiasis is a common world health problem causing patient agony, loss of work, and morbidity with grave socioeconomic consequences.[1] Percutaneous nephrolithotripsy (PCNL) is considered the gold standard for managing large and/or complex renal stones, with the potential possibility of complications.[2,3] Retrograde intrarenal surgery (RIRS), also popular as flexible uretero reno scopy (fURS), is less invasive, has fewer complications, and especially, useful in patients with complex anatomical

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kidneys, patients on anticoagulants, and patients with bleeding diathesis.[4,5] Success of any modality for stone disease needs to be evaluated in terms of stone-free rates (SFRs), auxiliary procedures needed, complications, and long-term follow-up. SFR in RIRS is subject to multiple parameters such as stone burden, stone location, number of stones, stone hardness (as measured by Hounsfield value on computed tomography CT scan), stone composition, calyceal anatomy, ureter anatomy, use of ureteral access sheath (UAS), and surgeon experience. We have evaluated the SFR in RIRS in relation to the stone burden, stone location, and stone number and present our experience. We thereby analyze and compare the efficacy and safety of RIRS against PCNL and its miniaturized versions.

METHODS

Aim

This study aims to evaluate the efficacy and safety of RIRS for the management of upper tract calculi.

Objectives

- To evaluate the SFR for renal and upper ureteric stones after RIRS on follow-up plain CT scan of kidney, ureter, and bladder (KUB)
- To evaluate the SFR after RIRS in relation to the stone burden, ranging from stone burden <1 cm to stone burden >2 cm
- To evaluate the SFR after RIRS in relation to the stone location
- To evaluate the SFR after RIRS in relation to the number of stones (single vs. multiple stones)
- To evaluate the SFR after re-RIRS procedure in relation to the stone burden
- To evaluate the necessity of pre-double J (DJ) stenting for RIRS
- To evaluate the use of UAS in patients for RIRS
- To evaluate the complication rate post-RIRS.

Ethics

The study protocol was reviewed and approved by the scientific committee and ethics committee of our hospital. All patients were counseled preoperatively regarding the merits and demerits of RIRS versus PCNL and were given the choice to select the modality. Informed consent was taken.

Study design

One hundred and thirty-one patients with single/multiple renal and/or upper ureteric stones were operated from August 2015 to April 2017 by a single surgeon. Routine preoperative assessment, urine culture, and plain CT KUB were performed and data were collected. Follow-up plain CT KUB was performed after 4 weeks of RIRS. Re-RIRS procedure was required for residual stones, and the stone clearance was noted after auxiliary procedures.

Inclusion criteria

- Patients with upper tract calculi of age >12 years to geriatric age
- Patients with single/multiple renal and/or upper ureteric stones
- Patients with stones in the upper, middle, and lower calyces; multiple calyces; pelvis; and upper ureteric stones
- Stone burden ranging from <1 to >2 cm
- Previous history of ureteroscopy (URS), PCNL, or extracorporeal shock-wave lithotripsy (SWL)
- Patients with comorbidities such as diabetes, hypertension, and ischemic heart disease and patients on anticoagulants.

Exclusion criteria

- Anatomically abnormal kidneys such as solitary kidney, horseshoe kidney, and ectopic kidney
- Pediatric age group <12 years
- Complete staghorn calculi
- Stone burden more than 3.5 cm.

Preoperative antibiotic was given according to the urine culture and sensitivity report. Stone burden was calculated as the longest dimension of single stone or the mean size of multiple stones. Anticoagulants were withheld for 5 days before the procedure.

We routinely do not pre-stent the patients. Preop stenting is done in cases of urinary tract infection (UTI). RIRS is performed when the repeat urine culture turns sterile after an antibiotic course. Stenting is also done when difficult ureteric anatomy does not allow UAS placement or fURS. Selected cases with large stone burden >2 cm required prior stenting so as to be able to put a bigger UAS or use a digital flexible scope, and thereby, achieve better and early stone clearance. Cystourethroscopy followed by ureteroscopy with a semirigid 4.5 fURS is done. Ureteroscopy helps to dilate the ureter, manage any ureteric stone fragment, and diagnose any surprise pathology such as transitional cell carcinoma in the ureter. Next, we place a UAS over the guidewire. Ureteric balloon dilatation is performed in cases of difficult UAS placement. Double-lumen ureteral catheter may be used to passively dilate the ureter, place a safety guidewire, or perform retrograde pyelography. We do not use any pathfinder or pressurized system or pump for irrigation. We attach a 100-cm extension tube to the flexible ureteroscope and irrigate manually just enough to have a clear vision. This helps avoid putting extra fluid and thereby increasing the intrapelvic pressure.

The next step is backloading the flexible ureteroscope over the guidewire through the UAS. This helps avoid traversing through the ureter blindly, especially, beyond the UAS. All the scopes and instruments are sterilized with plasma sterilization. We begin with inspecting all the calyces to understand the location, size, and number of stones. We try to basket the stones of size <1 cm from lower calyx into upper calyx or desirable position, and larger stones are first fragmented with holmium laser and then basketed. Fluoroscopy is used during the procedure to confirm the straight position of the flexible scope before introducing laser fiber or basket. This helps prevent damage to the scope with laser fiber or basket. A 273-micron laser fiber is usually used; a 200-micron fiber may be used in lower calyceal stones or difficult calyceal anatomy stones. Holmium YAG laser settings are usually 0.5–0.8 J, with a frequency of 12–15 Hz for stone dusting. We dust the stone beginning from periphery to center and later basket a few fragments for stone analysis and stone culture. We now perform contrast study to rule out any contrast intravasation and relook all the calyces with fURS. DJ stent is placed at the end of the procedure.

Postoperatively, patient is monitored for hematuria, flank pain, and signs of septicemia such as fever, chills, or hypotension. Routinely, we discharge patients on the next postoperative day. Follow-up is with plain CT KUB after 4 weeks to evaluate for residual stones. We consider stone fragment size >3 mm as clinically significant residual fragment. Re-RIRS is performed as second stage in case of residual fragment. Ureteric catheter is placed as an external stent in case of complete clearance during relook RIRS and removed on the next day. DJ stent is placed in case of residual stones. Third stage RIRS is required in few selected cases. Stent removal is done under local anesthesia in cases of complete clearance.

Statistics analysis

Data evaluation was done under the expert guidance of our statistician. Chi-square test was used to calculate the P value, $P < 0.01$ considered as significant. Statistical significance was evaluated for SFR after RIRS in relation to the stone burden, stone number, and stone location.

RESULTS

A total of 131 patients were operated for RIRS from August 2015 to April 2017. All patients were adults (mean age 45 years) except 1 child of 12 years of age. Eighty-one patients (61%) were of age <50 years, whereas 50 patients (39%) were aged >50 years. Seventy seven patients were males (59%), while 54 were females (41%). Fifty three patients (40%) had right side stones, 50 patients (38%) had left side, whereas 28 patients had bilateral stones (22%). Sixty nine patients (53%) had single stones, while 62 patients (47%) had multiple stones. The stone distribution was as follows: twelve patients (9%) had upper calyceal stones, 10 (8%) with middle calyceal stones, 26 (20%) with lower calyceal stones, 15 (11%) with pelvic stones, 41 (31%) with multiple calyceal stones, and 27 (21%) had upper ureteric stones. The stone burden was as follows: thirty four patients (26%) had stone size <1 cm, 47 patients (36%) with stone size 1–1.5 cm, 27 patients (21%) with stone size 1.6–2 cm, whereas 23 patients (17%) had stone size >2 cm.

Twenty-six patients were stented preoperatively (20%), whereas UAS was placed in 122 patients (93%). It could not be placed in 9 patients (7%); all of these patients were not stented pre-op. Stenting was done in seven patients (5.5%) for UTI, four patients (3%) were stented and staged due to difficult ureter anatomy, whereas 15 patients (11.5%) were stented pre-operatively for larger stone burden.

The SFR and residual stone rates according to pre-op stone burden and location are as shown in Tables 1 and 2. After the first procedure, we achieved stone clearance in 99 patients (76%) overall, whereas 32 patients (24%) had residual stones. SFR was in 68/81 patients (84%) with stone burden <=1.5 cm, whereas in 31/50 patients (62%) with size >1.5 cm ($P < 0.01$). SFR

Table 1: Stone-free rate according to stone burden after retrograde intrarenal surgery first procedure

Stone burden (cm)	Number of patients	Number of patients with residual stones	Residual stone rate (%)	Stone-free rate (%)
<1	34	4	12	88
1-1.5	47	9	19	81
1.6-2	27	8	30	70
>2	23	11	48	52
Total	131	32		

Table 2: Stone-free rate according to stone location after retrograde intrarenal surgery first procedure

Stone location	Number of patients	Number of patients with residual stones	Residual stone rate (%)	Stone-free rate (%)
Upper calyx	12	2	17	83
Middle calyx	10	1	10	90
Lower calyx	26	9	35	65
Pelvis	15	2	13	87
Multiple calyces	41	13	32	68
Upper ureter	27	5	18.50	81.50
Total	131	32		

was in 15/26 patients (65%) with lower calyceal renal stones whereas in 32/37 patients (86.5%) with non-lower calyceal renal stones (upper calyx, middle calyx, and pelvis stones) ($P < 0.05$). On average, 15/26 patients (65%) with lower calyceal stones had stone clearance versus 28/41 (68%) patients with multiple calyceal stones after the first procedure ($P > 0.05$). Stone clearance was in 49/63 patients (78%) with single calyx stones, while the same was in 28/41 patients (78%) with multiple calyceal stones ($P > 0.05$).

15/22 (68%) patients with lower calyceal stones of size <1.5 cm had stone clearance versus 2/4 (50%) patients with size >1.5 cm at the end of first procedure ($P > 0.05$). 13/16 (81%) patients with multiple calyceal stones of size <1.5 cm had stone clearance, whereas 15/25 (60%) patients with multiple calyceal stones of size >1.5 cm had stone clearance at the end of first procedure ($P > 0.05$). SFR in single stones is in 52/69 (75%) of patients versus 47/62 patients (76%) in multiple stones ($P > 0.05$). Stone clearance in single stones with stone size <=1.5 cm was in 44/49 patients (90%), whereas in 8/20 (40%) of patients with burden >1.5 cm ($P < 0.0001$). Stone clearance in multiple stones with stone size ≤ 1.5 cm was in 24/32 (75%), whereas in 23/30 (76%) of patients with burden >1.5 cm ($P > 0.05$).

Stone clearance was in 77/104 patients (74%) with renal stones, while the same was in 22/27 patients (81.5%) with upper ureteric stones ($P > 0.05$). 18/21 (86%) patients with upper ureteric stones of size <1.5 cm had stone clearance, whereas 4/6 (67%) patients with upper ureteric stones of size >1.5 cm had stone clearance at the end of first procedure ($P > 0.05$).

Out of the 32 patients (24%) with residual stones, two patients (1.5%) were managed with conservative medical management and/or SWL, whereas the rest 30 patients (23.5%) required a relook RIRS procedure. SFR was in 118/131 (90%) of patients after the second RIRS procedure and in 129/131 patients (98.5%) after the third RIRS procedure. The mean residual stone size was 8 mm (4–21 mm range). In patients with stone burden <1.5 cm, 68/81 (84%) stone clearance was achieved after the first procedure and 77/81 (95%) SFR after the second procedure. Among patients with stone size >1.5 cm, 31/50 (62%) achieved SFR after the first procedure, 41/50 (82%) clearance after the second procedure, and 48/50 (96%) clearance after the third procedure.

Most of the patients were discharged the next day. No bleeding or perinephric collection was noted. Fever/chills/hypotension was noted in 8/131 (6%) patients and managed with intravenous antibiotics. Contrast intravasation was noted preoperatively during contrast study in 3/131 (2%) patients, while stent-induced lower urinary tract symptoms were observed in 21/131 (16%) patients. One patient required to be converted to open ureterolithotomy as the ureteric kink did not allow even a guidewire placement. Minimal pain and early convalescence were noted postoperatively in all the patients.

DISCUSSION

RIRS is safe and effective for the management of upper tract stones. Stone clearance has always been a matter of debate for RIRS as compared to PCNL and its miniaturized versions. Prabhakar *et al*. evaluated the efficacy of RIRS for managing larger stones >1.5 cm up to 3.5 cm.[4] They considered residual fragment as a fragment seen on ultrasound after 3 weeks. Their SFR was in 30/34 patients (87%). In our study, fragment of size >3 mm on follow-up plain CT KUB is considered residual. Stone clearance for stone size <1.5 cm is 84%, whereas 62% for stone size >1.5 cm ($P < 0.01$). Demirbas compared the efficacy of ultra-mini PCNL (UMPNL) and RIRS in treating moderate-size kidney stones (greatest diameter of 10–25 mm).[5] SFR was 80% in UMPNL and 74.4% in RIRS ($P > 0.05$). They had significantly poor SFRs for lower pole stones with RIRS (43%) as compared to UMPNL (93%). In our study, stone clearance was 65% with lower calyceal stones as compared to 86.5% with non-lower calyceal stones ($P < 0.05$).

Atis *et al*. found the overall SFRs reached 94.4% for the PCNL group and 92.3% for the RIRS group after auxiliary procedures ($P > 0.05$).[6] In our study, stone clearance was 90% after the second RIRS procedure and 98.5% after the third RIRS procedure. In patients with stone burden <1.5 cm, we achieved 84% SFR at the end of the first procedure and 95% SFR after the second procedure. Among patients with stone size >1.5 cm, 62% SFR could be achieved after the first procedure, 82% SFR after the second procedure, and 96% SFR after the third procedure [Table 3].

Table 3: Stone-free rate according to the number of retrograde intrarenal surgery procedures required with respect to stone burden

Number of retrograde intrarenal surgery procedures	Stone-free rate in stone burden (cm)			
	<1 (%)	1-1.5 (%)	1.6-2 (%)	>2 (%)
First	30 (88)	38 (81)	19 (70)	12 (52)
Second	33 (97)	44 (94)	23 (85)	18 (78)
Third	0	0	26 (96)	22 (96)

Selmi *et al*. evaluated the efficacy of PCNL and RIRS for managing upper calyceal stones of size 10–20 mm and found similar success and complication rates.[7] Giusti *et al*. in their study of 316 patients with mean overall stone size of 16.5 ± 7.9 mm who underwent fURS found the overall primary SFR was 79.1%; the secondary and tertiary SFRs were 89.5% and 91.5%, respectively.[8] They concluded that fURS procedure is safe and effective, and a staged procedure is necessary to achieve SFR with large calculi. De *et al*. reviewed the literature and found that standard PCNL offers SFR superior to those of RIRS, whereas RIRS provides higher SFR than miniaturized PCNL. Considering the added morbidity and lower efficacy of MIPPs, they concluded RIRS as standard therapy for stones <2 cm.[9]

PCNL has its own limitations and potential complications including hemorrhage requiring blood transfusion, fever, sepsis, pneumothorax, and colonic injury.[2] On the contrary, most of the RIRS complications reported are of lower Clavien grades and major complications are uncommon.[10] Positive preoperative urine culture, irrigation rate, and operative time are factors that affect complications.[10] Kaplan has postulated that UAS facilitates repeated passage of the ureteroscope, minimizes damage to the ureter, improves the flow of irrigation fluid and visualization within the urethra, and reduces operative times.[11] This improves both the effectiveness of the surgery and reduces the costs. Placement of the UAS carries an increased risk of ureteral wall ischemia and injury to the mucosal or muscular layers of the ureter, and a theoretically increased risk of ureteral strictures. Auge studied the intrapelvic pressure during fURS with and without UAS and found higher pressures without the use of the UAS. They mention that UAS is potentially protective against pyelovenous and pyelolymphatic backflow with clinical implications for the ureteroscopic management of struvite stones or calculi associated with UTI.[12] We noted a 6% rate of sepsis related events. We propose strict aseptic precautions, plasma sterilization, negative urine culture, and low intrapelvic pressures due to UAS as the factors responsible for low infection rates.

Palmero Martí *et al*. also proposed RIRS as the first-line endourological treatment in stones <2 cm.[13] Breda and Angerri showed an overall SFR of 89.3%, with a major complication rate of 8% for stones >2.5 cm.[14] Recent European Urology Guidelines state fURS as a treatment option for stones < 2 cm within the renal pelvis and upper or middle calyces. RIRS is also recommended for lower calyceal stones including stones of size > 1.5 cm. They also state that fURS is an option to PCNL for stone size >20 mm with high risk of follow-up procedure and need of a DJ stent (Grade B recommendation).[2]

CONCLUSIONS

Larger stone burden and lower calyceal stone location are the important factors deciding low SFR in RIRS. No significant difference in stone clearance is noted between single versus multiple stones, single calyx versus multiple calyx stones, and renal versus upper ureteric stones. RIRS achieves comparable SFR to PCNL with auxiliary procedure in expert hands. Thus, RIRS is a technically feasible, safe, and effective management modality for upper tract stones. We consider the limitation of this article as not being a randomized controlled trial for comparing RIRS versus PCNL. Furthermore, factors such as stone hardness (Hounsfield value on CT scan), stone composition, calyceal and ureteric anatomy, and surgeon expertise need to be evaluated.

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Conflicts of interest
There are no conflicts of interest.

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