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Original Article

Surgery Section

A Retrospective Observational Study for Prediction of Stone Free Status after Single-session of Retrograde Intrarenal Surgery for Renal Stones

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ABSTRACT

Introduction: Retrograde Intrarenal Surgery (RIRS) is a preferred minimal invasive treatment modality for renal stones with advantages of being effective and having lower morbidity rates.

Aim: To predict the Stone Free Rate (SFR) after RIRS with lower pole and non-lower pole stones.

Materials and Methods: The records of 85 consecutive patients who underwent unilateral RIRS from September 2016 to July 2019 were retrospectively analysed. The studied parameters included patient demographics, stone characteristics (size, volume, and attenuation, Lower Pole Infundibulopelvic Angle (LP IPA) and operative time, presence of preoperative Double-J Stent (DJS) and Stone Free Status (SFS). Standard statistical tests were applied with level of significance as p<0.05.

Results: Overall success rate was 83.5% (71 cases) while 14 cases had Residual Stones (RS) at 1 month. The mean age of the patients was 41.07±12.25 years. The mean operative time was 68.85±22.3 minutes. Mean stone size and stone volume were higher in the RS group compared to SF (Stone free) group, 15.07±1.5 mm vs. 12.28±1.6 mm, 1187±145 mm^3 vs. 680.67±289 mm^3 respectively (p<0.001; p<0.001). In RS group, 93% (13) cases had IPA <45°, while 80% cases with IPA >45° were stone free. Patients with non-lower pole stones has SFR 2.8 times compared to LP stones (p<0.001). On linear regression analysis, only LP IPA and LP stone location predicts SFS after RIRS.

Conclusion: Retrograde Intrarenal Surgery (RIRS) is effective procedure for renal stones. Stone size, stone volume, Lower Pole (LP) stone location and LP IPA effectively predict SFR. However, LP IPA and LP stone location are the most significant predictor of SFS, after single session RIRS for solitary renal stone.

Keywords: Infundibulopelvic angle, Lower pole, Stone location

INTRODUCTION

Upper urinary tract calculi are commonly encountered in urology practice accounting for nearly 25% of outpatient's visits [1]. Percutaneous Nephrolithotomy (PCNL) is considered as gold standard for renal calculus >2 cm [2]. But increased risk of complications with PCNL has led to invent of RIRS. RIRS has very well established its role, as a preferred minimal invasive treatment modality for renal stones. Use of flexible ureterorenoscope and Holmium LASER has gained broad popularity in recent years. It is an effective surgical modality with lower morbidity and complication rates. Lesser postoperative pain, less blood loss, shorter hospital stays with good stone clearance rates are the merits of RIRS [3]. Several studies have been conducted to determine the factors affecting SFS after RIRS [4-6]. These studies included factors such as stone number, size, volume, location, hardness of the stones, anatomical features like Infundibulopelvic (IP) angle etc., [7]. Here, authors conducted a study on patients undergoing RIRS comparing the SFR with respect to stone size, stone volume and anatomical location of stone, especially in lower pole of kidney.

MATERIALS AND METHODS

A retrospective observational study was conducted from September 2016 to July 2019 at tertiary care centre on the patients undergoing unilateral RIRS for renal stones of 1-2 cm in size. The study was approved by Institutional Ethical Committee (IEC) with id. INU/RRC/08/2019. Details were retrieved from medical records department and out of 96 patients who underwent RIRS during the study period, 85 patients satisfied the inclusion criteria.

Inclusion criteria: Patients undergoing unilateral procedures for solitary renal stones of 1-2 cm during the study period.

Exclusion criteria: Patients with <15 years of age, patients with anatomically abnormal kidneys, poor on follow-up and patients who did not have a pre or postoperative imaging available.

All patients underwent routine biochemical tests and radiological investigations including Computed Tomography of Kidneys, Ureters and Bladder (CT-KUB) for detailed anatomical characteristics. The study parameters included patients demographics, stone characteristics {size, volume, location to Hounsfield Unit (HU)}, Operative time, LP IPA (<45° or >45°). Stone volume was calculated by: $Length \times Width \times Height \times \pi \times 0.167$ of stone from CT-KUB findings [8]. Urine culture was made mandatory sterile before surgery. Standard institutional antibiotic policy was followed.

Stone location was described into 2 subgroups: lower pole and non-lower pole stones. Lower pole group had 15 cases while non-lower pole group had 70 cases. Cases were also divided according to SFS with Group 1-Stone free and Group 2 Residual Stones (RS) group. Intraoperative and postoperative records were compared in these 2 groups. Comparison included operative time, overall SFR, SFR with reference to IPA and stone location in lower pole or non-lower pole.

Technique: All patients planned for RIRS were preoperatively DJ stented 2 weeks prior. Patients were given general anaesthesia and ureteral access sheath 9.5/11.5 Fr was advanced till pelviureteric junction under C-arm over a glidewire. A 4.9/7.95 French Flexible Ureteroreno Fiberscopes (OLYMPUS) was negotiated till the stone. In cases of lower pole stones, stone was grabbed in basket and shifted to pelvis and then fragmented, if feasible. HO:YAG LASER (200 micron fibre) was used for stone fragmentation. Postoperatively DJS was placed in all cases. Patients were discharged on postoperated day 1, if asymptomatic. All patients underwent X-ray of Kidneys, Ureter and Bladder and Ultrasonography (USG) of KUB region at 1 month, before stent removal for RS. If no RS or CIRF (Clinically Insignificant Residual Fragment i.e., ≤4 mm), then patients underwent stent removal.

STATISTICAL ANALYSIS

Done using Statistical Package for the Social Science (SPSS) (Version 20) software. Comparison of variables between SF and RS groups was done using chi-square test, one-way ANOVA and Linear regression analysis. The level of statistical significance was set at p-value <0.05.

RESULTS

Mean age of patients was 41.07±12.25 years. In present study, study population had male preponderance with 65 males and 20 females with mean BMI of 25.09±5.6 Kg/m^2. Most patients had right-sided stones with mean stone size of 12.46±1.3 mm. On stone distribution characteristics, 50% (44) stones were located in renal pelvis, 21 in mid pole, 15 in lower pole and 5 in upper pole. Mean stone density was 1070 HU [Table/Fig-1].

Variables	RIRS	Variables	RIRS
Sample	85	**Stone distribution**	
Age (years)	41.07±12.25	Upper pole	5
Sex (M:F)	65:20	Mid pole	21
BMI (Kg/m^2)	25.09±5.6	Lower pole	15
Laterality (R:L)	52:33	Renal pelvis	44
Stone size (mm)	12.46±1.3	Stone volume (mm^3)	764.11

[Table/Fig-1]: Patient's demographic characteristics and stone characteristics.
RIRS: Retrograde intrarenal surgery; BMI: Body mass index

All cases were divided in Group 1 (Stone free group) and Group 2 (RS group); on the basis of stone clearance at 1 month imaging study.

SFR was 83.5% at 1 month, with 71 patients out of 85 were stone free. Mean stone size and stone volume in Residual Group (RS) were significantly more than group 1 (p-value <0.001, respectively). These groups were further sub-classified on the basis of LP IPA in <45° and >45° group. The IP angle was a very significant predictor of stone free state (p≤0.001) with only 20% (14) patients having stone cleared in more acute IP angle of less than 45°, while 80% (57) of cases with IP angle >45° were stone free. Stone location in lower pole also adversely affected stone clearance with only 33.33% renal stones got cleared while 94.28% stone were cleared in non-lower pole group (p-value <0.001) [Table/Fig-2].

Variables	Group 1 (SF)	Group 2 (RS)	p-value
No. of cases	71	14	
Stone size (mm)	12.28±1.6	15.07±1.5	<0.001
HU value	1064±310	1116±323	0.576
Stone volume (mm^3)	680.6±289	1187.29±145	<0.001
Laterality			
Right	43 (60.56%)	8 (57.14%)	0.06
Left	28 (39.43%)	6 (42.85%)	
Lower pole IP angle			
<45°	14 (20%)	13 (93%)	<0.001
>45°	57 (80%)	1 (7%)	
Location			
Lower pole (LP)	5 (7.04%)	10 (71.4%)	<0.001
Non-LP	66 (92.95%)	4 (28.6%)	
Operative time (Min)	65.02±5.692	81.85±11.71	0.559

[Table/Fig-2]: Comparison of Study parameters in Group 1 and Group 2.
Statistical analysis was done using Chi-square test and one-way ANOVA; Level of significance considered at p-value less than 0.05; SF: Stone free; RS: Residual stone

On further multivariate linear regression analysis of significant variables neither stone size and nor stone volume predicts SFR. Lower polar stone location and more acute IPA are the strongest predictor of RS following RIRS (p-value <0.001) [Table/Fig-3].

Variable	Coefficient of standard error	T	p-value
Stone volume (mm^3)	0.000	-1.803	0.075
Stone size (mm)	0.022	-1.807	0.075
LP infundibulopelvic angle	0.058	4.841	**<0.001**
Location	0.071	-4.933	**<0.001**

[Table/Fig-3]: Linear regression analysis of significant variables.

DISCUSSION

In the present study mean age of patients was 41.07±12.25 years, with male preponderance as in studies by Tonyali S et al., and Goldberg H et al., [4,5]. In this study, mean stone size was 12.28 mm and 15.07 mm in stone free and RS groups which was similar to study by Tonyali S et al., and Resorlu B et al., [4,6].

With respect to renal anatomy of IP angle, patients with LP IPA less than 45° has stone clearance only in 20% cases, while patients with IPA >45°, 80% stone clearance was observed in single setting of RIRS. Similarly in group 2, 93% cases have RS, if IPA is less than 45°. This difference was found to be statistically very significant (p≤0.001). Our results are corroborated with outcomes of study by Resorlu B et al., who found SFR of 30% and 91.3%, respectively in IPA <45° and >45° [6]. The poorer SFR is attributed to more acute IPA and difficult access of LP stone. Similar results were obtained in systemic review by Karim SS et al., as they found, IPA <30° is most significant predictor of SFR in LP stones with success rate of 78-88% [9].

In the present study, non-lower pole stones had SFR of 92.95%, while lower pole stones had SFR of 7.04%. Similarly, RS group had 71.4% of the stone in LP, with a significant p-value <0.001. As per literature, the SFR after single session of RIRS ranges from 54-96% [10]. Tonyali S et al., also mirrored findings of this study with LP SFR of only 22.2% compared to 60% SFR at other locations [4]. Similarly in a study by Lim SH et al., non LP SFR was 94.4% while SFR in LP was only 60.4% [11]. In the present study, non-LP SFR was 2.8 times more compared to LP stones. However, the findings of Jacquemet B et al., Albala DM et al., and Martin F et al., were contrary and emphasises that LP anatomy fails to impact SFR [12-14].

With respect to above topic, only few studies were encountered, hence a similar prospective study with larger sample size, more detailed LP anatomy including infundibular width and infundibular length could strengthen results of this study and enlighten urologists for proper case selection.

The table below compares the demography and comparative outcomes of the present study with other similar studies [Table/Fig-4].

Factors	Tonyali S et al., [4]	Goldberg H et al., [5]	Resorlu B et al., [6]	Our study
Mean age (Years)	47.2	44.2	32.9	41.07
Sex (M:F)	63:37	54:30	111:96	65:20
Mean stone size (mm)	14.8±5.8	10.8±3.08	16.2±4.1	12.46±1.3
Stone attenuation (HU)	1010±416		1100±367	1070±291
Stone volume (mm^3)	937±92.9	856±89.2		764.11±69.9
Overall SFR	43%		91%	83.5%
Operative time (min)			60.8±24.2	68.85±22.3
Infundibulopelvic angle				
<45°			30%	20
>45°			91.3%	80
Stone free status				
Lower pole	22.2%		78.4%	7.04%
Non-lower pole	60%		91.7%	92.95%

[Table/Fig-4]: Comparison with other studies.

On Multivariate Linear regression analysis of prediction of SFR, no significant impact of stone size and stone volume was detected on SFR; while LP IPA and Lower polar stone location were the most significant parameters determining SFR. Hence, it can be concluded that LP anatomy plays the most important role in SFS in LP stones to be planned for RIRS.

The ideal optimal therapeutic technique is still doubtful. Overall RIRS offers acceptable SFS in non-LP stones. However, patients with LP stones should be subjected to alternative surgical modality specially PCNL, which offers better SFR.

Limitation(s)

There are several limitations with the present study like retrospective nature of study, smaller sample size and evaluation of patients in postop period by X-ray or USG KUB and not by screening CT KUB. This was done as CT-KUB imparts higher radiation exposure and increased cost.

CONCLUSION(S)

Retrograde Intrarenal Surgery (RIRS) is safe and very effective modality for management of upper tract calculi with good SFR. Larger stone size, more stone volume, lower pole stone location and narrower LP IPA predicts the poor SFR after single session of RIRS. However, lower polar stones and LP IPA <45° are the strongest predictor of SFS after RIRS. Alternative surgical modality should be considered for LP stones.

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