

Do we have a limit for retrograde intrarenal surgery for solitary kidney stone?

Bulent Kati, Eyyup Sabri Pelit, Mehmet Demir, Ismail Yagmur, Adem Tuncekin, Halil Ciftci

Harran University, Faculty of Medicine, Urology Department, Sanliurfa, Turkey.

Summary *Objective: The management of urolithiasis in patients with a solitary kidney is challenging for urologists. This study aimed to evaluate the safety of retrograde intrarenal surgery (RIRS) in the treatment of stones in patients with solitary kidney and to reply to the question if there is any limit for this surgery.*

Methods: Between January 2016 and December 2019, we enrolled 52 patients who had a solitary kidney and underwent RIRS. We collected data on preoperative patient characteristics, stone dimensions, and postoperative outcomes. Stone size, duration of operation, duration of fluoroscopy, type of anesthesia, and degree of surgical complication were evaluated retrospectively. Surgeries performed in less and more than 60 minutes and with and without complications were compared.

Results: A total of 52 patients with a kidney stone and a solitary kidney were evaluated. The mean stone size was 14 ± 0.4 cm and surgical success rate was 87.3%. In our study, 13 patients (24.5%) had grade 1 minor complications, and none required a blood transfusion. The mean operation time was 51.9 ± 17.3 minutes. The postoperative creatinine value increased in 6 patients. The duration of operation in the group with complications was significantly higher than that in the group without complications. In patients who underwent an operation lasting ≥ 60 minutes, stone size, fluoroscopy time, and complication rate were significantly higher than in patients who underwent an operation lasting ≤ 60 minutes. Conclusion: Our opinion is to be careful in patients with a solitary kidney with a big stone and we recommend assigning these procedure to experienced hands for not exceeding 60 minutes in one session.

KEY WORDS: Renal stone; Ureterscopy; Retrograde intrarenal surgery; Complication; Solitary kidney.

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INTRODUCTION

Due to recent advances in endourology, increases have been made in the success of surgical treatment of kidney stones as well as of the variety of complications that may develop. Minimally invasive surgery for kidney stones is particularly important for patients with renal failure or with solitary kidney. *Extracorporeal shock wave lithotripsy* (ESWL) treatment is a minimally invasive option that is frequently applicable due to its safety and success rate (1). However, since complications that may develop after ESWL in patients with solitary kidney may be more severe and require urgent intervention, ESWL is far from being

the first option in such patients without pre-stenting (2). In recent years, the advent of medical engineering has increased the suitability of surgical instruments used for the urinary system. In general, *retrograde intrarenal surgery* (RIRS) has been performed successfully and safely in patients with kidney stones (3). In patients undergoing RIRS, minor and major complications may occur due to the operator's surgical experience, the patients' unique situations and technical equipment. Complications can be treated palliatively but in patients with solitary kidneys, they should be considered more serious (4-5), although many studies have suggested that this surgery can be performed safely in solitary kidneys (6-7). We collected data to evaluate surgical outcomes and to identify limits of RIRS for safe treatment of these patients.

MATERIALS AND METHODS

This study was approved by the local ethics committee at our university. We retrospectively reviewed 52 patients with solitary kidneys who were treated with RIRS for renal stones between January 2016 and December 2019 including patients who were older than 18 years of age and were without any additional chronic diseases. The pre-operative urine cultures of all patients were confirmed to be negative. The stone burden was assessed by obtaining the stone's length, which was calculated according to the European Association of Urology guidelines. The RIRS procedures were performed by the same surgical team using a 9.5 F access sheath and the same flexible ureteroscope (*Karl Storz™ Germany*). A double J stent was used in patients who were unable to have an access sheath inserted and the surgery was postponed for 3-4 weeks later. The stones were broken using a Holmium YAG laser device (*Sphinx Xjr™, Germany*) with a force of 6-18 Kw. The anaesthesia type was evaluated in conjunction with the anaesthesiologist who performed high spinal or general anaesthesia according to the condition of the patient. Serum creatinine levels were evaluated preoperatively, at one day postoperatively and at one-week follow-up. Any surgical complications in the patients were assessed using a modified *Satava Classification System* (SCS). The stone sizes, duration of operation, duration of fluoroscopy, type of anaesthesia, and degree of surgical complications were evaluated retrospectively. Operations performed in less or more than 60 minutes were compared to set a time limit for risk of complication.

No conflict of interest declared.

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Statistical analysis

Mean, standard deviation, median, range, frequency and ratio values were used in the descriptive statistics of the data. The distribution of the variables was measured with the Kolmogorov-Smirnov test. An independent sample t-test and the Mann-Whitney U test were used to analyse the quantitative independent data.

In the analysis of dependent quantitative data, the Wilcoxon test was used. A chi-square test was used to analyse the qualitative independent data. For the data analysis, the *Statistical Package for the Social Sciences* (SPSS), version 22.0, was used.

RESULTS

Fifty-two stone patients with solitary kidney were evaluated before and after surgery (Table 1).

The solitary kidneys were congenital in 15 cases (28.3%), caused by a previous contralateral nephrectomy in 21 cases (39.6%) and caused by a non-functioning contralateral unit in 16 cases (32.1%). The postoperative follow-up period was approximately 3 months.

Our surgical success rate was 87.3%. Residual stones less than 4 mm were considered clinically insignificant and were evaluated by non-contrast *computerized tomography* (CT) after postoperative double J stent extraction. Double J stents were removed after an average of 25 ± 7.3 days in patients without additional intervention. Stone location was the lower pole of the kidney in 22 (42.3%) patients, lower pole and pelvis or middle pole in 16 (30%) patients, renal pelvis in 10 patients and upper pole in 4 patients. Mean age, sex and kidney side distribution and mean stone size in patients with and without complications did not differ significantly ($p > 0.05$) (Table 2).

The duration of surgical time in the group with complications was significantly higher than in the group without complications ($p < 0.05$).

There was no significant difference in the duration of fluoroscopy time in the group with and without complications. There was no significant difference ($p > 0.05$) of anaesthesia type in the group with and without complications (Table 2).

The preoperative creatinine value was not significantly different ($p > 0.05$) in patients with or without any complications. In the group with complications, the postoperative increase of serum creatinine was higher than the value recorded in the group without complications ($p < 0.05$) (Table 2). Mean age and sex, anaesthesia type and kidney side distribution of the patients were not significantly different between the groups in terms of operation time ($p < 0.05$).

In the group with operation time ≥ 60 min groups, stone size (Figure 1), duration of fluoroscopy time and any complication rate (Figure 2) were significantly higher than in the group with operation time was ≤ 60 min ($p < 0.05$) (Table 3).

Table 1.

General characteristics of patients with solitary kidney stones.

	Min-max	Median	Mean + s.d./n-%
Age	3.0 - 84.0	45.5	45.3 \pm 17.9
Gender			
Female			22 42.3%
Male			30 57.7%
Side			
Right			25 48.1%
Left			27 51.9%
Kidney stone size (cm)	0.8 - 2.2	1.3	1.4 \pm 0.4
Operation time (min.)	15.0 - 90.0	50.0	50.1 \pm 17.3
Anesthesia Type			
< 60			33 63.5%
≥ 60			19 36.5%
Fluoroscopy time (sec.)	5.0 - 95.0	45.0	42.0 21.8
Anesthesia Type			
General			15 28.8%
Spinal			37 71.2%
Complication			
(-)			40 76.9%
(+)			12 23.1%
Minor complication (grade 1)			1.1 21.2%
Major complication (> grade 1)			2 3.8%
Pre-op serum creatinine (mg/dL)	0.70 \pm 3.00	1.20	1.28 \pm 0.55
Post-op serum creatinine (mg/dL)	0.40 - 8.20	1.00	1.47 \pm 1.54
Creatinine difference (mg/dL)	-1.50 - 6.60	-0.10	0.19 \pm 1.55

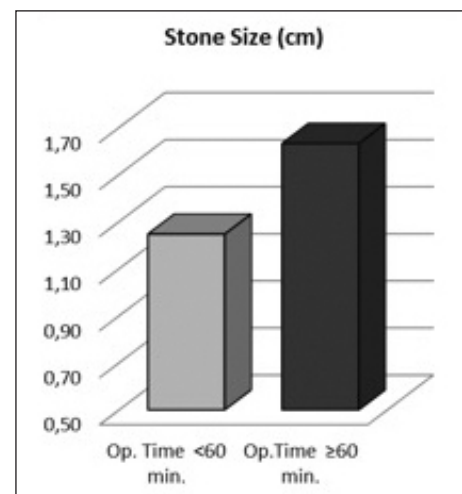


Figure 1. Relationship between stone size and operation time.

Figure 2.

Relationship between operation time and complications.

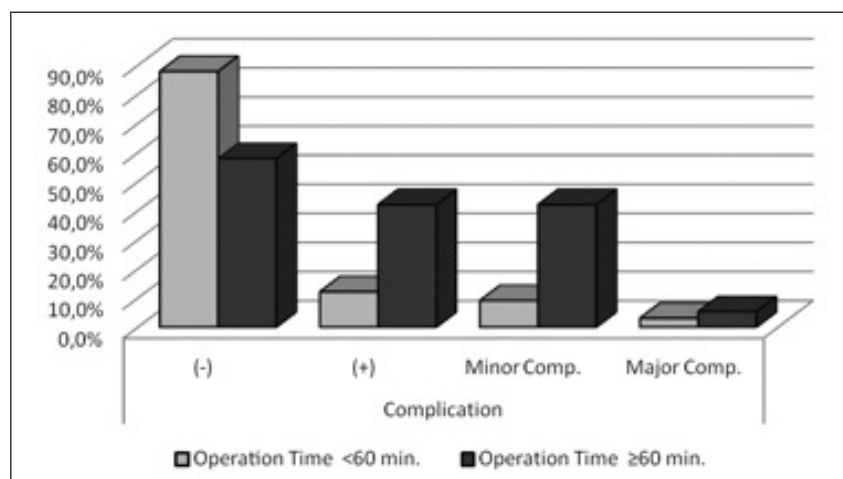


Table 2.
Comparison of patients with complications (minor or major) and without complications after RIRS.

	Complication (-)		Complication (+)		P	
	Mean ± s.s./n-%	Median	Mean ± s.s./n-%	Median		
Age	45.8 ± 18.9	45.5	43.8 ± 14.7	45.5	0.735 ^t	
Gender	Female	16 42.4%	6 50.0%		0.539 ^{X²}	
	Male	24 57.6%	6 50.0%			
Side	Right	19 54.5%	6 50.0%		0.879 ^{X²}	
	Left	21 45.5%	6 50.0%			
Stone size (cm)	1.3 ± 0.4	1.1	1.6 ± 0.4	1.5	0.099 ^m	
Operation time (min.) Süresi Dk	46.8 ± 15.1	45.0	61.3 ± 19.4	60.0	0.010 ^t	
Fluoroscopy time (min.)	39.3 ± 20.8	40.0	51.1 ± 23.4	52.5	0.100 ^t	
Anesthesia Type	General	11 27.5%	4 33.3%		0.696 ^{X²}	
	Spinal	29 72.5%	8 66.7%			
Serum creatinine (mg/dL)	Pre-op	1.23 ± 0.44	1.20	1.42 ± 0.83	1.15	0.810 ^m
	Post-op	1.03 ± 0.43	0.90	2.93 ± 2.72	2.05	0.005 ^m
Preop-postop difference	-0.20 ± 0.61	-0.10	1.52 ± 2.70	0.40	0.014 ^m	
In-group difference (p)	0.052 ^w		0.109 ^w			

^t: t test; ^m: Mann-Whitney u test; ^{X²}: Chi-square test; ^w: Wilcoxon test

Table 3.
Comparison of RIRS cases above and below 60 minutes of operation time.

	Operation time < 60 min.		Operation time ≥ 60 min.		P	
	Mean ± s.s./n-%	Median	Mean ± s.s./n-%	Median		
Age	44.8 ± 17.8	41.0	46.2 ± 18.6	52.0	0.798 ^t	
Gender	Female	14 42.4%	8 42.1%		0.982 ^{X²}	
	Male	19 57.6%	11 57.9%			
Side	Right	18 54.5%	7 36.8%		0.219 ^{X²}	
	Left	15 45.5%	12 63.2%			
Stone size (cm)	1.2 ± 0.4	1.0	1.6 ± 0.4	1.8	0.003 ^m	
Fluoroscopy time (min.)	31.4 ± 15.1	30.0	60.4 ± 19.4	60.0	0.000 ^t	
Anesthesia Type	General	7 21.2%	8 42.1%		0.109 ^{X²}	
	Spinal	26 78.8%	11 57.9%			
Complication	(-)	29 87.9%	11 57.9%		0.013 ^{X²}	
	(+)	4 12.1%	8 42.1%			
Minor complication	3 9.1%		8 42.1%		0.005 ^{X²}	
Major complication	1 3.0%		1 5.3%		0.687 ^{X²}	
Serum creatinine (mg/dL)	Pre-op	1.2 ± 0.5	1.2	1.3 ± 0.6	1.3	0.723 ^m
	Post-op	1.2 ± 1.0	0.9	1.9 ± 2.1	1.0	0.264 ^m
Preop-postop difference	0.0 ± 1.2	0.1	-0.5 ± 2.0	0.0	0.381 ^m	
In-group difference (p)	0.201 ^w		0.950 ^w			

^t: t test; ^m: Mann-Whitney u test; ^{X²}: Chi-square test; ^w: Wilcoxon test

DISCUSSION

Flexibility and thinning of endoscopic instrumentation have increased day by day for making more comfortable diagnosis and treatment of the urinary system.

Innovations in technology allowed improvement of ureteroscope design, surgical technique, and accessory instrumentation (8).

Although less invasive procedures have been developed for the treatment of kidney stones, the first procedure to be considered for certain types of stones is *extracorporeal shock wave lithotripsy* (ESWL), whose use is controversial

in patients with solitary kidneys. In fact, even if it is not invasive, ESWL is characterized by the risk of complications that may affect renal function and may be risky in patients with solitary kidneys due to a lack of functional compensation by the contralateral kidney. Ureteral obstruction by residual stone fragments (steinstrasse), urinary tract infection and sepsis, asymptomatic renal hematoma, kidney nephron losses, may vary between 6-10% in total and may be a more important risk for patients with solitary kidneys (9).

While *percutaneous nephrolithotomy* (PCNL) is the first surgical option that can be considered for kidney stones larger than 2 cm, RIRS is more preferred in patients with solitary kidney stones to prevent organ loss and greater risk of complications. In recent studies, complications like those of RIRS are described for miniaturized PCNL, which can be used instead of standard PCNL (10).

RIRS is an increasingly common and widely preferred procedure because of its high success rate for 1-3 cm kidney stones and its low complication rates (11-12). However, some minor complications, such as haematuria, hydronephrosis, ureteral obstruction by stone fragments and ureteral double J stent dislocation, might be not significant in a patient with two functional kidneys but could be more important for patients with solitary kidneys requiring urgent intervention.

Concern about the risk of renal dysfunction and subcapsular hematoma associated with the use of high-pressure irrigation during RIRS has been raised (13).

Animal studies have shown that high-pressure irrigation (> 150 mmHg) during ureterorenoscopy without a renal access sheath can lead to parenchymal damage and focal injury of the kidney (14). Therefore, this risk should be taken into consideration especially in patients with solitary kidney and renal access sheath should be used (15). Even if the success rate in the operations does not change, the use of urethral sheath is recommended, if possible, because it keeps the intrarenal pressure low during the procedure and reduces the risk of post-operative infection (16). We used a 9.5 F renal access sheath in all patients without pre-stenting. It has been shown that inserting a DJ stent before surgery does not affect complication or success (17, 18).

Performing RIRS should be more careful in patients with a solitary kidney stone. The application of access sheaths and use of laser should not harm the kidney or ureter and at the end of the procedure, it should be checked DJ stent correct placement (3, 7).

In our study surgery in solitary kidney was performed by experienced surgeons. The mean stone size was 14 ± 0.4 cm, surgical success was 87.3% and 4 patients (7.5%) had residual stones of

more than 4 mm. After all the procedures, DJ stents were applied and checked and left for the second session.

Classification systems have been proposed over time for grading complications that can develop during and after RIRS. We assessed complications using a modification of *Satava Classification System (SCS)* (19).

Ural et al. reported nearly 32% grade 1 intraoperative complications after RIRS according to modified SCS. Grade 1 complications included minimal haematuria, ureteral mucosal surface damage, and difficulties in reaching the stone (20). *Kuroda et al.* reported a rate of minor complication about 5% in a study comparing RIRS performed in solitary kidneys and normal patients (14). *Atis et al.* reported a rate of minor complications of 16.6% with no major complications and no need of blood transfusions (6).

In our study, 11 patients (20.5%) had grade 1 minor complications (most of them mild haematuria that was observed in 8 patients) and no one needed for blood transfusion. DJ stent migration is especially troublesome in postoperative follow-up of patients with solitary kidney. Although DJ stents are known to cause post-operative irritating symptoms, they should be applied after RIRS especially in patients with solitary kidneys (21). Accordingly, we applied DJ stents to all patients at the end of the procedure. Grade 3-4 complications after RIRS can threaten the health of patients. Although they are rare in the literature, deficit of post-operative follow-up and patient unconsciousness can increase the importance of these complications (22, 23). Two of our patients developed postoperative high serum creatinine and oliguria-anuria after discharge. The first patient did not receive enough post-operative hydration causing a reduced urine output until oliguria developed. On postoperative day 4th, urine output and serum creatinine levels returned to normal with appropriate hydration.

The other patient presented with anuria on the 5th postoperative day. He reported that his urine output had decreased and ceased for the last two days. Despite appropriate hydration, urine output did not increase, and serum creatinine values increased to around 8.9 mg/dl.

The patient was urgently operated: after DJ stent removal, ureteroscopy demonstrated a dust of fragments adherent along the ureter, ureter was cleaned, and a new 6 F DJ stent was placed. Although postoperative urine output increased, serum creatinine values did not fall below 4.3 mg/dl.

After the consultation of the nephrology department, it was decided to enter in a dialysis program with the diagnosis of chronic renal failure. Although major complications after RIRS are not common in the literature, poor socioeconomic conditions can affect the post-operative recovery of the patients (3-7).

It has been reported that patients with solitary kidney have very low complication rates compared to *percutaneous nephrolithotomy (PCNL)* (11, 22). RIRS has been considered a better alternative to PCNL surgery because of similar surgical success, but less blood loss and hospital stay (24).

When we evaluated our patients, we observed that minor and major surgical complications increased significantly after surgery of stone greater than 20 mm and when surgery time was more than 60 minutes. (Table 3) Although

RIRS appears to be safe and successful in patients with solitary kidneys, the prolongation of surgery may lead to an increase of postoperative complications. We set the 60-minute limit although this limit can be influenced by the characteristics of the patient, of the stone and of the surgical procedure.

Patients with solitary kidneys should be well informed and followed up before and after surgery. When evaluating a patient, attention should be paid to the size of the stone and therefore to the risk of increased surgical time. For cases that are thought to exceed one hour, we recommend leaving a DJ stent for a second session.

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Correspondence

Bulent Kati, MD, Associate Prof. (Corresponding Author)
bulentkati@harran.edu.tr

Eyyup Sabri Pelit, MD
dreyyupsabri@hotmail.com

Mehmet Demir, MD
drdemir02@gmail.com

Ismail Yagmur, MD
dr_iyagmur@hotmail.com

Adem Tuncekin, MD
dr_adem65@hotmail.com

Halil Ciftci, MD
halilciftci63@hotmail.com

Harran University, Faculty of Medicine Hospital, Urology, 63340 Sanliurfa (Turkey) Osmanbey Kampusu Urology Bolumu 63320 Sanliurfa (Turkey)