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Comparison of the outcomes of retrograde intrarenal surgery performed in upper urinary tract stones of any size at any location using three same-model flexible ureterorenoscopes

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Abstract

Aim: To evaluate the patients that were operatively treated using retrograde intrarenal surgery (RIRS) with three same-model ureterorenoscopes by a single surgeon in a single clinic between January 1, 2013 and December 31, 2017 and to compare the treatment outcomes.

Materials and methods: The retrospective study included a total of 267 patients that underwent RIRS via three different flexible endoscopes of the same brand between January 1, 2013 and December 31, 2017. The 267 patients were divided into three groups based on the endoscope used for each patient: group I (n=85), group II (n=82), and group III (n=100). Demographic characteristics (age, gender, body mass index (BMI), preoperative diseases, and history of extracorporeal shockwave lithotripsy (ESWL) and percutaneous nephrolithotomy (PCNL)), stone characteristics (affected kidney side, stone size and opacity, and locations of stones in kidneys), and surgical characteristics (operative and fluoroscopy times, use of ureteral access sheath [UAS], characteristics of patients for whom no UAS was implanted, pre- and post operative double-J (JJ) stenting, reasons for JJ stenting, UAS status in prestented patients, and postoperative Visual Analogue Scale (VAS) scores), classification of complications based on the modified Clavien-Dindo Classification System, and the residual rates in subgroups and all patients were reviewed for each patient. All the patients were followed up for 3 months postoperatively.

Results: The 267 patients were divided into three groups based on the endoscope used for each patient: group I (n=85), group II (n=82), and group III (n=100).No significant difference was found among the three groups with regard to demographic and stone characteristics and postoperative complications. The number of patients that underwent preoperative ESWL was the lowest in group III. However, significant differences were found among the three groups

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with regard to surgical characteristics (diameter of ureteral access sheath (UAS), UAS implantation, pre- and postoperative JJ stenting, reasons for preoperative JJ stenting, and UAS implementation in prestented patients). According to the modified Clavien-Dindo Classification, grade I complications were detected in 42, grade II complications in 23, grade IIIa complications in 12, and a grade IV complication was detected in 1 patient. As an auxiliary procedure for residual fragments, ESWL was performed in 22, ureteroscopy and laser stone fragmentation (URSL) was performed in 8, and RIRS was performed in 5 patients. The overall residual rate was 16.5%.The residual rate was 10.5% in stones <2 cm and was 26.7% in stones ≥2 cm and no significant difference was found. The patients were further classified based on stone localization: (i) ureteral, (ii) lower calyx, (iii) renal pelvis (upper-middle calyx and renal pelvis), and (iv) multiple calyces, and the highest residual rate was in lower calyx stones ≥2 cm. No significant difference was observed in terms of residuel rates among the subgroups of the three groups (prestented patients and patients with ureteral stones, renal pelvic stones, lower calyx stones, and UAS) with regard to both stone sizes, whereas a significant difference was found among the groups with regard to multiple calyx stones, all of which were larger than 2 cm.

Conclusion: Although RIRS may provide successful outcomes in upper urinary tract stones <2 cm, it cannot provide the same success in stones ≥2 cm. Prior to the RIRS procedure, the patients should be informed about this fact and the possibility that repeated RIRS sessions may be implemented with the support of auxiliary procedures if needed.

Introduction

Open surgery and Extracorporeal shockwave lithotripsy (ESWL) are known as the oldest techniques in the treatment of urinary tract stones. Of these, ESWL has been used since 1980s and remains an important technique in the treatment of urolithiasis [1,2]. Open surgery, on the other hand, has become a less preferred technique since early 1990s, particularly after the emergence of endoscopic instrument technology [3]. Additionally, open surgery is currently almost never used in the treatment of urolithiasis except for specific patients. Technological advancement in the field of ureteroscope technology chiefly involved the introduction of rigid instrumentation and these endoscopes have provided successful outcomes in lower ureteral stones and are currently used as the first-line treatment [4]. On the other hand, rigid ureteroscopes have been tried in the treatment of renal stones and upper ureter stones located above the lower level of the fourth lumbar vertebra corpus, and major complications and treatment failure have been reported [5]. With the advancement of flexible endoscope technology, however, relatively more successful outcomes with lower complication rates have been reported in upper ureteral and renal stones. Alternatively, retrograde intrarenal surgery (RIRS) has been proposed as a viable technique for patients that are indicated for percutaneous nephrolithotomy (PCNL) but also have hemorrhagic diathesis, morbid obesity, and ureteral stones, for patients with musculoskeletal deformities, and also for certain subgroups of patients for whom being stonefree is mandatory such as airline pilots [6]. Nevertheless, although RIRS has been shown to provide successful surgical outcomes in stones of any size, there is no stone size limit defined for RIRS in the literature.

In the present study, we aimed to evaluate the patients that were operatively treated using RIRS with three different flexible ureterorenoscopes of the same brand by a single surgeon in a single clinic between January 1, 2013 and December 31, 2017 and to compare the treatment outcomes in light of literature.

Materials and methods

Study design

The retrospective study included a total of 267 patients that underwent RIRS under flexible ureterorenoscopic guidance between January 2013 and December 2017. All the surgical procedures were performed by the same surgeon (Y.G.) at the same clinic, using three different flexible endoscopes of the same brand (Karl-Storz, Tuttlingen/Germany). The 267 patients were divided into three groups based on the endoscope used for each patient: group I (n=85), group II (n=82), and group III (n=100). The study included patients that had no benefit from other stone treatments, had an American Society of Anesthesiologists (ASA) score of <2, and provided a written consent form. However, pediatric patients and patients with abnormal serum creatinine levels were excluded from the study. Demographic characteristics (age, gender, body mass index [BMI], preoperative diseases, and history of ESWL and PCNL), stone characteristics (affected kidney side, stone size and opacity, and locations of stones in kidneys), and surgical characteristics (operative and fluoroscopy times, use of Ureteral Access Sheath (UAS), characteristics of patients for whom no UAS was implanted, pre- and post-operative double-J (JJ) stenting, reasons for JJ stenting, UAS status in patients stented with a JJ stent, and postoperative Visual Analogue Scale (VAS) scores),classification of complications based on the modified Clavien-Dindo Classification System, and the residual rates in subgroups and all patients were reviewed for each patient.

Preoperative assessment

Biochemical analysis, urine analysis and culture, plain radiography of the kidneys, ureters and bladder (KUB), renal ultrasonography (USG), and/or a Computed Tomography (CT) scan were performed for each patient. Stone size was measured as the longest diameter of the stone on the plain radiography of KUB or CT. Patients were taken to surgery after ensuring a negative urine culture. Single-dose intravenous (IV) ciprofloxacin was used as preoperative prophylaxis. All the surgical procedures were performed under general anesthesia.

Operative technique

A hydrophilic tip guidewire was inserted to the renal pelvis and then a UAS was placed over the guidewire and advanced into the renal pelvis. In patients in whom the UAS could not be advanced, no balloon dilation was performed. In some of these patients, a flexible ureterorenoscope was placed over the guidewire and advanced to the upper urinary tract; however, in failed cases or occasionally at the discretion of the surgeon, a JJ stent was implanted to achieve passive dilation and the surgery was postponed for 2-4 weeks in these patients. Subsequently, a 8.5 F flexible ureterorenoscope was inserted into the upper urinary tract and stone fragmentation and dusting were performed using a holmium (Ho): yttrium-aluminum garnet (YAG) laser(200-272 μm fiber) adjusted to produce 0.8-1.5 J at a pulse frequency of 8- 15 Hz. The fragments were removed with a stone extractor (NGage, Cook Urological Inc., Bloomington, IN, USA) adjusted to 1.7 or 2.2 nm. To facilitate stone fragmentation, the fragments with appropriate sizes were extracted to a suitable calyx or renal pelvis using the NGage basket. After complete fragmentation, a JJ stent or ureteral stent was inserted in each patient based on the surgeon's preference. The operative time was defined as the time from the introduction of the rigid endoscope to the insertion of a ureteral or JJ stent. Postoperative complications were classified according to the modified Clavien-Dindo Classification System [6].

Postoperative follow-up

At postoperative day 1, biochemical analysis, plain radiography of KUB, renal USG, and non-contrast-enhanced CT were performed for each patient. The same procedures were repeated at postoperative months 1 and 3. Patients with no symptoms or residual fragments smaller than 3 mm were accepted as stone-free.

Statistical analysis

Data were analyzed using SPSS for Windows version 22.0 (SPSS Inc. IBM Corp., Armonk, NY, USA). Normality of distribution was assessed using Shapiro-Wilk and Kolmogorov-Smirnov tests. Data with normal distribution were compared using One-Way ANOVA and data with non-normal distribution were compared using Kruskal Wallis test. The post hoc tests were subsequently performed using Tukey's test. A *p* value of <0.05 was considered significant.

Results

Table-1 presents the demographic and stone characteristics. Mean age was 45.9±15,1, 43.1±13,9 and 43.6±12,4 years in groups I, II, and III, respectively. The mean stone size of 15.45±7.07, 15.73±8.16, and 17.05±8.6 mm in groups I, II, and III, respectively. No significant difference was found between the groups with regard to gender, age, BMI, comorbidity, anticoagulant usage, previous ESWL/ PNL, stone opacity, stone side (right or left), location,and size.

Table-2 presents the operative data. There was a significant differences in terms of pre operative JJ stent, access sheath placement, JJ stent placement between the groups (<0,001, 0,026 and <0,001, respectively). However, operation time and flouroscopy time were not significant.

Table-3 presents the postoperative data. No significant difference was found between the groups with regard to residuel stone, auxiliary treatment and postoperative VAS score.

Table-4 presents the complication analysis. The overall complications were 29.4%, 32.9% and 27% in groups I, II, and III, respectively. No significant difference was found among the groups with regard to complications.

Table 1: Demographic data and stone characteristics

Variable	Group-1 (n:85)	Group-2 (n: 82)	Group-3 (n: 100)	p
Sex (female/male)	39/46	27/55	29/71	0.14
Age (years), mean ± sd	45.9±15,1	43.1±13,9	43.6±12,4	0.24
BMI (kg/m^2), mean ± sd	27.1±5,0	26.4±3,0	26.5±4,4	0.62
Comorbidity, n (%)				0,08
Dm	11 (12,3%)	7 (8,5%)	9 (9%)	
Ht	23 (27,1%)	19 (23,2%)	20 (20%)	
Cold	2 (2,4%)	1 (1,2%)	4 (4%)	
Anticoagulant usage, n (%)	5 (5,6%)	3 (3,7%)	7 (7%)	0,07
Previous Eswl/ Pnl, n (%)				
Eswl	46 (54,2%)	40 (48,8%)	33 (33%)	*0,04*
Pnl	2 (2,4%)	0	1 (1%)	0,17
Stone opacity, n (%)				0.69
Opague	54 (63,5%)	57 (69,5%)	68 (68%)	
Non-opaque	31 (36,5%)	25 (30,5%)	32 (32%)	
Stone side, n (%)				0.92
Right	44 (51,8%)	42 (51,2%)	47 (47%)	
Left	41 (48,2%)	40 (48,8%)	53 (53%)	
Stone size (mm), mean ± sd	15.4±7,07	15.7±8.16	17.0±8.6	0.25
Stone localization,n (%)				
Pelvis	22 (25,9%)	26 (31,7%)	31 (31%)	0,72
<2 cm	14 (16,5%)	16 (19,5%)	16 (16%)	
≥2 cm	8 (9,4%)	10 (12,2%)	15 (15%)	
Lower calyx	25 (29,4%)	24 (29,3%)	28 (28%)	0,68
<2 cm	14 (16,5%)	15 (18,3%)	19 (19%)	
≥2 cm	11 (12,9%)	9 (10,1%)	9 (9%)	
Ureter	33 (38,8%)	24 (29,3%)	34 (34%)	0,11
<2 cm	28 (32,9%)	21 (25,6%)	23 (23%)	
≥2 cm	5 (5,9%)	3 (3,7%)	11 (11%)	
Multiple calyx#				
≥2 cm	5 (5,9%)	8 (9,8%)	7 (7%)	0,23

SD: Standart Deviation; BMI: Body-Mass Index; Dm: Diabetes Mellitus; Ht: Hypertention, Cold:Chronic Obtructive Lung Disease; Eswl: Extracorporeal Schock Wave Lithotripsy; Pnl: Percutaneous Nephtolithotomy

All Stones In This Group Were Larger Than 2 Cm.

Table 2: Operative data

Variable	Group-1 (n:85)	Group-2 (n: 82)	Group-3 (n: 100)	p
Operation time (min.), mean ± sd	48,4±12.2	50,8±16,3	48,6±7,1	0,53
Fluoroscopy time (sec.), mean ± sd	59,6±22,1	60,2±26,7	57,8±22,5	0,42
Pre-operative JJ stent, n(%)	43(50.6%)	24(29.3%)	19(19%)	<0,001
Access sheath placement, n(%)	85 (100%)	64 (78%)	36 (36%)	0,026
JJ stent placement, n(%)	85 (100%)	72 (87.8%)	74 (74%)	<0,001
Post-op VAS score, mean ± sd	4,09±1,6	4,05±1,42	3,9±1,80	0,28

VAS: Visual Analog Scale

Table 3: Comparison of the groups in terms of residuel stone, auxiliary treatment and postoperative VAS score

Variable	Group-1 (n:85)	Group-2 (n: 82)	Group-3 (n: 100)	p
Residuel stone, no (%)				
overall	17(20%)	14(17.1%)	13(13%)	0.421
< 2 cm	7(11.3%)	6(10.7%)	4(6.9%)	0,296
≥2 cm	10(34.5%)	8(26.6%)	9(21.4%)	0,482
pelvis	3/22(13,6)	4/26 (15,4%)	3/31 (9,7%)	0,447
lower calyx	9/25(36%)	7/24 (29,2%)	7/28 (25%)	0,3650,550
ureter	3/33(9,1%)	3/24 (12,5%)	2/34 (5,6%)	0,032
multiple calyx	2/5 (40%)	0/8 (0%)	1/7 (14,3%)	
Auxiliary treatment, no (%)				
Eswl	7 (8,3%)	4 (4,9 %)	11 (11 %)	0,3740,326
Urs	3 (3,5%)	1 (1,2 %)	4 (4 %)	0,577
RIRS	2 (2,6%)	1 (1,2 %)	3 (3 %)	
Post-op VAS score, mean ± sd	4,09±1,6	4,05±1,42	3,9±1,80	0,28

ESWL: Extracorporeal Schock Wave Lithotripsy; URS: Ureterorenoscopy; RIRS: Retrograde Intrarenal Surgery, VAS: Visual Analog Scale

Table 4: Comparison of complications between the groups

Variable	Group-1 (n:85)	Group-2 (n: 82)	Group-3 (n: 100)	p
Overall complications, no (%)	25 (29.4%)	27 (32.9%)	26 (27.0%)	0.421
Complications, no (%)				
fever	3 (3,5 %)	1 (1,2 %)	2 (2 %)	0,326
uti	2 (2,4 %)	3 (3,7%)	4 (4 %)	0,392
urosepsis	2 (2,4%)	9 (11,0 %)	3 (3 %)	0,026
perforation	1 (1,2%)	1 (1,2 %)	0 (%)	0,986
subcapsular hematoma	1 (1,2 %)	0	0	0,325
ileus	3 (3,5%)	1 (1,2 %)	1 (1 %)	0,326
steinstrasse	2 (2,4 %)	3 (3,7 %)	5 (5%)	0,633
renal colic	3 (3,5%)	4 (4,9 %)	5 (5%)	0,678
JJ-related discomfort	8 (9,4 %)	5 (6,1 %)	6 (6%)	0,612
Modified Clavien-Dindo classification				
no complication	60 (70,6 %)	55 (67,1%)	74 (74%)	0,663
grade 1	17 (12 %)	11 (13,4 %)	14 (14 %)	0,243
grade 2	4 (4,7 %)	12 (14,6 %)	7 (7%)	0,031
grade 3a	3 (3,5%)	4 (4,9 %)	5 (5%)	0,678
grade 4	1 (1,2%)	0	0	0,325

Discussion

Extracorporeal shockwave lithotripsy (ESWL) is the method of choice in the treatment of renal and ureteral stones <2 cm around the world. ESWL has been reported to provide a stone-free rate of 50-80% and these rates are known to be affected by a number of factors including stone density, BMI, and musculoskeletal deformities. On the other hand, ESWL has been reported to have several drawbacks such as requirement of repeated sessions, long intervals between repeated sessions, and renal colic attacks [7].

Percutaneous nephrolithotomy (PCNL) is the golden standard in the treatment of renal stones ≥2 cm. However, although PCNL provides significantly high stone-free rates, it may lead to major complications, though rarely [8]. To reduce these complications and the risk of perioperative morbidity, various PCNL procedures have been developed, including mini, ultramini and micro PCNL [11]. Nevertheless, even mini-PCNL leads to longer hospitalization periods as well as higher fluoroscopy exposure and greater decrease in hemoglobin (Hb) levels compared to RIRS [9].

Retrograde intrarenal surgery (RIRS) is emerging as an increasingly popular technique in the treatment of upper urinary tract stones due to the advancements in flexible endoscopic devices and laser technology. Moreover, RIRS can be used for stones of any size and has been shown to be a viable alternative treatment for patients with failed ESWL or patients who have a stone >2 cm and do not wish to undertake the risk of complications associated with PCNL.

On the other hand, RIRS can also be successfully used in pediatric and geriatric patients of any age with no need to modify the endoscope. RIRS provides higher stone-free rates compared to ESWL [10] and also leads to shorter hospital stays, earlier return to daily life activities, lower complication rates, and acceptable stone-free rates compared to PCNL and mini-PCNL [11].

Accumulating evidence suggests that the success of RIRS is associated with a number of factors including the localization of stones in kidneys, stone size, anatomical characteristics of kidneys, period of impaction in ureteral stones, operative time, history of ESWL, preoperative JJ stenting, presence of UAS, and surgical experience [12]. RIRS has been shown to provide a success rate of 90-100% in urinary tract stones <2 cm [8]. In our study, the overall stone-free rate in our patients was 89.5%. Some previous studies compared the success rates of PCNL, mini-PCNL, and RIRS in ESWL-refractory stones smaller than 2 cm and reported similar success rates for the three approaches [13]. In such patients, loss of orientation and poor surgical visibility rarely occur during lithotripsy as their stone burden is relatively lower.

It is commonly known that as the stone size increases, the chance of stone clearance in a single RIRS session decreases. In large stones (≥2 cm), the dust resulting from stone fragmentation, the fragments accumulating in the surgical site, and the mucosal bleeding in the form of hematuria gradually lead to reduced surgical visibility during the surgical procedure. Complete advancement of UAS to the renal pelvis is likely to facilitate renal drainage. In most patients, however, the UAS cannot be advanced to the renal pelvis or migrates to the distal ureter during the surgery and thus total drainage cannot be achieved.

In our study, although no significant difference was found among the subgroups of patients with a stone ≥2 cm, patients with a stone ≥2 cm had an overall residual rate of 26.7% and a stone-free rate of 73.3%. Some previous studies compared PCNL and RIRS and reported that PCNL is superior to RIRS with regard to stone-free rates and that RIRS may provide acceptable success rates through repeated RIRS sessions. However, the studies also indicated that RIRS is superior to PCNL with regard to complication rates, reduced Hb levels, fluoroscopy exposure, and hospitalization periods [13]. Zhao et al. found that lower calyx stones, multiple calyx stones, and the presence of severe hydronephrosis were significant predictive factors for lower stone-free rates in RIRS in patients with 2-3 cm stones [14]. On the other hand, a previous study revealed that despite the documented superiority of PCNL over RIRS in stones ≥2 cm with regard to the stone-free rates achieved by a single session and although the patients were informed about this fact, most of the patients preferred RIRS over PCNL. This could be a reason as to why RIRS is an increasingly popular technique for the treatment of stones ≥2 cm. Additionally, a European Association of Urology Section of Urolithiasis (EULIS) Survey compared the effectivity of treatment techniques for renal stones >2 cm and revealed that RIRS is highly popular among urologists [15].

Another factor contributing to RIRS success is the calyx harboring the renal stone. The lower calyx is the most difficult to access by endoscopy and is also the most difficult to clear even after stone fragmentation. Literature indicates that the stone-free rates for the lower calyx are lower than those of other calyces even in stones <2 cm [16]. Some systematic reviews compared the effectivity of conventional PCNL, mini-PCNL, RIRS, and ESWL in lower calyx stones and indicated that the PCNL provided the highest success rates while ESWL had the lowest success rates [17]. Tonyali et al. found that the risk of residual fragments after RIRS was 2.25 times higher for the lower calyx compared to other calyces. In our study, the residual rate was 28.6% and the stone-free rate was 71.4% in all lower calyx stones, which were consistent with those reported in the literature. Moreover, no significant difference was found among the three groups and the subgroups, and the overall residual rate was 16.6% in stones <2 cm and 48.3% in stones ≥2 cm [18].

Factors contributing to RIRS failure in lower calyx stones include Infundibulopelvic angle (IPA), infundibular width (IW), infundibular length (IL),pelvicalyceal height (PCH),and stone size. Kilicaslan et al. used a cut-off value of 5 mm for IW in lower calyx stones [19], Karim et al. suggested that IPA is the most significant predictor of treatment outcomes for lower calyx stones [38], and Sari et al. defined the cut-off values for IPA, PCH, and stone size as 69.4°, 2.02 cm, and 17 mm, respectively [20]. Based on these findings, we recommend that in patients with lower calyx stones, preoperative urographic findings (intravenous pyelogram (IVP) or CT urography findings) should be evaluated based on these criteria and the patients and their relatives should be informed about the estimated surgical success prior to surgery.

Literature indicates that RIRS has higher residual rates compared to PCNL particularly in upper urinary tract stones ≥2 cm. Accordingly, administration of multiple RIRS sessions or the use of auxiliary procedures is often required to achieve complete stone-free status in stones ≥2 cm [21]. In the present study, ESWL, URSL, and RIRS were performed as auxiliary procedures in 22, 8, and 5 patients, respectively. Although these groups differed in terms of number of patients, this difference was statistically insignificant. In total, RIRS, ESWL, and URSL were performed in a total of 272, 22, and 8 patients, respectively, and the overall success rates were calculated based on the non-contrast enhanced CT scans performed at postoperative month 1 [22].

Flexible ureterorenoscopy (f-URS) has been shown to provide success rates of up to 100% in small and non-impacted upper ureter stones without causing any complications. However, in impacted, infected, ESWL-refractory upper ureter stones larger than 2 cm, the mucosal edema and polyps caused by long-term pressure of the stone on the mucosa leads to the easily mucosal bleeding and the inadequate working site for lithotripsy, in this case may lead to complications such as inadequate lithotripsy and ureteral perforation and also increase the need for auxiliary procedures, and even may result in nephrectomy due to complete ureteral detachment.

In our study, the overall residual rate and the stone-free rate for ureteral stones were 8.8% and 91.2%, respectively. Additionally, the overall stone-free rate in patients with stones ≥2 cm, who also included patients that underwent multiple RIRS sessions due to the presence of impacted stones and mucosal polyps, was consistent with the stone-free rates reported for ureteral stones in the literature (72-100%)(23).

Double-J (JJ) stenting is often recommended prior to RIRS in patients with sepsis, renal colic, or in whom a UAS cannot be inserted or the endoscope cannot be advanced over the guidewire. In our patients, preoperative JJ stenting was performed in 32.2% of the patients, group I having the highest rate of JJ stenting (50.6%). In all the patients, the most common reason for JJ stenting was ureteral stenosis (n=47; 54.65%), followed by renal colic (n=22; 25.6%) and sepsis (n=17; 19.77%).

Mahajan et al. implanted a JJ stent 2 weeks prior to RIRS in 5.4% of the patients in whom the lower ureter could not be dilated (43), Parikh et al. inserted a JJ stent in 20% of the patients due to urinary tract infections(UTI) and ureteral stricture [24], and Lee et al. reported that the administration of preoperative ureteral stenting for a period of 7.2 (± 3.7) days reduced the rate of intraoperative ureteral balloon dilation and prevented high-grade ureteral injuries [25]. In contrast, Kawahara et al. found no significant difference between prestented and nonprestented patients with regard to postoperative stone-free rates although prestenting led to more favorable stone-free rates in stones with a diameter of 2-4 cm [26]. In our study, although JJ stenting facilitated the insertion of UAS, it had no significant effect on the overall postoperative stone-free rate in both stone sizes.

Implantation of a UAS provides a number of advantages such as reducing intrapelvic pressure, facilitating drainage of intrarenal dust and stone fragments, easy endoscopic access to the kidney, and simple ureteral re-entry. In our study, however, a UAS could not be implanted in 24% of the patients and group III had the lowest rate of UAS usage. In the literature, a number of risk factors have been defined for UAS insertion including advanced age, long-term JJ stenting, and history of ureterorenoscopy (URS). Some other studies indicated that the rate of UAS usage can be as high as 90% in prestented patients as opposed to 70% in non-prestented patients [23,26]. Similarly, the rate of UAS usage in our patients was 96.5% in prestented patients and was 65.5% in non-prestented patients. These rates implicate that passive dilation may have a significant contribution to UAS insertion.

In a previous randomized, multicentric study conducted on Intensive Care Unit (ICU) patients, Traxler et al. evaluated the RIRS outcomes in patients treated with f-URS either with or without UAS support. Although no significant difference was found between the groups with regard to stone-free rates, UAS implantation was found to provide protection against UTI, ureteral lacerations, and bleeding (51). In our study, the residual rate for stones <2 and ≥2 cm were 9.6% and 21.6%, respectively, and no significant difference was found between the two stone sizes (p=0.398and$p$=0.084, respectively). Additionally, the overall residual rate among the patients that underwent UAS implantation was 14.8%.These rates indicate that UAS usage has no contributory effect on the stone-free status. However, the usage of UAS in our study provided a number of advantages such as ensuring a safe surgical site throughout the procedure, advancement of the guidewire on a straight axis, simple ureteral re-entry, reduced intrapelvic pressure, and renal protection. In addition, we consider that UAS usage also helps to prolong the life of the endoscope.

Implantation of a JJ stent after RIRS is also a major concern. In our patients, postoperative JJ stenting was performed in 86.5% of the patients, with group I having the highest rate of stenting (100%) and group III having the lowest rate (74%). Astroza et al. evaluated the effectivity of postoperative JJ stenting on postoperative pain and the requirement for hospital readmission and reported that the stented patients had worse outcomes compared to non-stented patients [29]. Similarly, Bosio et al. found that ureteral stents were responsible for significant postoperative urinary symptoms and pain [30]. We consider that the use of an overnight 5 or 6f ureteral stent for renal drainage after RIRS could be sufficient in patients with low stone burden and no ureteral trauma or ureteral polyposis.

In our patients, most of the complications were classified as minor complications except for the two complications in group I (ureteral perforation and subcapsular hematoma) that occurred in one patient each. The ureteral perforation was treated by 4-week JJ stenting and the subcapsular hematoma (55x70x110 mm) was treated conservatively and resolved completely after three months. On the other hand, 14 patients with urosepsis were treated by pathogenspecific antibiotic therapy and had a mean hospital stay of 14 days. Of these, 12 patients were discharged after ensuring a negative urine culture. However, the remaining two patients were discharged with a urine culture positive for Klebsiella pneumoniae. No ICU admission was required in any patient with urosepsis. In our patients, the rate of all postoperative complications was consistent with those reported in the literature for patients undergoing RIRS [6].

It is commonly known that the operative time is associated with a number of factors including stone size and localization, use of a basket catheter, surgical experience, and UAS usage. In our patients, mean operative time was 49.24±15.48 min, which was consistent with those reported in the literature for patients undergoing RIRS (25-106 min) [11]. However, no significant difference was found among the three groups with regard to operative time.

Conclusions

The results implicated that RIRS can be used in the treatment of renal stones of any size. However, it should be noted that in large stones (≥2 cm), acceptable outcomes may not be obtained by a single RIRS session and the patient should be informed about this fact prior to surgery. In conclusion, RIRS is a viable alternative for patients that are suitable for PCNL but have an increased surgical risk or are afraid of PCNL.

References

1. Yahong Xu, Yi Lu, Jian Li, Shunwen Luo, Yang Liu, et al. A meta-analysis of the efficacy of ureteroscopic lithotripsy and extracorporeal shock wave lithotripsy on ureteral calculi. Acta Cirúrgica Brasileira. 2014; 29.

2. Fábio César miranda Torricelli, alexandre danilovi, fábio Carvalho vicentini, giovanni scala Marchini, Miguel srougi, eduardo Mazzucchi. Extracorporeal shock wave lithotripsy in the treatment of renal and ureteral stones. Rev Assoc Med Bras. 2015; 61: 65-71.

3. Özer Ural Çakici, Kemal Ener, Murat Keske, Serkan Altinova, Abdullah erdem Canda, et al. Open stone surgery: A still-in-use approach for complex stone burden. Cent European J Urol. 2017; 70: 179-184.

4. Roberto Giulianelli, Barbara Cristina Gentile, Giorgio Vincenti, Luca Mavilla, LucaAlbanesi, et al. Lowcost semirigid ureteroscopy is effective for ureteral stones: Experience of a single high volüme center. Archivio Italiano di Urologia e Andrologia. 2014; 86.

5. Mert Ali Karadag, Aslan Demir, Murat Bagcioglu, Kursat Cecen, Ramazan Kocaaslan, et al. Flexible Ureterorenoscopy versus Semirigid Ureteroscopy for the Treatment of Proximal Ureteral Stones: A Retrospective Comparative Analysis of 124 Patients. Endourology and stone disease. 2014; 05: 1867.

6. Francesco Berardinelli, Silvia Proietti, Luca Cindolo, Fabrizio Pellegrini, Roberto Peschechera, et al. A prospective multicenter European study on flexible ureterorenoscopy for the management of renal stone. İBJU. 2016; 42: 479-486.

7. Ufuk Ozturk MD, Şener NC, Goksel Goktug HN, Gucuk A, Nalbant I, et al. The comparison of laparoscopy, shock wave lithotripsy and retrograde intrarenal surgery for large proximal ureteral Stones. Can Urol Assoc J. 2013; 7.

8. Yang Xun, Qing Wang, Henglong Hu, Yuchao Lu, Jiaqiao Zhang, et al. Tubeless versus standard percutaneous nephrolithotomy: an update meta-analysis. BMC Urology. 2017; 17: 102.

9. Li X, Li J1,, Zhu W, Duan X, Zhao Z, et al. Micropercutaneous nephrolithotomy versus retrograde intrarenal surgery in the treatment of renal stones: A systematic review and meta-analysis. PLoS One. 2018 19; 13.

10. Fan J, Zhang T, Zhu W, Gurioli A, Ketegwe IR, et al. The role of super-mini percutaneous nephrolithotomy (SMP) in the treatment of symptomatic lower pole renal stones (LPSs) after the failure of shockwave lithotripsy (SWL) or retrograde intrarenal surgery (RIRS).Urolithiasis. 2019; 47: 297-301.

11. Sari S, Ozok HU, Cakici MC, Ozdemir H, Bas O, et al. A Comparison of Retrograde Intrarenal Surgery and Percutaneous Nephrolithotomy for Management of Renal Stones ≥ 2 CM. Endourology and Stone Diseases. 2017; 14: 2949-2954.

12. Tonyalı Ş, Yılmaz M, Karaaslan M, Ceylan C, Işıkay L. Prediction of stone-free status after single-session retrograde intrarenal surgery for renal stones.Turk J Urol. 2018; 44: 473-477.

13. Zhu M, Wang X, Shi Z, Ding M, Fan D, et al. Comparison between retrograde intrarenal surgery and percutaneous nephrolithotripsy in the management of renal stones: A meta-analysis.Exp Ther Med. 2019; 18: 1366-1374.

14. Zhao Z, Sun H, Zeng T, Deng T, Liu Y, et al. An easy risk stratification to recommend the optimal patients with 2-3 cm kidney Stones to receive retrograde intrarenal surgery or mini-percutaneous nephrolithotomy.Zhao- Urolithiasis. 2019.

15. Zanetti SP, Talso M, Palmisano F, Longo F, Gallioli A, et al. Comparison among the available stone treatment techniques from the first European Association of Urology Section of Urolithiasis (EULIS) Survey: Do we have a Queen? PLoS One. 2018; 13.

16. Berkan Resorlu, Yasar Issi, Kadir Onem, Cankon Germiyanoglu. Management of lower pole renal stones: the devil is in the details. Ann Transl Med. 2016; 4: 98.

17. Chung DY, Kang DH, Cho KS, Jeong WS, Jung HD, et al. Comparison of stone-free rates following shock wave lithotripsy, percutaneous nephrolithotomy, and retrograde intrarenal surgery for treatment of renal stones: A systematic review and network meta-analysis.PLoS One. 2019: 21; 14.

18. Bozzini G, Verze P, Arcaniolo D, Dal Piaz O, Buffi NM, et al. A prospective randomized comparison among SWL, PCNL and RIRS for lower calyceal stones less than 2 cm: a multicenter experience : A better understanding on the treatment options for lower pole stones. World J Urol. 2017; 35: 1967-197.

19. Hakan Kilicarslan, Yurdaer Kaynak, Yakup Kordan, Onur Kaygisiz, Burhan Coskun, Kadir Omur Gunseren, Feyzi Mutlu Kanat. Unfavorable Anatomical Factors Influencing the Success of Retrograde Intrarenal Surgery for Lower Pole Renal Calculi. Urol J. 2015; 12: 2065-2068.

20. Sarı S, Ozok HU, Topaloglu H, Cakıcı MC, Ozdemir H, et al. The Association of a Number of Anatomical Factors with the Success of Retrograde Intrarenal Surgery in Lower Calyceal Stones. Endourology and Stone Disease. 2017; 14; 4008-4014.

21. Wang YB, Cui YX, Song JN, Yang Q, Wang G. Efficacies of Various Surgical Regimens in the Treatment of Renal Calculi Patients: A Network Meta-Analysis in 25 Enrolled Controlled Clinical Trials. Kidney Blood Press Res. 2018; 43: 1183-1198.

22. Danilovic A, Cavalanti A, Rocha BA, Traxer O, Torricelli FCM, et al. Assessment of Residual Stone Fragments After Retrograde Intrarenal Surgery.

23. Loi D, Chen M, He Y, Li X. Simultaneous retrograde intrarenal surgery for ipsilateral asymptomatic renal Stones in patients with ureteroscopic symptomatic ureteral stone removal. BMC Urology. 2015; 15: 22.

24. Mahajan PM, Padhye AS, Bhave AA, Sovani YB, Kshirsagar YB, et al. Is stenting required before retrograde intrarenal surgery with access sheath. Indian J Urol. 2009; 25: 326–328.

25. Kandarp Priyakant Parikh, Ravi Jineshkumar Jain, and Aditya Parikh Kandarp. Is retrograde intrarenal surgery the game changer in the management of upper tract calculi? A single-center single-surgeon experience of 131 cases. Urol Ann. 2018 Jan-Mar; 10: 29–34.

26. Lee MH, Lee IJ, Kim TJ, Lee SC, Jeong CW, et al. The effect of short-term preoperative ureteral stenting on the outcomes of retrograde intrarenal surgery for renal stones.

27. Yoshida T, Inoue T, Abe T, Matsuda T. Evaluation of Intrapelvic Pressure When Using Small-Sized Ureteral Access Sheaths of ≤10/12F in an Ex Vivo Porcine Kidney Model. J Endo urol. 2018 ;32: 1142-1147.

28. Mogilevkin Y, Sofer M, Margel D, Greenstein A, Lifshitz D. Predicting an effective ureteral access sheath insertion: a bicenter prospective study.J Endourol. 2014; 28: 1414-1417.

29. Traxer O, Nordah GW, Sodha H, Rassweiler J, Meretyk S, et al. Differences in renal stone treatment and outcomes for patients

treated either with or without the support of a ureteral access sheath: The Clinical Research Office of the Endourological Society Ureteroscopy Global Study. World J Urol. 2015; 33: 2137–2144.

30. Bosio A, Alessandria E, Dalmasso E, Peretti D, Agosti S, Bisconti A, et al. How bothersome double-J ureteral stents are after semi-rigid and flexible ureteroscopy: A prospective single-institution observational study.World J Urol. 2019; 37: 201-207.