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ORIGINAL PAPER

Effect of preoperative ureteral stenting on the surgical outcomes of patients with 1-2 cm renal stones managed by retrograde intrarenal surgery using a ureteral access sheath

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Summary *Objective: To assess the surgical results of patients who underwent retrograde intrarenal surgery (RIRS) using a ureteral access sheath (UAS) for management of renal stones sized 1-2 cm compared between patients who did and did not undergo preoperative ureteral stenting.*

Materials and methods: This prospective study included 83 patients (aged ≥ 20 years) who underwent RIRS from July 2021 to January 2023. All patients had renal calculi (stone size: 1-2 cm) located within the pelvicalyceal system. 43 and 40 patients were allocated to the non-prestent (group A) and prestent (group B), respectively. Patient baseline characteristics, renal stone details, operative data, stone-free rate (SFR) at 4 weeks and 6 months, and perioperative complications were compared between groups.

Results: The baseline characteristics of all patients were comparable across the groups. Four weeks after surgery, the overall stone-free rate (SFR) stood at 62.65%. In the non-prestent and prestent groups, the SFRs were 58.12% and 67.5%, respectively (p = 0.89). By the sixth month post-surgery, the overall SFR rose to 80.72%. In the non-prestent and prestent groups, the SFRs were 76.74% and 85%, respectively (p = 0.081).

No notable differences emerged in other variables, including perioperative complications, between the two groups.

Conclusions: The SFR showed no significant difference between the prestenting and non-prestenting groups at the 4-week and 6-month postoperative marks. Additionally, there were no substantial differences in complications during surgery and recovery between the groups. Notably, the SFR increased from 4 weeks to 6 months without any additional procedures in either group.

KEY WORDS: *Access sheath; Ureteral stenting; Renal stones.*

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INTRODUCTION

Using a *ureteral access sheath* (UAS) in *retrograde intrarenal surgery* (RIRS) offers several advantages. These include a reduction in operative time, simplified entry and reentry into the ureter, facilitation of active extraction of stone fragments, lower intrapelvic pressure during the procedure, and the elimination of the need for periodic bladder emptying (1, 2). The UAS enables repeated access to the renal pelvis without causing trauma to the ureter, enhances visibility, safeguards the ureteroscope, improves drainage, and allows swift extraction of stone fragments (3). However, it is important to note that the use of a UAS may elevate the risk of ureteral injury and is linked to increased postoperative pain after RIRS, especially when a postoperative ureteral stent is not inserted (1). Preoperative ureteric stenting is primarily employed for internal urinary drainage in patients with obstructive renal stones, hydronephrosis, urinary tract infections, and those requiring passive dilatation of the ureter. Nevertheless, the use of ureteral stents is associated with complications such as infection, encrustation, hematuria, and discomfort caused by tissue irritation. Previous studies have reported conflicting views on the impact of preoperative ureteral stenting on the stone-free rate (SFR) after ureteroscopic lithotripsy (4, 5). Consequently, the objective of this study was to examine the surgical outcomes of patients undergoing RIRS with a UAS for the management of kidney stones measuring 1-2 cm, comparing those who underwent preoperative ureteral stenting with those who did not.

MATERIALS AND METHODS

Between July 2021 and January 2023, we enrolled 83

patients who underwent RIRS in this prospective comparative study. All procedures performed in this study complied with institutional and/or national research council ethical standards as well as the 1964 Declaration of Helsinki and its subsequent amendments or similar ethical standards. Protocols and written informed consent for all participants were approved by the *Research Ethics Committee of Thumbay University Hospital* (affiliated with Gulf Medical University, REC #: 487/2021).

Among participants, 43 patients were assigned to the non-prestent group (Group A), while 40 patients belonged to the preoperative ureteral stenting (group B). All participants met our study's inclusion criteria, which included being 18 years or older, having renal calculi within the pelvicalyceal system, and stone sizes ranging from 1 to 2 cm. The same experienced surgeon consistently performed the procedures. Preoperative ureteral stents were placed for reasons such as the inability to pass UAS or a flexible ureterorenoscope, a history of renal or ureteral calculi operation, upper urinary tract infection, or hydronephrosis. Stone size was determined using plain *kidney, ureter, bladder* (KUB) radiography or non-contrast-enhanced *computed tomography* (CT). The largest diameter of a single renal calculus or the sum of the largest diameters of multiple stones was recorded as the overall stone size. SYNAPSE 5 (*Fujifilm Corporation, Tokyo, Japan*) was the radiographic program employed for assessing stone size. Before initiating the RIRS procedure, antibiotic prophylaxis, typically third-generation cephalosporins or fluoroquinolones for patients with penicillin allergy was administered intravenously. Patients were positioned in the lithotomy position. Following cystoscopy, a *Sensor™ PTFE-Nitinol Guidewire* with *Hydrophilic Tip* (*Boston Scientific Corporation, Marlborough, MA, USA*) was passed through the ureter toward the renal pelvis to serve as a safety guidewire. Under fluoroscopy, a dual-lumen catheter was inserted into the ureter using the guidewire as a guide. An *Amplatz Super Stiff® Guidewire* (*Boston Scientific*) was then introduced into the ureter via the second lumen of the dual-lumen catheter. The dual-lumen catheter was subsequently removed, leaving the *Sensor™ PTFE-Nitinol Guidewire* and the *Super Stiff® Guidewire* in the ureter. A UAS (11/13 French size (Fr) or 12/14 Fr) was placed over the *Amplatz Super Stiff® Guidewire* and advanced through the ureter up to the proximal ureter to facilitate kidney access. The *Amplatz Super Stiff® Guidewire* was then removed. *Flexible ureteroscopy* (fURS) with a *holmium: yttrium-aluminum-garnet* (Ho: YAG) laser lithotripsy device featuring a 272-µm laser fiber was employed to fragment the stone(s). The choice of laser lithotripsy technique (fragment and basketing, dusting, or popcorn) depended on the stone's appearance. Dusting or popcorn was used for soft stones, while fragment and basketing were employed for hard stones. A 1.9 Fr tipless stone basket was used to extract as many residual stone fragments as possible. The final step involved removing the UAS and carefully inspecting the ureter for potential injuries as the fURS was withdrawn. In the majority of cases, a ureteral stent (6 or 7 Fr) was left indwelling after successful RIRS. Plain KUB radiography was the primary imaging modality post-procedure, although non-contrast-enhanced CT-KUB was conducted in cases involving non-opaque or semi-opaque stones. *Stone-free rates* (SFRs) were assessed at 4 weeks and 6 months post-RIRS, representing early and late follow-ups, respectively. Stone-free was defined as the absence of stone fragments or the presence of fragments less than 2 mm in diameter. Complications were classified as intraoperative or postoperativePostoperative complications, as observed in this study, included fever (defined as a febrile state with hemoculture showing no growth) and urosepsis (defined as hemoculture showing positive growth for a bacterial organism). Bleeding requiring blood transfusion was not observed in any patient.

Statistical analysis was conducted using *PASW Statistics 18.0.0 software* (*SPSS, Inc., Chicago, IL, USA*). Categorical data were compared using the chi-square test or Fisher's exact test, with results presented as numbers and percentages. For normally distributed data, the unpaired t-test was employed, while the Mann-Whitney U test was used for non-normally distributed data. Mean plus/minus standard deviation and median and range were used to present normally and non-normally distributed data, respectively. A p-value less than 0.05 was considered statistically significant for all tests.

Results

Patients included in the prestenting group underwent preoperative stenting for various reasons: 32.5% due to the inability to pass UAS or flexible ureterorenoscope, 22.5% following a previous operation for renal calculi, 20% following a previous operation for ureteral calculi, 15% due to upper urinary tract infection, 2.5% for flank pain, 2.5% for hydronephrosis, and 5% for an unrecorded reason. Among the 80 patients in the prestenting group, the median duration of preoperative ureteral stenting was 42 days (range: 7-76). Patient demographic, clinical and renal stone characteristics were compared between the non-prestent and prestent groups, as shown in Table 1. No significant differences were observed in any of the variables described in Table 1 between the non-prestent and prestent groups. The median stone size in the non-prestent group and prestent group was 14.2 mm and 14.1 mm, respectively (p = 0.878). The incidence of calyceal stones in the lower pole was 44.2% in the non-prestent group and 55% in the prestent group (p = 0.163). Post-operative imaging consisted of plain x-rays for 98% of cases. Pre-operative imaging included 48% CT scans and 52% plain x-rays. Early outcomes were evaluated by *Stone-Free Rate* (SFR) at 4 weeks after RIRS, and late outcomes were evaluated by SFR 6 months after RIRS. Operative data, stone profiles, and clinical outcomes were compared between the non-present and present groups, as described in Table 2. The mean operative time was identical in both groups (45 min; p = 0.845). After RIRS, postoperative ureteral stent placement was performed in all included patient of this study (Table 2). The median duration of stenting before stent removal was 24 days and 19 days in the non-prestent and prestent groups, respectively (p = 0.931). Calcium stones, mostly consisting of calcium oxalate monohydrate, were the most common stone composition (34.9% in the non-prestent group vs. 47.5% in the prestent group; p =

Table 1.
Patient demographic, clinical and renal stone characteristics compared between the non-prestent (group A) and prestent (group B).

Variables	Group A (n = 43)	Group B (n = 40)	p-value
Age (years), mean ± SD	53.2 ± 12.2	56.3 ± 12.5	0.116
Gender, n (%)			0.565
Male	18 (41.9%)	19 (47.5%)	
Female	25 (58.1%)	21 (52.5%)	
BMI (kg/m^2) Mean ± SD	21.3 ± 4.5	24.1 ± 5.3	0.116
Comorbidities, n (%)			
Diabetes mellitus	12 (27.9%)	9 (22.5%)	0.536
Hypertension	25 (58.1%)	20 (50%)	0.466
Dyslipidemia	16 (37.2%)	16 (40%)	0.969
Gout	1 (2.3%)	2 (5.0%)	0.718
Coronary artery disease	4 (9.3%)	1 (2.5%)	0.689
Preoperative eGFR, n (%)			0.427
eGFR < 60	9 (20.9%)	11 (27.5%)	
eGFR > 60	34 (79.1%)	29 (72.5%)	
Kidney side, n (%)			
Right kidney	19 (44.2%)	15 (37.5%)	0.307
Left kidney	24 (55.8%)	25 (62.5%)	
Total stone size (mm), (mean ± SD)	14.2 ± 3.1	14.1 ± 3.5	0.878
Total stone size in lower pole	13.9 ± 3.3	13.8 ± 3.4	0.868
Total stone size in non-lower pole	14.4 ± 3.1	14.5 ± 3.9	0.836
Stone location, n (%)			
Lower pole	19 (44.2%)	22(55%)	0.163
Non-lower pole	24 (55.8%)	18 (45%)	

A p-value < 0.05 indicates statistical significance.
SD, standard deviation; BMI, body mass index; eGFR, estimated glomerular filtration rate.

Table 2.
Operative data, stone profiles, and clinical outcomes compared between the non-prestent (group A) and prestent (group B).

Variables	Group A (n = 43)	Group B (n = 40)	p-value
Operative time (minutes)	45 (18-102) (n = 43)	45 (12-122) (n = 36)	0.845
Median (range) Ureteral access sheath size (Fr)			< 0.001
11/13	29 (67.4%)	8 (22.2%)	
12/14	15 (34.9%)	28 (77.8%)	
Postoperative stent (Fr)			0.089
6 Fr	38 (88.37%)	32 (80%)	
7 Fr	5 (11.63%)	8 (20%)	
Length of hospital stay (days), median (range)	1 (1-16)	1 (1-17)	0.758
Duration of postoperative stenting (days), median (range)	24 (5-47)	19 (9-160)	0.931
Major stone composition			0.219
Calcium oxalate monohydrate	15 (34.9%)	19 (47.5%)	
Calcium oxalate dihydrate	8 (18.6%)	5 (12.5%)	
Calcium phosphate	16 (37.2%)	10 (25%)	
Non-calcium	4 (9.3%)	6 (15%)	
Stone-free rate at 4 weeks	25 (58.12%)	27 (67.5%)	0.089
SFR of lower pole stone	11 (25.6%)	12 (30%)	0.881
SFR of non-lower pole stone	14 (32.6%)	15 (37.5 %)	0.741
Stone-free rate at 6 months	33 (76.74%)	34 (85%)	0.081
SFR of lower pole stone	15 (34.88%)	16 (40%)	0.326
SFR of non-lower pole stone	18 (41.86%)	18 (45%)	0.398
Increase in SFR from 4 weeks to 6 months	19.6%	17.1%	0.477

A p-value < 0.05 indicates statistical significance. Fr, French size; SFR, stone-free rate.

Table 3.
Intraoperative and postoperative complications compared between the non-prestent (group A) and prestent (group B).

Complications	Group A (n = 43)	Group B (n = 40)	p-value
Intraoperative complications			
Overall intraoperative complication	7 (16.3%)	3 (7.5%)	0.061
Ureteric injury grade I	5 (11.6%)	1 (2.5%)	0.052
Ureteric injury grade II	3 (6.9%)	1 (2.5%)	0.724
Ureteric injury grade III	1 (2.3%)	1 (2.5%)	1
Postoperative complications			
Overall postoperative complication	13 (30.2%)	7 (17.5%)	0.071
Clavien-Dindo Classification Grade 1	12 (27.9%)	6 (15%)	0.037
Clavien-Dindo Classification Grade 3 A	1 (2.3%)	1 (2.5%)	0.678

A p-value < 0.05 indicates statistical significance.

0.219). There was a significant difference in UAS size between the groups (77.8% of the prestented group used 12/14 Fr, while 67.4% of the non-prestented group used 11/13 Fr; p < 0.001). The SFRs at 4 weeks after RIRS were 58.12% in the non-prestent group and 67.5% in the prestent group (p = 0.089). At 6 months after RIRS, the SFRs in the non-prestent and prestent groups were 76.74% and 85%, respectively (p = 0.081). Although the SFRs in the prestent group were notably higher than those in the non-prestent group at both follow-up time points, these differences did not reach statistical significance. The SFR increased by 18.62% in the non-prestent group and 17.5% in the prestent group from the 4-week follow-up to the 6-month follow-up. Intraoperative and postoperative complications were compared between the non-prestent and prestent groups (Table 3).
Intraoperative complications occurred in 12.5% of the 83 patients included in the study, defined as ureteral wall injury graded according to the endoscopic classification proposed by *Traxer et al.* (6) (please see Appendix). The rate of ureteral injury was non-significantly lower in the prestent group (7.5%) than in the non-prestent group (20.8%) (p = 0.063), and most injuries in both groups were grade I. Postoperative complications, including fever and urosepsis, showed no significant differences between the groups. At the 6-month follow-up, no ureteric stricture or new incidences of hydronephrosis or hydroureter were detected in any study patient.

Discussion

RIRS stands as a widely employed treatment for renal calculi due to several factors. Reported *Stone-Free Rates* (SFRs) for RIRS are noted to be comparable to those achieved through *percutaneous nephrolithotomy* (PCNL) and surpass those of *extracorporeal shockwave lithotripsy* (ESWL) for patients with small to medium-sized stones. RIRS is characterized as less invasive with lower morbidity when compared to PCNL, which is commonly preferred for larger stones carrying a higher risk of major complications (7, 8). While various studies on URS have reported SFRs for renal and ureteral calculi (8-10), specific data regarding the impact of preoperative ureteral stenting on SFR, particularly in renal stone sizes of 1-2

cm, remains limited (4, 11-15). *Jones et al.* (11, 16) were the pioneers in reporting that the insertion of a ureteral stent, following the failure of initial URS, significantly improved the success rate of calculus extraction during the second URS. Subsequent studies aimed to validate these findings, and although most reported similar results, the majority focused on SFRs for ureteral stones or small renal stones (4, 11, 13-15). The influence of preoperative ureteral stenting on SFR in large renal stones (diameter: 1-2 cm) after RIRS procedures has not been addressed in existing literature. No significant differences were found for any evaluated patient and renal stone characteristics listed in Table 1. Prior studies have identified stone size and location as the most significant predictors of SFR after RIRS (17, 18). As indicated in Table 2, the UAS size used in the prestent group was significantly larger than that in the non-prestent group ($p < 0.001$), aligning with findings reported by *Hyeong et al.* (5). This could result from passive ureteral dilation from preoperative ureteral stenting (5). Despite the improved accessibility afforded by a larger UAS size, there was no significant difference in SFRs between the groups. Our preference for using UAS size 11/13 Fr stems from its lack of impact on SFRs or complications. Additionally, reports suggest that intrarenal pressure during RIRS does not significantly differ between 11/13 Fr and 12/14 Fr UAS (19). The primary benefit of a larger UAS size lies in increased irrigation fluid flow during the procedure (19). Moreover, the ureteral injury rates did not significantly differ when using a larger-sized UAS (20). SFRs reported in the literature vary widely (54-96%) for renal stones sized 1-2 cm after a single session of RIRS (18). This variability may be attributed to differences in the definition of 'stone-free' and variations in the imaging methods used during follow-up. Previous studies considered a residual stone size of 4 mm (21) and 2 mm (22) as clinically significant. Imaging modalities for stone detection include plain radiography, ultrasound, and CT scans, each possessing different sensitivity and specificity (23). While CT scans offer higher sensitivity and specificity, the increased radiation exposure to the patient favors the use of plain radiography or ultrasound. In this study, the overall SFR at 4 weeks and 6 months of follow-up was 67.5% and 85% in the prestent group, and 58.12% and 76.74% in the non-prestent group, respectively, representing a 12.5-18.62% increase in SFR after a more extended follow-up period. Our study defines SFR as ≤ 2 mm of residual stone size, lower than sizes reported in other studies (11, 12). While studies by *Hyeong et al*. (5) and *Sung et al.* (25) found no significant association between preoperative ureteral stenting and stone clearance, studies by *Netsch et al.* (11) and *Kawahara et al.* (12) reported improved SFRs after RIRS with preoperative ureteral stenting. These discrepancies may stem from differences in knowledge, technology, and instruments available at the time of these studies. In our study, SFRs at 4 weeks after RIRS were not significantly different between the non-prestent and prestent groups (62.65% *vs.* 67.5%, respectively; $p = 0.089$). Similarly, SFRs at 6 months after surgery showed no significant differences between the non-prestent and prestent groups (76.74% *vs.* 85%, respectively; $p = 0.081$). This finding aligns with *Bal et al.* (26), who reported that preoperative ureteral stenting before RIRS may not significantly impact the one-month postoperative SFR. Notably, we observed that the SFR in both groups improved with a longer duration of follow-up, requiring no additional procedure. Specifically, the SFR increased by 18.62% in the non-prestent group and 12.5% in the prestent group from the 4-week follow-up to the 6-month follow-up. There were no significant differences in overall intraoperative or postoperative complications between the prestent and non-prestent groups ($p = 0.061$ and $p = 0.0710$, respectively), consistent with previous studies (11-13). Most cases of ureteral injury in this study were grade I injuries. Although the incidence of ureteral injury resulting from UAS insertion was lower in the prestent group (7.5%) than in the non-prestent group (16.3%), no significant difference was observed between the groups. It's worth noting that a larger UAS size could be used in the pre-stented group (12/14 Fr) than in the non-prestented group (11/13 Fr). *Traxer et al.* (6) reported that the incidence of ureteral injury grade III could be decreased by prestenting, but our study lacked sufficient cases of grade III injury to support this assertion.

Conclusions

The findings from this research indicate that there was no notable disparity in the *Stone-Free Rate* (SFR) between the group with preoperative ureteral stenting and the group without it, both at the 4-week and 6-month postoperative assessments. Moreover, there was no significant contrast in complications observed during both the surgery and the recovery phase between these two groups.

Additionally, it is noteworthy that the SFR showed an increase at the 6-month mark compared to the 4-week assessment in both groups, and this improvement occurred without any supplementary procedures.

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