

One-stage versus staged ureteroscopy and percutaneous nephrolithotomy for simultaneous ureteral and renal stones

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Abstract

Objectives: This study is aimed to investigate the outcome of one-stage ureteroscopy (URS) and percutaneous nephrolithotomy (PCNL) for simultaneous ureteral and renal stones over 10 years at a tertiary urology institute.

Materials and methods: We retrospectively analyzed the data of patients who were operated on for simultaneous ureteral and renal stones from January 2011 to December 2020. Patients were divided into 2 groups: group A, who underwent one-stage URS and prone PCNL, and group B, who underwent staged procedures. The overall success, complications, operative time, and hospital stays were compared between the 2 groups.

Results: Data for 190 patients were reviewed; mean age was 50 ± 13 years old, and 146 (77%) were male. The one-stage (A) and staged (B) groups included 102 and 88 patients, respectively. Group A included older patients, with a high The American Society of Anesthesiologists score, while group B included more patients with multiple or staghorn stones. The one-stage group recorded shorter operative time (120 ± 12 min vs. 140 ± 16 min, $p=0.02$) and shorter hospital stays (3 days [2–6] vs. 4 days [3–9], $p=0.06$). Otherwise, both groups had equal outcomes in terms of success rates and complications.

Conclusions: PCNL and URS can be performed in one-session for simultaneous ureteral and renal stones, except for multiple renal and staghorn stones. The results are comparable to those of the staged procedure in terms of success rate and complications, with the advantage of a shorter operative time and hospital stay.

Keywords: Kidney stones; Percutaneous nephrolithotomy; Ureteral stones; Ureteroscopy

1. Introduction

Urinary tract stone disease is a common health problem affecting 8%–15% of the population. The prevalence and the incidence of nephrolithiasis has been increasing worldwide.^[1] Besides medical treatment and extracorporeal shock wave lithotripsy (ESWL) as treatment modalities for stones, ureteroscopy (URS) and percutaneous nephrolithotomy (PCNL) have become standard treatment options for ureteral and renal stones with a high stone-free rate.^[2,3]

Patients who presented with simultaneous ureteral and renal stones are of special concern. The presence of multiple ureteral and renal stones increases the stone burden, which means that SWL is not the appropriate treatment choice in those cases. URS

and PCNL have traditionally been performed in separate sessions. However, with the recent advances in endoscopic procedures, the refinement of tools, and increased experience in endourology, complex procedures, like URS and PCNL, can be performed as a one-stage procedure in select patients.^[2,4] Few studies in the literature have investigated the safety of one-stage URS and PCNL.^[5] However, in all studied cases, PCNL was performed in supine position^[6] and included only a small number of patients.^[7] Moreover, this topic has not been addressed according to the European Association of Urology guidelines.^[3] We aimed to determine the outcomes of a single session URS and prone PCNL over a 10-year period at a tertiary urology institute. The cohort of patients was compared to a similar group who underwent URS and prone PCNL in a staged strategy during the same period.

2. Materials and methods

After institutional review board approval, we retrospectively analyzed computed data files for patients who were operated on for simultaneous ureteral and renal stones from January 2011 to December 2020. Patients were divided into 2 groups: Group A, who underwent one-stage URS and prone PCNL, and Group B, who underwent staged procedures. Patients who had obstructive uropathy were managed first with insertion of a ureteral stent or nephrostomy and were included in the study.

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2.1. Preoperative work-up

Standard protocol was followed through medical history and focused physical exam. All patients had routine laboratory investigations (including urine analysis and culture, complete blood count, renal function, liver function, and coagulation profile). Any urinary tract infection was treated preoperatively with culture-specific antibiotics. Non-contrast computed tomography (CT) was used to measure the stone size and burden. The decision for the one-stage or staged procedures was made based on the patient's condition, anesthetic recommendations, and the surgeon's judgement.

2.2. Operative technique

Unless directed by urine culture, an IV 3rd generation cephalosporin was given to all patients prior to surgery. In the lithotomy position, a rigid cystoscope was introduced for a bladder scan and insertion of a 0.038F guide wire into the ureter was performed under fluoroscopic guidance. Then, a semi rigid 8–10F ureteroscopy (Richard Wolf GmbH, Knittlingen, Germany) was used in most cases.

Pneumatic Lithotripter (LithoClas[®] Ultra, EMS, Nyon, Switzerland) or holmium-YAG Laser (Calculase II, Karl Storz, Tuttlingen, Germany) was used for stone fragmentation, and forceps or a basket was used to remove the fragments. At the end of the URS procedure, a 5F open-tip ureteric catheter was inserted, and the patient was repositioned to the prone position.

Under fluoroscopic guidance (BV Pulsa, Philips Medical System, Eindhoven, Netherlands), and with retrograde contrast administration, kidney puncture was performed targeting the posterior calyx in most cases. The tract was dilated using Alken's coaxial telescopic dilator (Karl Storz Endoskope, Tuttlingen, Germany) to 30F. Then, a rigid nephroscope 26F (Karl Storz Endoskope) was used through the Amplatz sheath (Boston Scientific Corp., Natick, MA). A second puncture was performed when indicated, and the guidewire was left in place for future use. Stone disintegration was performed with ultrasonic (Calculon, Karl Storz Endoskope) or pneumatic lithotriptors. Stone fragments were removed by forceps. A flexible nephroscope was used to retrieve stone fragments away from the original tract. At the end of the PCNL procedure, a 22F nephrostomy tube was left. A ureteric stent was inserted for cases with ureteral injuries or for future SWL. URS procedures were performed by staff with all levels of expertise: residents, intermediate (fellows), and senior staff members (consultants), but PCNL was performed only by intermediate and senior staff members.

2.3. Early postoperative

On the next day, X-ray (KUB) was requested for radiopaque stones and non-contrast CT for radiolucent ones. For patients who had no residual stones or insignificant fragments (≤ 4 mm), the nephrostomy was removed followed by the ureteric catheter after 24 hours. When needed, a second look PCNL was performed for significant residual stones. Postoperative complications were recorded and stratified on a modified Clavien Scale. Persistent urinary leakage from the nephrostomy site was managed by ureteric stents.

2.4. Follow-up

A follow-up appointment was scheduled after 1 month for all patients who were cleared of stones and those with insignificant residuals. Patients who had significant residuals were managed accordingly. All patients were instructed to go to the emergency department immediately for high fever, severe pain, or bleeding.

Readmission was defined as occurrence of any disease related to the procedure that required admission within 3 months from the date of surgery.

2.5. Outcome

The primary outcome compared the overall success (stone-free and insignificant residual stones < 4 mm), while secondary outcomes compared complications, operative times, and hospital stays between the 2 groups. Operative time was calculated from the start of the cystoscopy to insertion of the nephrostomy tube.

2.6. Statistical analysis

The data were collected using IBM SPSS[®] version 21. Frequency and percentage were used to express nominal and ordinal variables. Mean and standard deviation were used to express scale variables with normally distributed data. Median and range were used for non-normally distributed data. For bivariate analysis, chi-square test was used for nominal variables, student's *t* test for scale variables with normally distributed data, and Mann-Whitney test for non-normally distributed data. In all tests, the *p*-value was 2-sided, and the significance was set at $p < 0.05$.

3. Results

Of the 197 patients, 190 were eligible for the study. The mean age of the study group was 50 ± 13 years, 146 (77%) were male, and 15 (7%) had solitary kidneys. Group A included 102 patients and Group B included 88 patients.

As shown in Table 1, both groups had comparable patient parameters, with the exceptions that patients in the one-stage group were significantly older and more patients had an American Society of Anesthesiologists score of II and III. Similarly, the preoperative parameters were comparable for both groups, except that the staged group included more multiple or staghorn stones.

The operative time (mean \pm SD) and hospital stay (median [range]) were shorter for the one-stage group (122 ± 12 minutes, 3 days [2–6]) compared to the sum of both procedures (URS and PCNL) for the staged group (140 ± 16 minutes, 4 days [3–9]; Table 2).

The postoperative data are summarized in Table 3. The overall success was comparable for ureteric and renal stones in the one-stage arm (84% and 77%) versus (82% and 67%) the staged arm ($p = 0.6$ and 0.1 , respectively). CT was used as a control film in 43%, X-ray KUB in 35%, and both CT and X-ray were used in the remaining 22%. Forty patients (18 in the staged group) had residual stones more than 4mm, of which 12 and 8 were successfully treated by 2nd look PCNL and SWL, respectively. The remaining patients were followed-up. Other postoperative parameters, including creatinine and hemoglobin, did not reveal any statistically significant differences between the 2 groups. Intraoperative complications included renal pelvis perforation in 2 patients in the one-stage group and 1 patient in the staged group. All were managed with ureteral stent insertion.

In the early postoperative period, 8 complications were recorded. On the Clavien scale, all were grade I, except 1 grade II. Six were observed in the one-stage group: 3 cases of fever that were managed with antibiotics only and 3 cases of hematuria, 2 cases that were managed with bed rest and 1 case required blood transfusion. In the staged group, 1 case of fever was managed with antibiotics and 1 case of hematuria was managed with bed rest. No cases of postoperative sepsis were recorded.

Table 1

Patient demographics and renal and stone parameters in the one-stage and staged groups.

Parameters	One-stage group (n = 102)	Staged group (n = 88)	p
Patient characteristics			
Gender, n (%) [*]			0.06
Male	84 (57)	62 (43)	
Female	18 (41)	26 (59)	
Body mass index, (mean±SD), kg/m ²	26±5	25±5	0.8
Age, (mean±SD), [†] yr	52±12	46±14	0.005
ASA score, [‡] n (%) [*]			0.01
ASA I	63 (47)	71 (53)	
ASA II	32 (71)	13 (29)	
ASA III	7 (63)	4 (37)	
Preoperative creatinine, median (range), mg/dL	1.6 (0.6–15)	1.2 (0.5–10)	0.2
Preoperative hemoglobin, (mean±SD), g/dL	13±3	13±3	1
Recurrent stone, n (%) [*]			0.6
No	68 (53)	61 (47)	
Yes	34 (55)	27 (45)	
Renal characteristics			
The side, n (%) [*]			0.3
Right	45 (52)	42 (48)	
Left	45 (52)	41 (48)	
Bilateral	12 (70)	5 (30)	
Solitary kidney, n (%) [*]			0.2
No	96 (55)	79 (45)	
Yes	6 (40)	9 (60)	
Preoperative hydronephrosis, n (%) [*]			0.6
No	4 (37)	5 (63)	
Mild	51 (54)	43 (46)	
Moderate	43 (55)	36 (45)	
Marked	4 (50)	4 (50)	
Preoperative stent or PCN, n (%) [*]			0.2
No	75 (50)	74 (50)	
Yes	27 (65)	14 (35)	
<i>DJ stent</i>	17	9	
<i>PCN</i>	10	5	
Stone characteristics			
Ureteric stones, location, n (%) [*]			0.1
Lumbar	20 (57)	15 (43)	
Iliac	21 (45)	26 (55)	
Pelvic	37 (51)	35 (49)	
Multiple locations	24 (67)	12 (33)	
Ureteric stones, n (%) [*]			0.3
Single	61 (51)	59 (49)	
Multiple	41 (58)	29 (42)	
Ureteric stone size, median (range), mm	7.6 (4–12)	10 (1.5–15)	0.9
Kidney stones, location, n (%) [*]			0.02
Single calyceal	48 (77)	14 (23)	
Renal pelvis	23 (63)	13 (37)	
Staghorn (partial/complete)	3 (33)	7 (67)	
Multiple	28 (34)	54 (46)	
Kidney stone size, median (range), mm	16.8 (10–30)	20 (10–32)	0.6
Stone opacity, n (%) [*]			0.2
Radiopaque	81 (56)	63 (44)	
Radiolucent	21 (46)	25 (54)	
Stone density			
Hounsfield unit, median (range)			
Ureteric	700 (250–1400)	680 (260–1290)	0.2
Renal	540 (240–1360)	740 (310–1260)	0.3

Bilateral means stone ureter on one side and stone kidney on the other side. ASA = American Society of Anesthesiologists; DJ = Double J; PCN = Percutaneous nephrostomy; SD = standard deviation.

^{*} Percentages are given for rows. Numbers rounded for simplicity.

[†] Statistically significant with Student's *t* test.

[‡] Statistically significant with chi-square test.

Table 2

The operative parameters between the one-stage and staged groups.

Parameters	Groups (total n = 190)		p
	One-stage group (n = 102)	Staged group (n = 88)	
Operative time, (mean±SD), min			0.02
URS	122±12	40±7.5	
PCNL		98±11	
URS and PCNL		140±15	
Hospital admission, median (range), <i>d</i>	3 (2–6)	4 (3–9)	0.06
URS			
Disintegration, n (%) [*]			0.5
No	51 (56)	40 (44)	
Yes	51 (51)	48 (49)	
Pneumatic	32	35	
Laser	19	13	
PCNL			
Number of punctures, n (%) [*]			0.5
Single	93 (54)	78 (46)	
Upper	10	6	
Middle	23	20	
Lower	60	52	
Multiple	9 (48)	10 (52)	
Postoperative stenting, n (%) [*]			0.8
Ureteric catheter	88 (53)	77 (47)	
Ureteric stent	14 (56)	11 (44)	

PCNL = percutaneous nephrolithotomy; URS = ureteroscopy.

^{*} Numbers rounded for simplicity. Percentages are given for rows.

Readmission was recorded in 5 patients: 3 had severe renal colic from migrating stones obstructing the ureter and 2 were admitted for removal the DJ stents. Late complications included 3 cases of ureteric stricture: 2 in the staged and 1 in the one-stage group. Two of the cases required endoureterotomy.

4. Discussion

In our study, we reported on the outcome of one-stage URS and PCNL in the prone position. Additionally, this cohort was compared to a control group of those who had the procedures performed in a staged strategy. The European Guideline of Urology recommends URS as a standard surgical modality for ureteral stones ≥1 cm and PCNL for the treatment of renal stones ≥2 cm and lower pole stones ≥1 cm with unfavorable outcome

Table 3

The postoperative data (the outcome) between the two groups.

Parameters	Groups		Significance (p)
	One-stage group (n = 102)	Staged group (n = 88)	
Postoperative creatinine, mg/dL	1.2 (0.6–3)	1.2 (0.7–2.8)	0.16
Postoperative Hb, g/dL	12±1.8	12±1.9	0.19
Success rate			
Ureteric stone, [†] n (%) [*]	86 (84)	72 (82)	0.6
Renal stone, [†] n (%) [*]	84 (82)	66 (75)	0.1

Hb = Hemoglobin.

^{*} Numbers rounded for simplicity. Percentages are given for columns.

[†] Measurement is the longest diameter.

anatomy for SWL, as well as special indications when SWL or medical treatments fail.^[3,8] Traditionally, URS and PCNL were performed in a staged procedure; however, this double admission puts more psychological stress on patients^[9] and incurs a greater financial cost. Optimally, the 2 procedures would be performed in single session, in appropriately selected patients, as it allows for one course of anesthesia and one hospital admission. This saves time, lowers costs, and promotes early recovery and return to work. Also, it opens additional slots in the operating schedule for other patients. As shown in Table 1, the one-stage approach was chosen more frequently for older patients (mean of 52 years old in one-stage vs. 46 in staged group) and for those who have a high American Society of Anesthesiologists score and cannot tolerate repeated anesthetic settings. On the other hand, the staged-procedure arm represented most staghorn and multiple renal stones. In those cases that surgeons expected the procedure to require more time, they chose to perform PCNL as a separate procedure. The shorter operative time in the one-stage group was expected compared to the sum of the URS and PCNL procedures. However, the other operative parameters in both groups did not show any significant differences, as shown in Table 2. In a similar study by Shen et al.,^[4] with cases concerning URS on the contralateral side including 52 in the one-stage arm and 51 in the staged arm, the authors reported the one-stage procedure to be safe and effective. Furthermore, Mason et al.^[7] retrospectively reviewed 26 patients who underwent PCNL and simultaneous retrograde URS for bilateral urolithiasis. They concluded that the one-stage approach allowed patients to return to normal activities without the need for a second, staged procedure. The recent technical advance in endoscopic tools allows for complex endourological procedures to be performed simultaneously, not only on one side, but also bilaterally, as in bilateral URS^[4,9] and bilateral PCNL in appropriately selected patients. Among the 1575 patients who underwent URS, 95 patients underwent simultaneous bilateral URS. Watson et al.^[5] reported bilateral URS as being efficacious for treating and evaluating the upper urinary tract, resulting in a stone-free rate of 86%. The complete stone clearance after URS in our study was close to that reported by Watson (83% in the one-stage vs. 81% in the staged group). The stone clearance rate in URS in our series was higher than that reported by Wirtz et al.,^[6] who took advantage of the one-stage URS on the contralateral side with PCNL to evaluate the clearance after URS precisely. Sixty percent (37/63) of patients left the procedure free of ureteric stones, and the majority of the remaining (17/26=65%) had stones less than 3mm. We may attribute the difference of the stone clearance, being higher in our series, to the frequent use of X-ray KUB film for radioopaque stones. As reported in the Wirtz series,^[6] X-ray usually misses small fragments that are identified by CT. On a large scale, 908 at our institution, the stone-free rate after URS was reported to be 87%.^[10] In the PCNL, and considering residual stones less than 4 mm as insignificant, the clearance rate was 83% in the one-stage versus 74% in the staged group ($p=0.1$). This may reflect the inclusion of complex stones that were in the staged group, but the clearance rate is in accordance with the published data.^[11,12] Kan et al.^[7] prospectively studied one-stage URS and PCNL, but in the supine position. Although the authors reported the feasibility of the one-stage procedure, the number was too small (11 patients) to provide solid conclusions. PCNL in the prone position is still the prototype and is the most conventional technique. Also, this technique provides free working space allowing for angulation of instruments, multiple access channels and a higher stone-free rate

than in the supine position.^[13] An online survey was administered to active Endourological Society members, revealing that 85% of respondents used the prone position to obtain access, 10% used supine, and 4% used lateral decubitus.^[14] As per our protocol, we routinely used a postoperative ureteric catheter for 2 days after all procedures, either one-stage or staged, unless otherwise directed by the surgeon. In a few patients, we used a ureteric stent (25/190=13%).

Considering the median sizes of ureteric and renal stones, our study showed that the one-stage approach was safe and had the same operative parameters and outcome as compared to the staged group. The same session procedure is a good option in appropriately selected patients. Our study was a retrospective one, and few variables were unmatched between the 2 groups. On the other hand, this revealed the benefits of the one-stage procedure more frequently. A prospective randomized study could achieve matching between the 2 groups and could calculate the cut-off values of the ureteral stone, in which the one-stage procedure can achieve the same results as the staged procedure. Additionally, the endoscopic procedures were performed by multiple surgeons. Despite these limitations, our study addressed a topic that is rarely addressed in the literature and reported on a larger number of patients at a tertiary urology institute with experts in the field.

5. Conclusions

PCNL could be performed with URS as a one-session procedure for simultaneous ureteral and renal stones, except in the case of multiple renal and staghorn stones. This one-session procedure yields equal results compared to the staged procedure in terms of success rate and complications, with the advantage of a shorter operative time and hospital stay. Moreover, it is a good choice for patients with high anesthetic risk by necessitating only one surgical procedure and shortening the hospital stay.

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None.

Statement of ethics

This study was approved by Research Committee, Urology and Nephrology Center, Mansoura University. No participant's consent was taken, for it was a retrospective review on the electronic database. All procedures performed in this study were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Conflict of interest statement

The authors declare no conflict of interest.

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Author contributions

All authors contributed equally in this study.

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