Original Article

JHSMR Journal of Health Science and Medical Research

Flexible Ureteroscopy in Complex Renal Stone Disease: A Retrospective Cohort Study

Supavadee Pratoomsut, M.D., Nattaporn Wanvimolkul, M.D., Ekkarin Chotikawanich, M.D., Kantima Jongjitaree, M.D.

Division of Urology, Department of Surgery, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok 10700, Thailand.

Received 16 January 2026 ● Revised 16 March 2026 ● Accepted 20 March 2026 ● Published online 19 October 2026

Abstract:

Objective: Flexible ureteroscopy is the standard treatment for renal calculi ≤2 cm in patients with normal anatomy; however, its role in anatomically complex kidneys, defined as an anatomical kidney abnormality, remains unclear. Our study evaluated stone-free rates (SFRs) and postoperative complications following flexible ureteroscopy in complex upper urinary tract stone disease.

Material and Methods: A retrospective review was conducted of 59 adult patients who underwent flexible ureteroscopy between 2016 and 2024 for stones associated with calyceal diverticula, horseshoe kidney, duplicated collecting systems, transplanted kidneys, or ectopic ureters. Primary outcomes included SFRs at 1 month and postoperative complications. The continuous and categorical variables were reported using descriptive statistics. Subgroup analysis was performed using SPSS Statistics version 25.0

Results: A total of 59 patients were included: The most common condition was calyceal diverticulum (47 cases). Six cases of duplicated collecting systems, four cases of horseshoe kidneys, one case of ectopic ureter, and one case of transplanted kidney. Overall SFRs were 74.5% for calyceal diverticulum, 50% for horseshoe kidneys, and 50% for duplicated collecting systems. Both transplanted kidney and ectopic ureter cases achieved 100% SFRs. Stone size was the only significant predictor of residual stones in calyceal diverticulum (p-value=0.012). Complications were mainly infection, occurring most frequently in duplicated collecting systems.

Conclusion: Flexible ureteroscopy is a feasible and effective option for selected complex renal stone cases, with stone size being the key determinant of success.

Contact: Kantima Jongjitaree, M.D.
Division of Urology, Department of Surgery, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok 10700, Thailand.
E-mail: kantima035@gmail.com

J Health Sci Med Res
doi: 10.31584/jhsmr.20261466
10.31584/jhsmr.20261466www.jhsmr.org

© 2026 JHSMR. Hosted by Prince of Songkla University. All rights reserved.
This is an open access article under the CC BY-NC-ND license (http://www.jhsmr.org/index.php/jhsmr/about/editorialPolicies#openAccessPolicy).

Keywords: Flexible ureteroscopy, retrograde intrarenal surgery, calyceal diverticulum, horseshoe kidney, duplicated collecting systems

Introduction

Flexible ureteroscopy has become the standard treatment for renal calculi measuring up to 2 cm in normally configured kidneys because of its high stone-free rates (SFRs) and low morbidity[1]. The primary objective of surgical management of nephrolithiasis is to maximize stone clearance while minimizing patient morbidity. Owing to its minimally invasive nature and continuous technological advancements, flexible ureteroscopy is widely adopted for the management of upper urinary tract urolithiasis, particularly for kidney stones smaller than 2 cm^2.

However, the optimal treatment modality in anatomically complex cases remains controversial. In this study, complex cases are defined as urinary tract stones in patients with anatomical kidney abnormalities, including transplanted kidneys, horseshoe kidneys, ectopic ureters, calyceal diverticula, and duplicated collecting systems. Although these conditions are relatively uncommon compared with other urological disorders, the incidence of stone formation varies widely, ranging from 2% in transplanted kidneys to 50% in calyceal diverticula[3-8], depending on the specific anatomical abnormality. The prevalence of upper tract stones in these complex settings is likely underreported, and the role of flexible ureteroscopy in their management has not been well established. Organizing the stone in complex cases by using the flexible ureteroscopy may provide an advantage over other methods, for example, reducing the risk of bleeding or the iliac position of the transplanted kidney.

Therefore, we retrospectively evaluated complex upper-tract stone cases managed with flexible ureteroscopy in our institution to assess SFRs and postoperative complications.

Material and Methods

The study protocol was approved by the Institutional Review Board of the Faculty of Medicine Siriraj Hospital, Mahidol University, Thailand, protocol number COA no. Si 004/2025. We retrospectively reviewed the data from 59 anatomically complex kidney patients who underwent flexible ureteroscopy between 2016 and 2024 in Siriraj Hospital. Eligible patients were aged ≥18 years and had complete demographic and clinical data, including age, comorbidities, stone characteristics, and type of anatomical abnormality. All patients were diagnosed with urinary tract calculi using computed tomography (CT). Preoperative variables included maximum stone size, number of stones, stone location, and stone attenuation values measured in Hounsfield units (HU). All procedures were performed under general anesthesia in the lithotomy position. Flexible ureteroscopy was used with holmium:YAG laser lithotripsy. Ureteral access sheath *facilitated* channel dilatation during endoscopy. A postoperative 4.8 Fr double-J ureteral stent was routinely placed. Ultrasonography or plain KUB film was performed to determine the residual stone. Patients who had received prior stone interventions, were pregnant, and or had incomplete data after the operation were excluded from the cohort.

Surgical success was defined, using the SFRs, as a residual stone less than 2 mm on plain KUB or ultrasonography in a radiolucent stone at the 1-month follow-up after hospital discharge. Postoperative complications were recorded and analyzed.

Statistical analyses were performed using SPSS Statistics version 25.0. Baseline characteristics were summarized using descriptive statistics and are presented as numbers with percentages of categorical variables and means or medians of continuous variables. Subgroup analysis was compared using both the chi-square and independent t-test, as appropriate.

Results

Patient characteristics

A total of 59 patients were included in the analysis: 47 cases of calyceal diverticulum (79.7%), six cases of stones in duplicated collecting systems (10.2%), four cases of horseshoe kidneys (6.8%), one case of a transplanted kidney, and one case of an ectopic ureter (1.7%). The cohort comprised 30 male and 29 female patients. The mean age across the groups ranged from the fifth to the seventh decade of life. Hypertension was the most common comorbidity, followed by diabetes mellitus and dyslipidemia. In contrast, patients with horseshoe kidneys more commonly had gout and chronic kidney disease.

Maximum stone size differed substantially among groups. Stones in duplicated collecting systems were the largest (mean 27.8 mm), whereas those in horseshoe kidneys were the smallest (mean 7.2 mm). Stone composition analysis revealed that mixed calcium oxalate and calcium phosphate stones were the most common across all groups.

The mean operative time ranged from 60 to 90 minutes, and the median length of hospital stay was 2–4 days. Follow-up imaging was performed within 1 month after hospital discharge.

Surgical outcomes and complications

The overall SFR at 1 month was highest in the calyceal diverticulum group (74.5%), followed by the horseshoe kidney (n=2/4) and duplicated collecting system groups (n=3/6) (50% each). Postoperative complications were most frequent in patients with duplicated collecting systems (33.3%), followed by the calyceal diverticulum group (12.8%). The most common complications were urinary tract infection and sepsis. One case of ureteral injury grade 2 was found in the calyceal diverticulum group and treated with postoperative double-J ureteral stent. No complications were observed in the horseshoe kidney group.

Both the transplanted kidney and ectopic ureter cases achieved a 100% SFR (n=1) without postoperative complications or the need for ancillary procedures.

Subgroup analysis: calyceal diverticulum

Subgroup analysis of patients with calyceal diverticulum cases demonstrated that maximum stone size was the only factor significantly associated with postoperative SFR (p-value=0.012). Stone density (HU), number of stones, stone location, and operative time were not significantly associated with residual stones.

Discussion

According to the European Association of Urology (EAU) guidelines[2], the management of urolithiasis should be individualized based on stone size, location, number, composition, and renal anatomy. Complex urolithiasis presents additional challenges due to anatomical variations, necessitating tailored surgical approaches and careful preoperative assessment.

Transplanted kidney stones

De novo nephrolithiasis occurs in approximately 2% of kidney transplant recipients within three years[4]. Stone removal is mandatory because of the increased risk of infection in immunocompromised patients with a solitary functioning graft. Clinical presentation may be atypical due to graft denervation, with patients often presenting late with hematuria, fever, or sepsis[9,10]. The EAU guidelines

recommend individualized management for stones in transplanted kidneys, with selection of the most appropriate technique. For large renal or ureteral stones, percutaneous nephrolithotomy (PCNL) with antegrade access is generally preferred. However, retrograde endoscopic approaches can be technically challenging due to the ureteroneocystostomy anatomy and acute angulation of the lower calyx. Despite these challenges, retrograde approaches carry a lower risk of bleeding and graft injury compared with PCNL.

In our study, advancements in flexible ureteroscope design, including reduced instrument caliber and improved deflection, facilitated a retrograde approach in a transplanted kidney. A 10-mm lower-pole graft stone was successfully treated using flexible ureteroscopy without complications. This finding supports emerging evidence that flexible ureteroscopy is an effective and less invasive alternative for selected patients with small stones (<15 mm), achieving SFRs of up to 91.7%[11,12].

Calyceal diverticulum stones

PCNL and flexible ureteroscopy are the two principal treatment modalities for calyceal diverticulum stones. Several comparative studies have reported variable results, with PCNL generally achieving higher SFRs[13,14]. Nevertheless, flexible ureteroscopy is often favored because it provides acceptable SFRs with lower morbidity. PCNL, particularly when direct puncture of the diverticulum is performed, allows reliable access to diverticula in any location and offers excellent stone clearance, especially for large stones; however, it is associated with increased procedural morbidity. In contrast, flexible ureteroscopy is less invasive and associated with shorter hospital stays, although identification of the diverticular neck may be technically challenging.

In our study, flexible ureteroscopy achieved an SFR of 74.5%, with stone size identified as the only significant predictor of surgical success. Eleven patients required ancillary procedures, including PCNL or extracorporeal shock wave lithotripsy (SWL), for residual stones. Postoperative complications occurred in 12.8% of patients and were predominantly infectious, including fever and sepsis. These findings are consistent with previous reports demonstrating favorable outcomes for stones smaller than 1.5 cm, with lower complication rates compared with PCNL. Therefore, flexible ureteroscopy represents an appropriate first-line treatment in carefully selected patients, while PCNL remains an important option for larger stones or as a second modality following failed endoscopic management.

Horseshoe kidney stones

Horseshoe kidney is associated with impaired urinary drainage and an increased risk of stone formation. Treatment options include SWL, PCNL, and ureteroscopy. Although PCNL generally provides the highest SFRs, ureteroscopy has emerged as an attractive alternative because of acceptable SFRs and lower complication profiles[15],particularly in low-lying horseshoe kidneys that are difficult to access percutaneously. Previous studies have reported wide variability in SFRs following ureteroscopy, ranging from 33% to 70%[16,17]. This variability may be attributed to differences in operator experience, instrumentation, anatomical variations inherent to horseshoe kidneys, and stone-related factors. In our series, flexible ureteroscopy achieved SFRs of 50% in patients with horseshoe kidney stones, all of which were located in the lower pole. Treatment failure was primarily associated with multiple renal stones and ureteral stent encrustation. The presence of multiple stones and unfavorable lower-pole anatomy likely contributed to incomplete stone clearance. Therefore, careful patient selection based on stone size, number, and location remains critical when considering flexible ureteroscopy for horseshoe kidney stone management.

Ectopic ureter and duplicated collecting system stones

Stones in ectopic ureters and duplicated collecting systems are rare, and the available evidence is largely limited to case reports[8]. Endoscopic management with ureteroscopy is generally considered the treatment of choice and is associated with favorable outcomes; however, anatomical variations may complicate identification and access to the ureteric orifice. Abnormal ureteral insertion may obscure the ureteral opening or create unfavorable angles for endoscopic intervention. Open or laparoscopic surgery is usually reserved for cases in which endoscopic management fails.

Table 1 Demographics, complications, and outcomes of horseshoe kidney, calyceal diverticulum, and duplicated collection system stones

Demographic data	Horseshoe kidney (N=4)	Calyceal diverticulum (N=47)	Stone in duplicated collecting system (N=6)
Sex			
Male (n (%))	3 (75%)	22 (46.8%)	3 (50%)
Female (n (%))	1 (25%)	25 (53.2%)	3 (50%)
Age (Mean, years)	51.8	56.9	62.3
Hypertension (n (%))	0	20 (42.6%)	2 (33.3%)
Diabetes Mellitus (n (%))	0	11 (23.4%)	0
Dyslipidemia (n (%))	0	14 (29.8%)	0
Gout (n (%))	1 (25%)	0	0
Chronic kidney disease (n (%))	1 (25%)	7 (14.9%)	0
Stone maximum size (mean, mm)	7.2	11.2	27.8
Location (n (%))			
Upper calyx	0	21 (44.7%)	2 (33.3%)
Middle calyx	0	6 (12.8%)	0
Lower calyx	4 (100%)	20 (42.5%)	4 (66.7%)
Operative time (mean, min)	82.5	61.2	95.8
Length of stay (median, days)	3	2	3.5
Stone-free rate (n (%))	2 (50%)	35 (74.5%)	3 (50%)
Stone analysis (n (%))			
Calcium oxalate	1 (25%)	11 (23.4%)	1 (16.7%)
Calcium phosphate	0	4 (8.5%)	2 (33.3%)
Calcium oxalate + calcium phosphate	3 (75%)	23 (48.9%)	2 (33.3%)
Uric stone	0	0	1 (16.7%)
Calcium oxalate + uric acid	0	2 (4.3%)	0
Struvite	0	1 (2.1%)	0
Others	0	6 (12.8%)	0
Post-operative complication (n (%))	0	6, (12.8%)	2 (33.3%)
Fever	0	1 (2.1%)	0
Sepsis	0	2 (4.3%)	1 (16.7%)
Urinary tract infection	0	2 (4.3%)	1 (16.7%)
Ureteral injury	0	1 (2.1%)	0
Ancillary procedure (n (%)			
PCNL	2 (50%)	1 (2.1%)	0
SWL	0	4 (8.5%)	1 (16.7%)
URSL	0	0	1 (16.7%)

In our study, flexible ureteroscopy successfully treated a stone in an ectopic ureter with 100% stone clearance, supporting ureteroscopy as the preferred modality for ureteric stones in ectopic ureters, regardless of stone size. In contrast, stones in duplicated collecting systems demonstrated lower SFRs (50%), likely attributable to large stone size (mean size, 27 mm) and lower pole location. Furthermore, complex intrarenal anatomy may reduce endoscopic visibility and access, and the combination of large stone burden and unfavorable stone location appears to negatively affect surgical outcomes.

Limitations

This study is limited by its retrospective design and small sample size, reflecting the rarity of these anatomical conditions. Larger multicenter studies or systematic reviews are needed to validate these findings. Surgical success depended on the surgeon's experience and the lack of standardized imaging for detecting underestimated residual stones.

Conclusion

Flexible ureteroscopy has emerged as a feasible and effective, minimally invasive modality for the management of renal stones in anatomically challenging conditions for carefully selected patients, including transplant kidney and ectopic ureter, where percutaneous access may be technically difficult or associated with higher complication rates. Flexible ureteroscopy also represents a valuable alternative treatment option for stones located within

Table 2 Subgroup analysis of calyceal diverticulum (N=47, 1 was converted to PCNL)

Demographic Data	Stone free (n=35)	Residual stone (n=11)	p-value
Underlying disease			
Hypertension (n (%))	16 (45.7%)	4 (36.4%)	0.56
Diabetes Mellitus (n (%))	8 (22.9%)	3 (27.3%)	0.77
Dyslipidemia (n (%))	8 (22.9%)	6 (54.5%)	0.046
Gout (n (%))	0	0	
Chronic kidney disease (n (%))	6 (17.1%)	1 (9.1%)	0.52
Stone analysis			
Calcium oxalate (n (%))	10 (28.6%)	1 (9.1%)	0.19
Calcium phosphate (n (%))	2 (5.7%)	2 (18.2%)	0.2
Calcium oxalate + calcium phosphate (n (%))	16 (45.7%)	6 (54.5%)	0.61
Number of stones			
1 (n (%))	8 (22.9%)	4 (36.4%)	0.41
2 (n (%))	8 (22.9%)	1 (9.1%)	
3 (n (%))	4 (11.4%)	0	
4 (n (%))	15 (42.9%)	6 (54.5%)	
Stone location			
Upper calyx (n (%))	19 (54.3%)	2 (18.2%)	0.07
Middle calyx (n (%))	4 (11.4%)	1 (9.1%)	
Lower calyx (n (%))	12 (34.3%)	8 (72.7%)	
Maximum size of stone (mean, mm)	10.24	14.46	0.012
Attenuation coefficient (mean, HU)	669.11	782.55	0.58
Operative time (mean, min)	59.4	59.8	>0.99

PCNL=Percutaneous nephrolitnotomy, HU=Hounsfield unit

calyceal diverticula and demonstrates fair and acceptable outcomes in patients with horseshoe kidneys and duplicated collecting systems. In these complex anatomical settings, surgical outcomes are influenced by multiple factors, of which stone size is the most critical predictor of success. Strict patient selection based on stone size, number, and location, together with thorough preoperative assessment and individualized treatment planning, is essential for optimizing SFRs while minimizing the need for secondary procedures.

Acknowledgement

The authors would like to express gratitude to Miss Jitsiri Chaiyatho and Miss Julaporn Pooliam for her valuable contributions to this study.

Funding sources

None.

Conflict of interest

There are no conflicts of interest to declare.

References

1. Joshi R. Early experience of retrograde intrarenal surgery for renal stone: a descriptive cross-sectional study. JNMA J Nepal Med Assoc 2020;58:465-9.
2. Akram M, Jahrreiss V, Skolarikos A, Geraghty R, Tzelves L, Emilliani E, et al. Urological guidelines for kidney stones: overview and comprehensive update. J Clin Med 2024;13.
3. Boonyapalanant C, Saksirisampant P, Taweemonkongsap T, Leewansangtong S, Srinualnad S, Chotikawanich E. Factors Impacting Stone-Free Rate After Retrograde Intrarenal Surgery for Calyceal Diverticular Calculi. Res Rep Urol 2020;12:345-50.
4. Ganesan C, Holmes M, Liu S, Montez-Rath M, Conti S, Chang TC, et al. Kidney Stone Events after Kidney Transplant in the United States. Clin J Am Soc Nephrol 2023;18:777-84.
5. Timmons JW, Jr., Malek RS, Hattery RR, Deweerd JH. Caliceal diverticulum. J Urol 1975;114:6-9.
6. Pawar AS, Thongprayoon C, Cheungpasitporn W, Sakhuja A, Mao MA, Erickson SB. Incidence and characteristics of kidney stones in patients with horseshoe kidney: a systematic review and meta-analysis. Urol Ann 2018;10:87-93.
7. Manurung MA, Aslim O, Novianda AH, Wahyudi I, Birowo P, Situmorang GR. Staghorn stones in a congenital malrotation double collecting kidney managed by laparoscopy. Urol Case Rep 2023;50:102524.
8. Heijkoop B, Lahoud J, Wong ELH. Endoscopic stone management in an ectopic ureter inserting into the prostatic urethra. BMJ Case Rep 2023;16.
9. Boissier R, Rodriguez-Faba O, Zakri RH, Hevia V, Budde K, Figueiredo A, et al. Evaluation of the Effectiveness of Interventions on Nephrolithiasis in Transplanted Kidney. Eur Urol Focus 2023;9:491-9.
10. Markic D, Krpina K, Ahel J, Grskovic A, Spanjol J, Rubinic N, et al. Treatment of kidney stone in a kidney-transplanted patient with mini-percutaneous laser lithotripsy: a case report. Case Rep Nephrol Dial 2016;6:26-31.
11. Lo CYZ, Chong D, Sjariffudin IF, Chong TW, Lu Y. Percutaneous nephrolithotomy for adult renal transplant de novo graft lithiasis: a single center analysis and systematic review of the literature. World J Urol 2024;42:373.
12. Hyams E, Marien T, Bruhn A, Quirouet A, Andonian S, Shah O, et al. Ureteroscopy for transplant lithiasis. J Endourol 2012;26:819-22.
13. Gauhar V, Traxer O, Woo SJQ, Fong KY, Ragoori D, Wani A, et al. PCNL vs RIRS in management of stones in calyceal diverticulum: outcomes from a global multicentre match paired study that reflects real world practice. World J Urol 2023;41:2897-904.
14. Zeng J, Zhang L, Chen X, He H, Li X. The treatment option for calyceal diverticulum stones: flexible ureteroscopy lithotripsy (FURL) or all-seeing needle-assisted percutaneous nephrolithotomy (PCNL)? Urolithiasis 2022;50:743-9.
15. Lavan L, Herrmann T, Netsch C, Becker B, Somani BK. Outcomes of ureteroscopy for stone disease in anomalous kidneys: a systematic review. World J Urol 2020;38:1135-46.
16. Atis G, Resorlu B, Gurbuz C, Arikan O, Ozyuvali E, Unsal A, et al. Retrograde intrarenal surgery in patients with horseshoe kidneys. Urolithiasis 2013;41:79-83.

17. Süelözgen T, İşoğlu CS, Karabıçak M, Yalçın MY, Yeni S, İlbey YÖ. Our retrograde intrarenal surgery experience with horseshoe kidney. J Urol Surg 2017;4:106-8.