Percutaneous Nephrolithotomy in Patients with Renal Stones and Prior Robotic-Assisted Radical Cystectomy: Challenges and Surgical Outcomes

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ABSTRACT

Introduction and Objectives. Renal stones are a common complication in patients with a history of radical cystectomy, particularly in those who have undergone urinary diversion. The altered anatomy following robotic-assisted radical cystectomy (RARC) increases the risk of stone formation due to urinary stasis, metabolic imbalances, and chronic infections. Percutaneous nephrolithotomy (PCNL) is a well-established treatment for large renal stones. This study aims to evaluate the outcomes of PCNL in this complex patient population, assessing stone-free rates, complications, and technical modifications required for successful intervention.

Materials and Methods. A retrospective analysis was conducted over a ten-year period at the Urology Clinic of Mureș County Clinical Hospital, including patients with renal stones who previously underwent RARC with urinary diversion (ileal conduit, orthotopic neobladder, or cutaneous ureterostomy). PCNL was performed using ultrasound-guided renal puncture, fluoroscopic tract optimization, and lithotripsy via ultrasonic or holmium-YAG laser. The primary outcomes measured were stone-free rates, operative time, length of hospitalization, and complications classified using the Clavien-Dindo system. Crystallographic and bacteriological analyses of the stones were performed.

Results. Five male patients met the inclusion criteria, with a mean age of 66.6 years (range: 58–74). Urinary diversions included three ileal conduits, one orthotopic neobladder, and one cutaneous ureterostomy. All patients had sterile preoperative urine cultures. Stone locations included four renal calculi (one staghorn) and one lumbar ureteral stone. The mean operative time was 41 minutes (range: 25–70), and PCNL achieved a 100% stone-free rate confirmed via postoperative imaging. One patient required multiple access tracts due to a large staghorn calculus. Hospitalization ranged from 3 to 6 days. Complications included one case of Clavien IIIb bleeding requiring ICU admission and transfusion, with no further surgical intervention necessary. Crystallographic analysis identified struvite stones in four cases and calcium oxalate monohydrate in one, with one stone testing positive for Proteus mirabilis.

Conclusions. PCNL is a feasible and effective treatment for renal stones in patients with prior robotic radical cystectomy, despite the anatomical challenges posed by urinary diversion. Careful preoperative planning, modified access techniques, and strict perioperative management are essential for optimizing outcomes. The high incidence of struvite stones highlights the need for infection control strategies, and close postoperative monitoring is warranted due to the increased risk of complications. Further multicenter studies with larger cohorts are needed to establish standardized PCNL protocols in this unique patient population.

Key-words: percutaneous nephrolithotomy, Robotic-Assisted Radical Cystectomy, urinary diversion, stone-free rate, urolithiasis

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INTRODUCTION AND OBJECTIVES

Renal stones are a common urological condition, affecting a significant proportion of the general population. Their incidence is notably increased in patients with a history of radical cystectomy, particularly those with urinary diversion [1]. The altered anatomy of the urinary tract following cystectomy, whether with an ileal conduit or a neobladder, can contribute to stone formation due to factors such as urinary stasis, metabolic changes, and chronic infections. In such patients, the management of renal stones poses unique challenges due to the modified urinary drainage and altered access routes[2].

Robotic-assisted radical cystectomy (RARC) has emerged as a preferred surgical approach for the management of muscle-invasive bladder cancer due to its minimally invasive nature, reduced blood loss, and shorter recovery times compared to open surgery. However, despite these advantages, the anatomical changes resulting from this intervention significantly impact the upper urinary tract. The reconfiguration of the urinary system may lead to impaired urine drainage, ureteral stricture formation, and increased susceptibility to stone formation. Furthermore, access to the kidney for endourological procedures, such as PCNL, can be more complex due to post-surgical adhesions, altered renal orientation, and the absence of a natural bladder reservoir for retrograde instrumentation[3].

PCNL is a well-established technique for the management of large and complex renal stones. However, its application in patients with a history of robotic cystectomy requires careful preoperative planning and technical modifications to ensure procedural success while minimizing complications.

The objective of this study is to evaluate the efficacy and safety of PCNL in patients with renal stones who have previously undergone robotic radical cystectomy. By analyzing surgical outcomes, complication rates, and stone clearance rates, this study aims to provide insights into the challenges and advantages of PCNL in this unique patient population.

MATERIALS AND METHODS

Study design

This is a retrospective study conducted over a ten-year period, from January 2015 to December 2024, at the Urology Clinic of Mureș County Clinical Hospital. The study involves the analysis of medical records of patients who underwent PCNL after robotic-assisted radical cystectomy. Data were collected from hospital archives and electronic medical records, including demographic information, surgical details, postoperative outcomes, and complication rates.

Inclusion criteria

Patients included in the study had a history of RARC performed for bladder cancer or other medical indications such as neurogenic bladder or refractory interstitial cystitis. Additionally, they had undergone a urinary diversion procedure, including the creation of an ileal conduit, an orthotopic neobladder or a cutaneous ureterostomy.

The study included patients diagnosed with unilateral or bilateral renal stones, confirmed through CT scan. Eligible patients had kidney stones measuring at least 10 mm in size or cases that required surgical intervention due to complications such as urinary obstruction, infection, or significant symptoms. Patients included in the study underwent PCNL, which was indicated in cases where extracorporeal shock wave lithotripsy (ESWL) or retrograde ureteroscopy (URS) was not feasible due to factors such as stone size, anatomical constraints, or failure of prior treatments. Only adult patients aged 18 years or older were included to ensure comparability in treatment approaches. Furthermore, the study considered only patients with complete medical records, including operative reports, imaging findings, stone composition analysis (if available), and documented postoperative outcomes, to facilitate a comprehensive evaluation of results.

Exclusion criteria

Patients were excluded from the study if they had undergone open radical cystectomy instead of robotic-assisted surgery. Patients with asymptomatic renal stones smaller than 10 mm and

no clinical indication for intervention were also excluded.

Patients with severe anatomical or functional kidney abnormalities were excluded if they had a non-functioning kidney on the affected side or conditions such as pelvic kidney, horseshoe kidney, or renal malrotation, which would make percutaneous access technically impossible.

Contraindications to PCNL were also considered exclusion criteria. Patients with uncorrected bleeding disorders, such as hemophilia or thrombocytopenia, were not included, as well as those with an active urinary tract infection (UTI) or sepsis that had not been controlled with antibiotic therapy before surgery. Additionally, patients with uncorrected coagulopathy who could not safely undergo a percutaneous procedure were excluded. Finally, patients with incomplete medical records were not included in the study. Those lacking detailed perioperative and postoperative follow-up data, including complication rates, duration of hospital stay, and stone-free status, were excluded to ensure accurate data collection

Patient group

The demographic distribution of the patient cohort included an analysis of sex and age groups. Additionally, the study assessed relevant comorbidities, including diabetes mellitus, hypertension, chronic kidney disease (CKD), metabolic disorders, and cardiovascular diseases.The presence of recurrent urinary tract infections (UTIs) was also considered.

Technical details

For all patients (except for the one with bilateral cutaneous ureterostomies) renal puncture was performed under ultrasound guidance due to the inability to catheterize the ureteral orifice and insert the ureteral catheter. Contrast medium was injected to confirm the correct placement. A secondary puncture under fluoroscopic guidance was performed when deemed necessary to optimize tract positioning. Dilation of the percutaneous tract was achieved using telescopic metal dilators.

The type of renal access was determined based on stone location, kidney anatomy, and ease of entry. The puncture was primarily directed through the middle or lower calyx, as these access points provided better stone clearance and minimized the risk of vascular injury.

For stone fragmentation an ultrasonic lithotripsy or olmium-YAG laser (or combination) was used to ensure effective stone disintegration and clearance. Ultrasonic lithotripsy was the preferred technique as it allowed for simultaneous fragmentation and aspiration, thereby facilitating faster stone clearance. We did not use a safety guidewire in any of the procedures. A 20 Ch Foley nephrostomy tubes were placed in all patients at the end of the procedure and were removed 48 hours postoperatively. The insertion of ureteral catheters (either Double-J or Mono-J catheters) was not considered mandatory and was only performed when a difficult passage of the anterogradely administered contrast agent was observed.

The bacteriological and crystallographic analysis of the stones was performed.

To enhance patient safety and reduce the risk of infection, infection prophylaxis was strictly implemented. All patients received a preoperative dose of broad-spectrum antibiotics, according to antibiograms and patient history. Standard prophylaxis included a single preoperative dose of a third-generation cephalosporin (e.g., ceftriaxone 1g IV) or an aminoglycoside, administered at 30–60 minutes before the procedure.

Evaluated parameters

Operative success was primarily measured by the clear stone rate as confirmed by postoperative imaging (ultrasound or non-contrast CT scan). Patients were considered stone-free if no residual fragments >4 mm were detected at follow-up.
Perioperative complications were systematically recorded and categorized according to the Clavien-Dindo classification to assess their severity. Among the primary complications, bleeding was evaluated by determining the need for blood transfusions.
Infections were another significant complication, with data collected on the incidence of postoperative fever, urinary tract infections (UTIs), bacteremia and sepsis.

Total operative time (from the initiation to the completion of the PCNL) was recorded. Hospital stay duration was measured in days. The need readmission within 30 days was also included in the assessment of postoperative outcomes.

Results

A total of five patients met the inclusion and exclusion criteria for the study, all of whom were male. The mean value recorded among these patients was 66,6 (SD 6,54). The patients' ages ranged between 58 and 74 years.

All patients underwent RARC for bladder tumor, followed by a urinary diversion procedure. Among them, three patients had an ileal conduit, one patient received an orthotopic neobladder, and one patient had a cutaneous ureterostomy. For the patient with bilateral cutaneous ureterostomy, the stoma was positioned in the lumbar region. Initially, the patient underwent an orthotopic neobladder urinary diversion. However, due to postoperative complications, including severe septic events, a reintervention was required, leading to the removal of the neobladder and the creation of the bilateral cutaneous ureterostomies mentioned above. Preoperative characteristics of the patients included in the study and the associated comorbidities detailed in Table 1.

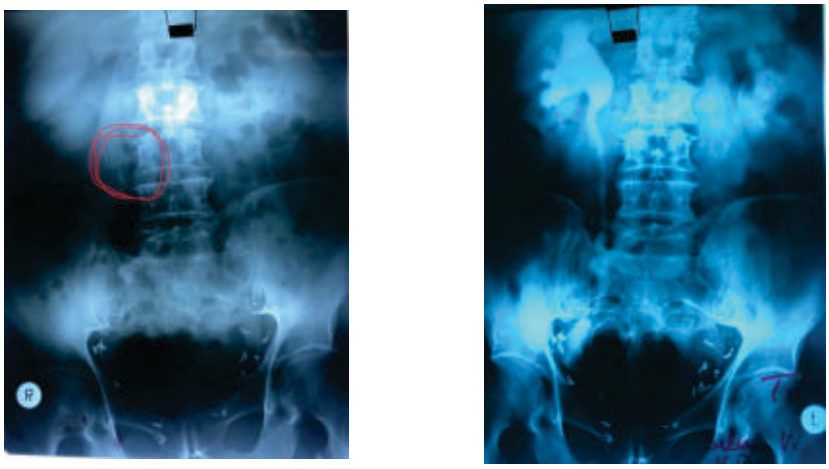
Table 1. Preoperative characteristics of the patients included in the study

	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5
Age	58	62	71	68	74
Year of cystectomy	2016	2016	2019	2019	2022
Years since cystectomy	2	2	4	3	2
Urinary diversion type	orthotopic neobladder	ileal conduit	ileal conduit	cutaneous ureterostomy (bilateral lumbar position)	ileal conduit
Comorbidities					
diabetes mellitus	-	+	+	-	-
hypertension	-	+	+	+	+
chronic kidney disease	Stage 2	Stage 1	Stage 2	Stage 2	Stage 3a
glomerular filtration rate (mL/min/1.73m²)	69	94	73	75	51
Obesity	Overweight	Normal weight	Obesity class II	Obesity class II	Obesity Class I
BMI (kg/m²)	28,4	25	37,3	36,4	32.9
cardiovascular diseases	-	-	+	-	+
Stone location					
ureter	-	-	+	-	-
kidney	+	+	-	+	+
Type of stone/	Staghorn of the inferior calyx	Lumbar ureter	Renal pelvis	Renal pelvis +inferior calyx	Renal pelvis
Size (mm)	44/35	24/18	11/6	24/22, 7/5	23/19
Preoperative urine culture	Negative	Negative	Negative	Negative	Negative

Regarding stone location, one patient presented with a lumbar ureteral stone (Figure 1 a, b), while the .

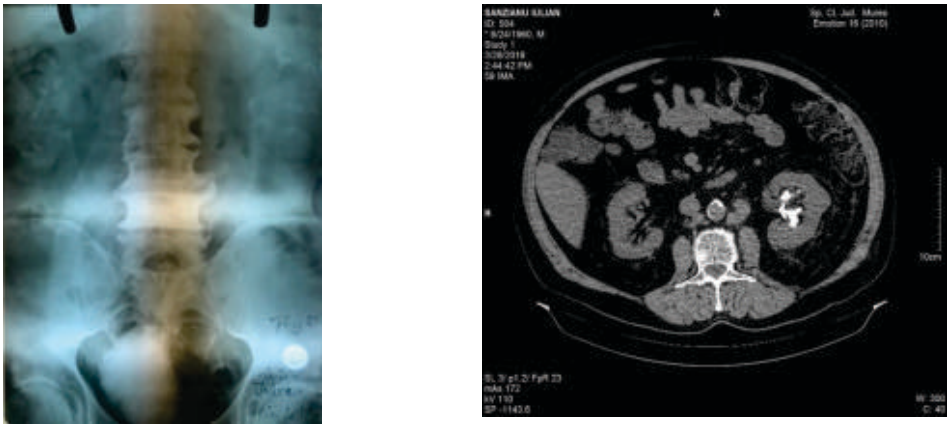
remaining four cases involved renal stones. Among these four renal stone cases, one was identified as a staghorn of the inferior calyx (Figure 2 a, b)

Figure 1. Patient 2. KUB X-ray and IVU: (a) A radiopaque stone located in the upper right lumbar region, (b) Ureteral dilation upstream of the stone and segmental ureteral dilation caused by a metal clip.



(a) (b)

Figure 2. Patient 1. IVU (a) and native CT (b): Staghorn stone located in the lower half of the left kidney



(a) (b)

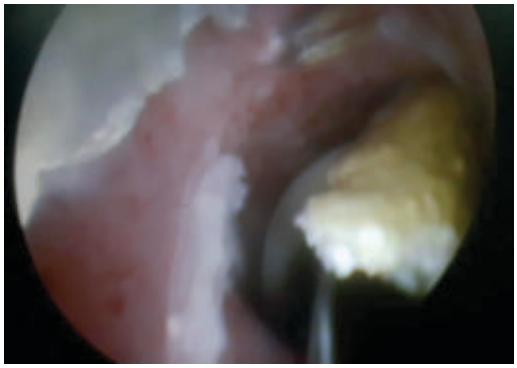
Preoperative urine cultures were sterile in all patients.

For the patient with a staghorn calculus and neobladder, two percutaneous tracts were required for complete stone extraction. After the removal of he nephrostomy tubes, a lumbar urinary fistula was detected, and ultrasound evaluation revealed a tresidual stone measuring 7-8 mm. A second PCNL procedure was attempted; however, the stone could not be visualized, leading to the placement of a Double-J catheter. Subsequently, during the same session, PCNL was performed through the second tract, successfully identifying and extracting the residual stone.

Figure 3. Patient 1. (a) KUB X-ray showing the presence of two Foley nephrostomy tubes in the left kidney, (b) Second endoscopic procedure: visualization of the residual stone and the Double-J ureteral catheterFor the patient with the ureteral stone, extraction was performed anterogradely using a Dormia basket (Figure 4), followed by the anterograde placement of a Mono-J catheter (Figure 5 a, b). The decision to insert the catheter was made due to extrinsic compression of the ureter, caused by a metal clip positioned near the pelvic part of the ureter (Figure 2 b).



(a)



(b)

Figure 4. Ureteral stone extraction using a Dormia basket.



Figure 5. Fluoroscopic appearance of the right mono-J ureteral catheter: (a) at the renal level, (b) at the pelvic level and within the Bricker conduit.The average operative time was 41 minutes, with a range between 25 and 70 minutes. Intraoperative ureteral catheter placement was performed in two patients. The stone-free rate was 100%, as confirmed by ultrasound evaluation, except for one patient, in whom the assessment was conducted using a native CT scan.



(a)



(b)

Table 2. Surgical and postoperative characteristics of PCNL patients

	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5
Number of tracts	2	1	1	1	1
Need for reintervention	Yes	No	No	No	No
Cause	Lombar fistula				
Ureteral catheter placement	Yes	Yes	No	No	No
Type of catheter	Double-J	Mono-J	-	-	-
Total operative time	70 min (first) 50 min (second)	45 min	35 min	25 min	30 min
Hospitalization duration	6 days	3 days	3 days	6 days	3 days

There were no postoperative hemorrhagic complications requiring blood transfusion. However, three weeks after surgery, Patient 4 experienced a significant episode of hematuria at the ureterostomy site, leading to severe anemia (Hb 6.7 g/dL), which required hospitalization in the intensive care unit (ICU) and the administration of three units of blood. The bleeding stopped spontaneously, and neither surgical intervention nor superselective embolization was necessary.

There were no cases of fever, urinary tract infections (UTIs), bacteremia, or sepsis. Postoperative antibiotic treatment was administered prophylactically to all patients throughout hospitalization and continued at home for an additional 5 to 7 days.

Crystallographic and bacteriological analysis was performed for all stones. Except for the lumbar ureteral stone, which was composed of calcium oxalate monohydrate, all other stones were identified as struvite. Bacteriological analysis revealed bacterial growth (Proteus mirabilis) in one stone.

Table 3. Postoperative outcomes and complications in PCNL patients

	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5
Surgical Complications	Urinary fistula	No	No	Bleeding	No
Clavien-Dindo Classification	Grade IIIb	-	-	Grade II	-
Crystallographic analysis	Struvite	oxalate monohydrate	Struvite	Struvite	Struvite
Bacteriological analysis	Sterile	Sterile	Sterile	Proteus mirabilis	Sterile
Need readmission within 30 days	No	No	No	Yes	No

Discussion

We excluded patients who had undergone open radical cystectomy to maintain a homogeneous study cohort, focusing exclusively on patients with robotic-assisted surgery. This approach aimed to provide a clearer evaluation of the impact of robotic-assisted cystectomy on renal stone formation and the effectiveness of PCNL in this specific patient population.

Urinary diversion significantly impacts the feasibility of retrograde endoscopic access to the upper urinary tract, which is essential for standard ureteroscopic management of nephrolithiasis – [4]. In our study, patients with ileal conduit diversion and cutaneous ureterostomy required an exclusively percutaneous approach due to the lack of a direct ureteral access route. For patients with an orthotopic neobladder, ureteroscopic intervention may be feasible in selected cases. However, our study highlights that flexible ureteroscopy was unsuccessful in four out of five patients due to ureteral orifice stenosis or altered angulation at the anastomotic site, reinforcing the necessity of PCNL as a primary modality in such cases.

Previous studies have highlighted the increased incidence of renal stone formation in patients with urinary diversions [5] due to chronic urinary stasis, metabolic alterations (hypercalciuria, hyperoxaluria and hypocitraturia), recurrent urinary tract infections (UTIs), and mucus secretion [6]. The recurrence rate of stone formation after PCNL in patients with urinary diversion is 63% within five years, indicating a high risk of upper-tract stone recurrence in this population [7]. In our cohort, 80% of patients had renal stones, with one case of a large staghorn calculus requiring multiple percutaneous tracts for complete removal. This finding is consistent with prior research indicating that stone burden in patients with urinary diversions is often larger and more complex, necessitating more

invasive treatment strategies.

The success rate of PCNL in the general population is well-documented, with a reported stone-free rate of approximately 75–90%, depending on stone characteristics and case complexity [8,9]. In our study, we achieved a 100% stone-free rate, as confirmed by postoperative imaging. This rate is higher than those reported in standard PCNL cases and may be influenced by careful patient selection, meticulous surgical planning, and the relatively small number of patients included in the study. However, the need for multiple punctures and secondary interventions, as seen in one patient with a residual calculus, aligns with reports emphasizing the technical difficulties of PCNL in altered urinary tract anatomy.

A key challenge in performing PCNL in this patient group is the loss of normal lower urinary tract access. The absence of a functional bladder precludes retrograde ureteral catheter placement, often necessitating alternative strategies such as primary ultrasound-guided renal puncture, which was used in all but one of our cases. Other studies have also recommended anterograde access in similar situations, as retrograde passage of guidewires is frequently unsuccessful due to ureteral reimplantation at an atypical angle or the presence of strictures.

The number of percutaneous tracts influences stone clearance rates and renal function preservation. In our study, one patient required two access tracts, while the remaining patients had single-tract PCNL. The need for multiple tracts is commonly reported in patients with complex stones, particularly in those with staghorn calculi or lower pole stones[10].

One patient required reintervention due to a persistent renal fistula, which was ultimately attributed to residual stone fragments that were identified on subsequent imaging. The necessity for second-look procedures in PCNL has been reported in up to 15% of cases, particularly in patients with complex stones or unfavorable anatomy[11].

Another significant challenge is percutaneous tract establishment, as post-cystectomy patients often present with post-surgical adhesions and renal malrotation. In our study, all renal accesses were obtained through the middle or lower calyx, with additional fluoroscopic guidance employed to refine puncture positioning. This approach was specifically utilized to minimize vascular injury risk and enhance stone clearance efficiency, particularly in anatomically altered kidneys[12].

The mean operative time was 41 minutes (range: 25–70 minutes), which is consistent with reported averages for standard PCNL. However, the operative time may be prolonged in cases requiring multiple access tracts [13]. Factors contributing to extended operative time included challenging renal puncture, complex stone burden, and the need for intraoperative bleeding control measures.

Postoperative hospitalization ranged from 3 to 6 days, exceeding the typical 2–3 days reported for standard PCNL cohorts [14]. The primary reason for extended hospital stays in our study was the routine postoperative placement of a nephrostomy tube for 48 hours, which influenced the overall recovery period.

Postoperative complications were categorized using the Clavien-Dindo system, with one patient developing Clavien IIIb bleeding approximately one month after discharge, necessitating ICU admission and transfusion. However, the underlying cause remained undetected on CT examination.

The incidence of postoperative complications in our study (20%) is comparable to reported rates in high-risk PCNL populations, where bleeding, infection, and ureteral injury are the most frequent concerns [15].

Bacteriological analysis of the extracted stones confirmed Proteus mirabilis in one case, reinforcing the established link between struvite stones and urease-producing bacteria [16]. The presence of infection-related stones highlights the importance of preoperative urine cultures, targeted antibiotic prophylaxis, and close postoperative surveillance in this patient group.

Crystallographic analysis revealed that struvite stones were the predominant composition in our cohort, which is consistent with findings in patients with urinary diversions who are predisposed to recurrent urinary infections and urease-producing bacteria . The exception was one calcium oxalate stone, reflecting metabolic stone disease rather than infection-related lithiasis. Given the identified risk factors for urosepsis following PCNL for struvite stones, perioperative management should incorporate preventive strategies to minimize complications[17].

This study has several limitations, including its small sample size, which restricts the generalizability of the findings. Larger, multicentric studies are needed to validate our results and further refine technical modifications for PCNL in this complex patient population. Additionally, long-term follow-up is required to assess recurrence rates and functional renal outcomes following PCNL.

Conclusion

In conclusion, PCNL is a safe and effective intervention for renal stone management in patients with prior robotic radical cystectomy, despite the anatomical challenges posed by urinary diversion. Careful patient selection, optimized access techniques, and strict perioperative management are crucial to achieving high stone-free rates while minimizing complications. Further research is warranted to establish standardized protocols for performing PCNL in this challenging cohort.

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