REVIEW PAPER

Simultaneous single-tract percutaneous nephrolithotomy and intrarenal laser marsupialization via non-cyst-transgressing access: a pilot case series

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Introduction Ipsilateral renal stones and simple cysts usually require separate procedures or risk urinary extravasation with cyst-transgressing percutaneous techniques. This pilot study evaluated the safety and feasibility of single-tract percutaneous nephrolithotomy (PCNL) combined with intrarenal holmium:YAG laser marsupialization via a non-cyst-transgressing access.

Material and methods Nine consecutive patients with renal stones (>20 mm) and a solitary Bosniak I cyst underwent single-tract PCNL. A specific non-cyst-transgressing puncture was used. Following stone clearance, the cyst wall was identified via combined endoscopic and ultrasonographic guidance and incised intrarenally to create a ≥1 cm window.

Results All procedures were completed with a single tract (median operative time 50 minutes). Stone-free status was achieved in 100% (9/9). Marsupialization succeeded in 8/9 patients; one case with a thick-walled cyst identified intraoperatively was managed by aspiration only. No Clavien–Dindo grade II or higher complications occurred. At 6 months, median cyst diameter decreased by 66% (from 5.6 cm to 1.9 cm), with complete symptom resolution.

Conclusions Simultaneous single-tract PCNL and intrarenal marsupialization via non-cyst-transgressing access is a feasible and safe technique. It eliminates the risk of retroperitoneal extravasation inherent to cyst-transgressing approaches. Careful patient selection, particularly regarding cyst wall thickness, is essential.

Key Words: percutaneous nephrolithotomy ‹› renal cyst ‹› marsupialization ‹› holmium laser ‹› simultaneous management ‹› one-session

INTRODUCTION

The coexistence of ipsilateral renal stones and simple cysts presents a unique therapeutic challenge. Traditionally, these conditions are managed as separate entities – percutaneous nephrolithotomy (PCNL) or ureteroscopy for stones, and laparoscopic decortication for cysts – necessitating staged procedures that increase anesthesia exposure and healthcare costs [1]. While simultaneous management has been proposed to mitigate these burdens, current techniques have significant limitations. Flexible ureteroscopy with marsupialization is often restricted by anatomical constraints and large stone burdens [2]. Conversely, PCNL using a "cyst-transgressing" tract allows for stone removal but creates a direct communication between the collecting system and the retroperitoneum, posing a risk of urinary extravasation [3, 4]. To address these shortcomings, we propose a technique that utilizes the established PCNL tract to marsupialize the cyst internally without violating its outer wall. This pilot study evaluates

the safety and feasibility of simultaneous single-tract PCNL and intrarenal holmium laser marsupialization via a non-cyst-transgressing access.

MATERIAL AND METHODS

Study design and participants

This prospective case series enrolled nine consecutive patients with ipsilateral renal stones and solitary Bosniak I renal cysts treated at a tertiary referral center between December 2022 and March 2025.

Inclusion and exclusion criteria

Patients were eligible if they presented with renal or upper ureteral stones with a stone burden >20 mm (including staghorn calculi) indicated for PCNL, and a concurrent solitary Bosniak I cyst (4–8 cm). Inclusion required sterile preoperative urine cultures. Preoperative evaluation included a routine multiphasic contrast-enhanced computed tomography (CECT) scan for all patients. Cysts were strictly classified as Bosniak I based on specific imaging criteria: the presence of a hairline-thin wall, fluid attenuation (–10 to 20 Hounsfield units), absence of septations or calcifications, and no measurable enhancement (<15 HU increase) after contrast administration. Crucially, a delayed (excretory) phase (typically 10–15 minutes post-injection) was routinely reviewed to confirm the absence of contrast communication with the cystic cavity, thereby definitively excluding calyceal diverticula, dilated calyces, or calyceal neck obstructions. Exclusion criteria included cysts classified as Bosniak II or higher, multiple cysts, uncorrected coagulopathy, or active urinary tract infection.

Surgical technique

All procedures were performed under spinal anesthesia with the patient in the lateral decubitus position.

Percutaneous access and lithotripsy

Renal access was established under ultrasonographic guidance. A puncture was made directly into the stone-bearing calyx, strictly adhering to a non-cyst-transgressing trajectory to avoid violating the cyst wall. The calyx for percutaneous puncture was selected solely based on the optimal trajectory for stone clearance. The puncture site was not influenced by the cyst location, provided the targeted calyx allowed subsequent endoscopic navigation to the cyst. The tract was dilated to 18 Fr, and nephroscopy was performed. Stones were fragmented using a holmium:YAG laser (1.5–2.0 J, 20–25 Hz), and fragments were evacuated through the sheath.

Intrarenal marsupialization

Following confirmation of stone clearance, endoscopic inspection of the renal pelvis was performed using a rigid nephroscope to identify the anatomical relationship with the cyst. The thin, avascular common wall separating the collecting system from the cyst was localized. Endoscopically, this common wall typically appeared as a translucent, bulging area. This was immediately confirmed using intraoperative real-time ultrasonography, which identified a thin (<2 mm) echogenic interface separating the collecting system from the anechoic cyst cavity. Doppler ultrasound was routinely utilized to map the common wall and confirm the absence of crossing vessels at the planned incision site. Using the holmium:YAG laser, the cyst window was created by making a transmural incision directly at the common wall interface. For the cyst wall incision, the laser settings were adjusted to 1–1.2 J and 10–15 Hz using a 365-μm laser fiber to ensure precise, clean cutting. To optimize hemostasis during marsupialization, the laser was slightly defocused by pulling the fiber tip back 1–2 mm from the tissue surface. This window was widened to create an internal stoma of at least 1 cm in diameter to ensure adequate drainage. The nephroscope was then advanced into the cyst cavity to evacuate fluid, inspect the cyst lining, and remove any intracystic debris. Thick-walled or highly vascularized cysts identified intraoperatively were managed by aspiration only to minimize bleeding risks.

Stenting and drainage

A double-J stent was placed antegrade. We prioritized positioning the proximal coil within the cyst cavity ("coil-in-cyst" technique) to mechanically maintain the patency of the marsupialized tract. If anatomical constraints prevented this, the coil was placed in the renal pelvis. A 14 Fr nephrostomy tube was placed for temporary drainage.

Postoperative management and follow-up

Plain radiography (KUB) was performed on postoperative day (POD) 1. The urethral catheter was removed on POD 1, and the nephrostomy tube was removed on POD 3, provided the patient was afebrile

and imaging confirmed stone clearance. Patients were followed up at 1 and 6 months with clinical assessment, ultrasonography, and KUB radiography. The double-J stent was removed at 1 month postoperatively.

Outcome measures and statistical analysis

The primary endpoints were stone-free status (defined as residual fragments <4 mm assessed strictly via KUB radiography and ultrasonography), successful marsupialization (defined as an internal opening ≥1 cm with >50% reduction in cyst diameter at 6 months), and perioperative complications classified by the Clavien–Dindo system. To minimize radiation exposure in asymptomatic patients, noncontrast CT (NCCT) was not included in the routine follow-up protocol. Secondary endpoints included operative time and hospital length of stay. Data were analyzed using descriptive statistics (SPSS version 20.0). Continuous variables are presented as median (range) or mean ± standard deviation, and categorical variables as frequencies and percentages.

Bioethical standards

The study protocol was approved by the Institutional Ethics Committee of VietDuc University Hospital (approval number: 269/QĐ-VĐ, dated November 18, 2022), and written informed consent was obtained from all participants.

RESULTS

Nine patients (6 men, 3 women; median age 52 years [37–68]) were included (Figure 1). All presented with flank pain; two also reported transient gross hematuria. Cysts were solitary Bosniak I lesions, median diameter 5.6 cm (4.9–6.6), located in the lower pole (n = 5), mid-pole (n = 2), or upper pole (n = 2). Stone distribution included renal pelvis (n = 1), renal pelvis + lower calyx (n = 3), staghorn calculi (n = 3), renal pelvis with intracystic stone (n = 1), and upper ureter + lower calyx (n = 1). Patient and lesion characteristics are shown in Table 1.

All procedures were completed with a single tract. Median operative time was 50 (35–70) minutes. No intraoperative complications occurred. Cyst marsupialization was successful in 8/9 patients (88.9%), each with an internal opening ≥1 cm. In one patient with a thick-walled cyst (4.9 cm, lower pole), marsupialization was not feasible; only aspiration was performed (Figure 2C). Six patients received coil-in-cyst stenting, and three coil-in-pelvis. Operative and follow-up outcomes are shown in Table 2.

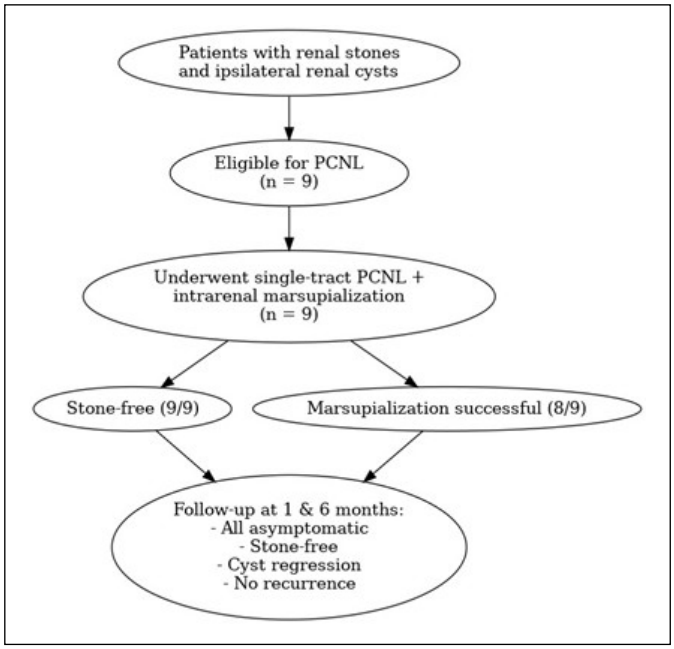

Figure 1. *Study flow diagram.*

Table 1. *Patient and lesion characteristics*

Characteristic	Median (range) / n
Age (years)	52 (37–68)
Sex (M/F)	6 / 3
Side (left/right)	5 / 4
Symptoms	Flank pain 9 (100%); hematuria 2 (22.2%)
Cyst size (cm)	5.6 (4.9–6.6)
Cyst location	Lower pole 5; mid-pole 2; upper pole 2
Stone type	Renal pelvis 1; pelvis + lower calyx 3; staghorn 3; pelvis + intracystic stone 1; upper ureter + lower calyx 1

Table 2. *Operative and follow-up outcomes*

Outcome	Median (range) / n
Single tract achieved	9/9
Operative time (min)	50 (35–70)
Stone-free status	9/9
Successful marsupialization	8/9
Stent position	Coil-in-cyst 6; coil-in-pelvis 3
Hospital stay (days)	4 (3–5)
Complications	None
Cyst size (cm) – baseline	5.6 (4.9–6.6)
Cyst size (cm) – 1 month	2.1 (1.5–2.8)
Cyst size (cm) – 6 months	1.9 (1.4–2.6)

Median hospital stay was 4 (3–5) days. The urethral catheter was removed on postoperative day (POD) 1, nephrostomy on POD 3. No Clavien–Dindo grade II or higher complications were recorded. Mild transient hematuria (Grade I) occurred but resolved spontaneously.

At 1 month, all patients were asymptomatic. As per our protocol, follow-up imaging relied exclusively on KUB radiography and ultrasonography; no patient underwent an NCCT scan during the follow-up period to minimize radiation exposure. Based on these specific modalities, all patients were considered stone-free (no visible residual fragments >4 mm). The median cyst diameter reduced to 2.1 cm (1.5–2.8 cm) (62.5% reduction from baseline). At 6 months, cysts further decreased to 1.9 cm (1.4–2.6 cm) (66% reduction from baseline), with no recurrence or reintervention.

DISCUSSION

This prospective case series demonstrates that single-tract PCNL combined with intrarenal holmium laser marsupialization via a non-cyst-transgressing approach is a safe, feasible, and effective strategy for simultaneous management of ipsilateral renal stones and simple Bosniak I cysts (Figure 3). To our knowledge, this is among the first reports to systematically evaluate a technique that specifically avoids direct cyst puncture while achieving complete treatment of both conditions in a single session. In nine consecutive patients, we achieved a 100% stone-free rate and successful cyst marsupialization in 88.9% (8/9 patients), with no Clavien–Dindo grade II or higher complications. Notably, cyst regression was progressive and substantial, with median cyst diameter decreasing from 5.6 cm preoperatively to 1.9 cm at 6 months, accompanied by complete and sustained symptom resolution. These findings indicate that both pathologies can be definitively managed in a single operative session with minimal morbidity, offering a practical alternative to staged procedures or cyst-transgressing techniques that carry a higher risk of urinary extravasation. Current treatment strategies for simple renal cysts include percutaneous aspiration, flexible ureteroscopy (fURS) with marsupialization, and laparoscopic decortication. Simple percutaneous aspiration, while technically less invasive, is associated with high recurrence rates ranging from

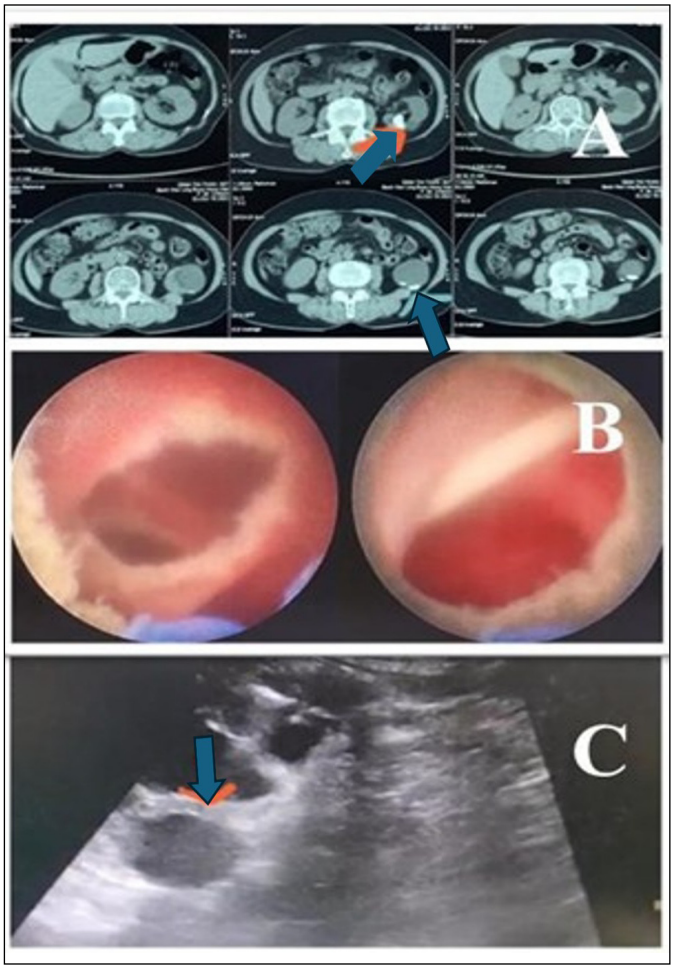

Figure 2. *Representative images of simultaneous management:* **A)** *Preoperative CT scan demonstrating ipsilateral renal stone (red arrow) and simple renal cyst (blue arrow).* **B)** *Endoscopic view after intrarenal marsupialization, showing creation of the internal opening with placement of a double-J stent coil inside the cyst cavity.* **C)** *Ultrasonography image of a thick-walled cyst in which marsupialization was not feasible, managed with aspiration only.*

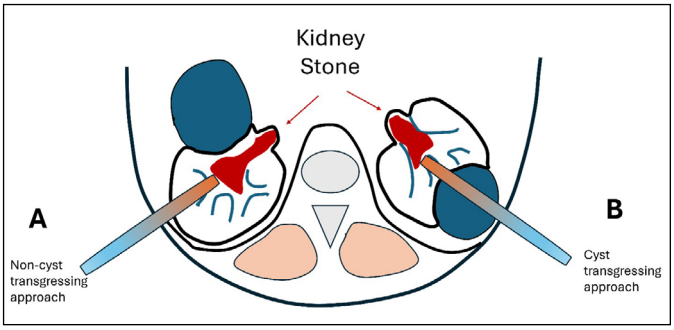

Figure 3. *Comparison of percutaneous access strategies in patients with ipsilateral renal cysts and kidney stones:* **A)** *Non-cyst-transgressing approach, in which the access tract enters the targeted calyx without violating the cyst wall, followed by endoscopic marsupialization of the cyst through the collecting system.* **B)** *Cyst-transgressing approach, in which the access needle and tract pass directly through the renal cyst before entering the collecting system.*

30% to 80% due to the persistent secretory activity of the residual cyst epithelium [5]. Laparoscopic decortication remains the gold standard, with long-term success rates exceeding 90% [6], but it is invasive and costly. Flexible ureteroscopy has emerged as a minimally invasive alternative; however, as noted by Kang et al., its efficacy can be restricted by lower-pole anatomy, difficult cyst localization, and the inability to manage large stone burdens efficiently [2]. Recent meta-analyses confirm that while laparoscopic decortication offers higher long-term resolution, endoscopic approaches provide shorter operative times and faster recovery [7].

When ipsilateral stones and cysts coexist, treatment becomes more complex. Traditional staged approaches increase patient burden and cumulative healthcare costs. PCNL offers unique advantages in this scenario, particularly for patients with large stone burdens (>20 mm) requiring definitive intervention. Several groups have explored simultaneous management using PCNL [8]. Chen et al. [3] reported a "cyst-transgressing" technique in which the tract passes directly through the cyst. While effective for stone removal, this creates a direct communication between the collecting system and the retroperitoneum, posing a significant risk of urinary extravasation and potential urinoma formation [3]. Our technique addresses this gap by establishing percutaneous access directly into the stone-bearing calyx, strictly avoiding the cyst. The primary strength of this approach is its "two-birds-with-one-stone" efficiency, resolving both pathologies in a single session using standard PCNL equipment. Moreover, this technique is particularly advantageous for cysts located in challenging positions, such as anteriorly located cysts or upper pole cysts. In these scenarios, a direct "cyst-transgressing" puncture from the flank is often technically difficult or hazardous due to the risk of injuring adjacent visceral organs or the pleura. By utilizing a standard posterior caliceal access to the stone, we can safely drain these "hard-to-reach" cysts internally while eliminating the risk of urine leakage into the retroperitoneal space. The use of the holmium:YAG laser is pivotal in this step, allowing for precise, hemostatic incision of the cyst wall with minimal thermal injury to the surrounding parenchyma, a safety profile supported by similar percutaneous laser studies [9]. Furthermore, we adhered to the principle of creating a wide internal stoma (≥1 cm), as recommended by Shao et al., to prevent premature closure and ensure durable drainage [4]. While simple Bosniak I cysts are typically benign and asymptomatic, the primary indication for surgical intervention in our cohort was the significant stone burden (>20 mm) causing flank pain. The intrarenal marsupialization was performed as a simultaneous, opportunistic procedure. Since a working percutaneous tract was already established, internal drainage of a relatively large adjacent cyst (median size 5.6 cm) added negligible operative time and mitigated the risk of future cyst enlargement and subsequent pelvicalyceal compression. However, we acknowledge the potential risk of overtreatment. Therefore, we advocate that this simultaneous procedure should be carefully selected and primarily reserved for larger cysts (e.g., >4–5 cm) or those situated in locations prone to future obstruction, rather than small, incidental cysts.

The safety profile in our series compares favorably with alternative approaches. The absence of major complications (bleeding requiring transfusion, infection, or leakage) reflects careful patient selection and our non-cyst-transgressing strategy. A critical learning point was the reliance on intraoperative ultrasonography. In the single unsuccessful case, although preoperative CT suggested a simple thin-walled cyst, intraoperative ultrasound revealed a wall thickness >5 mm with significant vascularity. Consequently, we aborted the marsupialization to avoid bleeding risks. As noted by Israel and Bosniak, CT imaging can occasionally underestimate the complexity of cystic lesions, particularly subtle wall thickening, which may be better characterized by real-time ultrasound [10]. This experience underscores that intraoperative ultrasound serves as an essential safety checkpoint, and thick-walled cysts should be considered a relative contraindication.

To improve preoperative predictability and minimize the risk of intraoperative abandonment, we recommend refining the patient screening protocol across two key dimensions: cyst complexity and anatomical proximity. First, regarding cyst complexity, high-resolution Doppler or contrast-enhanced ultrasound should be incorporated for equivocal lesions. These modalities provide superior sensitivity compared to standard CECT in detecting microvascularity and subtle wall thickening, thereby allowing for precise patient selection and potential upgrading of the Bosniak category [11, 12]. Second, regarding anatomical topography, the spatial relationship between the cyst and the collecting system is a critical determinant of successful intrarenal marsupialization. In our series, we targeted cysts immediately adjacent to the collecting system, sharing a thin common wall. Cysts located deep in the peripheral cortex or separated by a thick layer of renal parenchyma (>10 mm) are unsuitable for this technique due to the heightened

risk of significant parenchymal injury and bleeding during laser incision. Therefore, we emphasize the necessity of carefully reviewing multiplanar reconstructions on preoperative CECT or magnetic resonance imaging to accurately measure the "common wall" interface as a primary anatomical selection criterion.

This study has several notable strengths, including prospective enrollment, standardized surgical technique, and objective imaging-based follow-up. However, limitations warrant acknowledgment. First, the small sample size (n = 9) and single-center design limit generalizability. Second, the 6-month follow-up precludes assessment of long-term cyst recurrence. Third, this technique relies heavily on the surgeon's proficiency with intraoperative ultrasound to identify the "common wall" safely, implying a potential learning curve for urologists accustomed to fluoroscopy alone [13]. Fourth, our follow-up imaging protocol relied on KUB radiography and ultrasonography rather than NCCT. While this minimizes radiation exposure in asymptomatic patients, it is less sensitive for detecting micro-fragments (<4 mm) and may introduce measurement variability for cyst volume. Consequently, the reported 100% absolute stone-free rate and the precise magnitude of cyst regression might be slightly overestimated compared to strict NCCT criteria. Finally, strict selection criteria (only Bosniak I cysts) mean results may not apply to more complex anatomies.

CONCLUSIONS

Our pilot series suggests that single-tract PCNL combined with intrarenal holmium laser marsupialization via a non-cyst-transgressing access is a feasible and safe technique for selected patients with concurrent large renal stones and ipsilateral Bosniak I cysts. This approach potentially mitigates the risk of retroperitoneal extravasation associated with cyst-transgressing tracts while offering the logistical and economic benefits of a single-session procedure. However, careful patient selection – particularly avoiding thick-walled cysts – is paramount. Further investigation with larger cohorts and long-term follow-up is warranted to validate these preliminary findings against standard staged interventions.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

FUNDING

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ETHICS APPROVAL STATEMENT

This study was approved by the Institutional Ethics Committee of Viet-Duc University Hospital (approval number:. 269/QĐ-VĐ). Written informed consent was obtained from all participants.

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