Cureus
Part of SPRINGER NATURE

Open Access Case Report

Single-Session Retrograde Clearance of a 28 mm Renal Calculus With an Intelligent Irrigation-Suction System and Intraoperative Intrarenal Pressure Display in an Elderly Patient With Chronic Kidney Disease: A Case Report

Muhammad Danial Bin Rosli [1], Nur Farah Hanee Binti Mohammad Anuar [2], Abdelazem Elsherbeny [1]

1. Urology, Craigavon Area Hospital, Craigavon, GBR 2. Emergency Medicine, Daisy Hill Hospital, Newry, GBR

Corresponding author: Abdelazem Elsherbeny, abdelazem.elsherbeny@southerntrust.hscni.net

Review began 10/22/2026
Review ended 11/19/2026
Published 11/24/2026

© **Copyright** 2026
Bin Rosli et al. This is an open access article distributed under the terms of the Creative Commons Attribution License CC-BY 4.0., which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

DOI: 10.7759/cureus.120195

Abstract

A 79-year-old woman with chronic kidney disease stage 3b, ischaemic heart disease on aspirin, and a left kidney largely replaced by cyst was found to have a 28 mm right renal stone. We treated her with flexible ureteroscopy and holmium laser lithotripsy using the i-MIMERsys™ (ZSR Biomedical Technology Co., Ltd, Dongguan, China) intelligent irrigation and suction system, which aspirates dust and displays intrarenal pressure during the case. Displayed pressure readings ranged from 6 to 17 mmHg across 96 minutes, aspirin was never stopped, and the kidney was clear endoscopically after one session. She was discharged on day two. This case illustrates feasibility in a selected high-risk patient.

Categories: Urology
Keywords: chronic kidney disease, flexible ureteroscopy, intrarenal pressure, laser lithotripsy, primary hyperparathyroidism, suction ureteral access sheath

Introduction

Renal stones larger than 2 cm are usually treated percutaneously. Percutaneous nephrolithotomy (PCNL) reaches the kidney through a puncture in the flank, whereas retrograde intrarenal surgery (RIRS) reaches it along the natural urinary tract with a flexible ureteroscope. European Association of Urology guidance places PCNL first at this size [1], because a single PCNL clears more stone than a single retrograde procedure [2], and series of RIRS for stones over 2 cm often reach comparable final clearance only after two or three sessions [3]. These recommendations rest largely on clearance. The morbidity of the percutaneous tract carries more weight in some patients than in others: bleeding, transfusion, and longer admission follow from passing a sheath through the parenchyma, and those risks are greater in older patients, in those taking antiplatelet drugs, and in those whose contralateral kidney contributes little.

Retrograde surgery has constraints of its own, and most of them relate to fluid. Irrigation keeps the view clear but raises pressure within the collecting system. Above approximately 30 mmHg, irrigation fluid can be driven from the collecting system into the venous and lymphatic circulation, carrying bacteria and endotoxin with it; this is termed 'pyelovenous' and 'pyelolymphatic backflow' [4]. Intrarenal pressure (IRP) is not routinely measured during conventional ureteroscopy, and reported pressures during routine cases frequently exceed this threshold [5], while infection remains the complication responsible for the greatest harm after ureteroscopy [6]. A large stone compounds the problem, because longer lasing means longer exposure to raised pressure. There is a practical cost as well: dust obscures the field, so the surgeon pauses, flushes, or withdraws the scope to retrieve fragments with a basket.

Suction access sheaths and pump-driven irrigation-suction systems were designed around both problems. A flexible and navigable suction sheath (FANS) performed well in a large multicentre series [7], and in a porcine model, pump irrigation combined with suction produced the lowest IRP of any configuration tested [8]. For stones of 2-3 cm, a recent international randomised trial found flexible ureteroscopy with a FANS sheath non-inferior to mini-PCNL [9], so suction-assisted RIRS at this stone burden is itself established rather than novel. The i-MIMERsys™ system (ZSR Biomedical Technology Co., Ltd, Dongguan, China) adds a continuous on-screen display of IRP during the case; bench testing against a urodynamic reference found close agreement [10]. Reviews of these devices are appearing [11], and early clinical comparisons suggest fewer infective complications [12], but published clinical experience with intraoperative IRP display remains limited.

The specific gap we address is therefore narrow. It is not single-session clearance of a large stone, which the trial above already supports, nor the suction sheath itself. It is the combination of an intelligent irrigation-suction platform with intraoperative pressure display in a patient at high risk from percutaneous surgery: an elderly woman with a 28 mm calculus, chronic kidney disease (CKD) stage 3b, uninterrupted aspirin, and a

contralateral kidney largely replaced by cyst. We report what was observed in that setting. A single case cannot establish comparative safety or efficacy against PCNL or against conventional RIRS, and we make no such claim.

Case Presentation

History

A 79-year-old woman presented to the emergency department with left loin pain (month 0). Computed tomography (CT) showed a 5 mm left vesicoureteric junction calculus with moderate hydronephrosis, together with bilateral renal calculi. Blood tests were normal, and she was managed conservatively; a CT at month 2 confirmed spontaneous passage of the ureteric stone and resolution of that episode. The passed stone was not retrieved. The presenting episode was therefore left-sided and self-limiting, and the subsequent indication for intervention was the residual bilateral renal stone burden rather than the presenting pain. Her comorbidities were ischaemic heart disease, hypertension, and CKD. Medications were aspirin, bisoprolol, isosorbide mononitrate, nicorandil, glyceryl trinitrate, simvastatin, pantoprazole and escitalopram.

Imaging

The month 2 CT showed an elongated right renal calculus measuring 28.3 mm in maximal length, extending across the upper and middle calyces, with a mean attenuation of 677-771 Hounsfield units (HU) on region-of-interest measurement across representative slices. The left kidney contained an 8 mm upper calyceal calculus, and its parenchyma was largely replaced by a large simple cyst (Figure *1*). Reduced functional contribution from the left kidney was inferred from this appearance; split renal function was not measured by nuclear medicine imaging, and the inference is therefore anatomical rather than functional. No further cross-sectional imaging was performed before surgery.

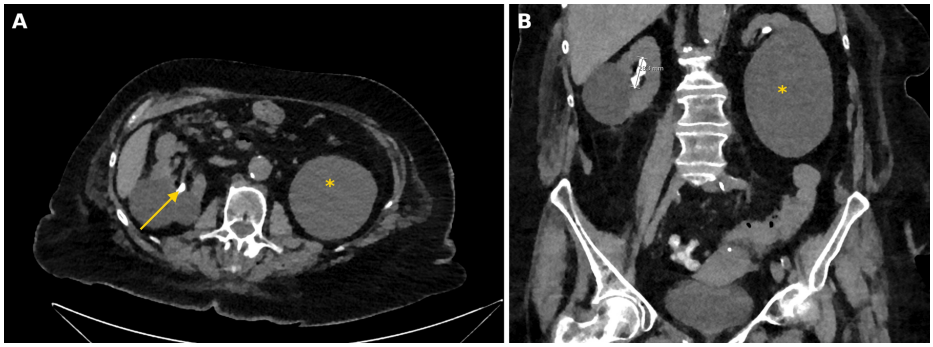


FIGURE 1: Pre-operative CT of the urinary tract.

(A) Axial image showing the right renal calculus (arrow) and the large cyst replacing most of the left renal parenchyma (asterisk). (B) Coronal reconstruction showing the elongated right calculus spanning the upper and middle calyces, with an electronic calliper measurement of 28.3 mm, and the left renal cyst (asterisk).

Biochemistry

Pre-operative results, with the time point of each sample, are summarised in Table *1*. Renal function was consistent with CKD stage 3b (eGFR 40-44 mL/min/1.73m^2). Metabolic screening at month 12 showed an adjusted calcium of 2.71 mmol/L with a non-suppressed parathyroid hormone (PTH) of 88 ng/L; phosphate was 0.79 mmol/L at month 13, and 25-hydroxyvitamin D was replete at 69 nmol/L at month 10. A 24-hour urine collection at month 13 returned a total volume of 922 mL with low calcium excretion (1.87 mmol/24 h), giving a calcium/creatinine clearance ratio (CCCR) of 0.011. Serum sodium of 146 mmol/L and chloride of 110 mmol/L in the same week were consistent with volume depletion at the time of collection. She was referred to endocrinology and placed on six-monthly surveillance.

Parameter	Reference range	Month 12	Month 13 (pre-operative)	Post-operative day 2
Serum creatinine (µmol/L)	45–84	113	104	110
eGFR (mL/min/1.73 m²)	> 90	40	44	41
Urea (mmol/L)	2.5–7.8	7.6	7.3	6.5
Sodium (mmol/L)	133–146	143	146	143
Chloride (mmol/L)	95–108	108	110	107
Adjusted calcium (mmol/L)	2.20–2.60	2.71	2.59	–
Parathyroid hormone (ng/L)	15–65	88	–	–
Phosphate (mmol/L)	0.80–1.50	–	0.79	–
White cell count (×10⁹/L)	4.0–11.0	–	–	7.3
Neutrophils (×10⁹/L)	2.0–7.5	–	–	4.45

TABLE 1: Peri-operative biochemistry.

A dash (–) indicates that the parameter was not measured at that time point. 25-hydroxyvitamin D 69 nmol/L (month 10). 24-hour urine (month 13): volume 922 mL; calcium 1.87 mmol/24 h; phosphate 9.31 mmol/24 h; creatinine 6.5 mmol/24 h; calculated calcium/creatinine clearance ratio 0.011. eGFR, estimated glomerular filtration rate (CKD-EPI). Reference ranges are those of the reporting laboratory.

Decision-making

In the stone clinic, she reported persistent loin discomfort, worse on the left, and anxiety about further colic, and chose intervention over surveillance. A staged approach was agreed, treating one side at a time. Although symptoms were more prominent on the left, the right kidney carried the substantially larger stone burden and, by imaging appearance, most of the functioning parenchyma, so it was treated first. Given her age, uninterrupted antiplatelet therapy, cardiac comorbidity, and renal impairment, a retrograde approach was preferred to PCNL. Shock wave lithotripsy was not considered appropriate for a 28 mm calculus. Surgery took place at month 13, after an elective waiting period. The clinical course is summarised in Figure 2.

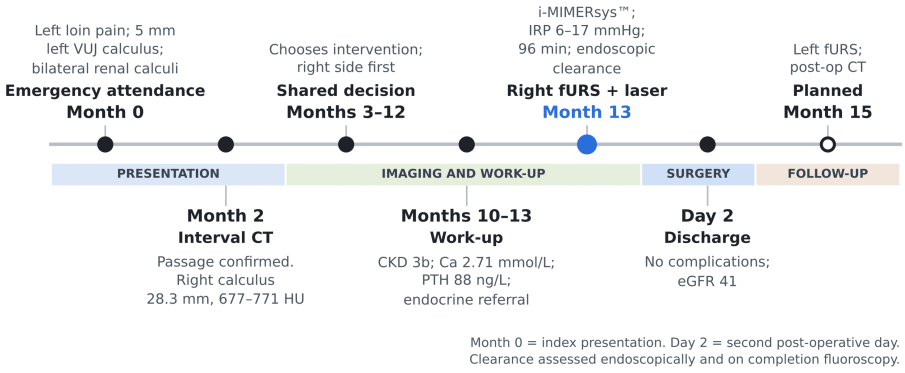


FIGURE 2: Timeline of the clinical course, with time expressed relative to the index presentation (month 0).

The coloured band beneath the axis separates the four phases of care: presentation and conservative management, imaging and work-up, surgery, and the post-operative course. CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate; fURS, flexible ureteroscopy; HU, Hounsfield units; IRP, intrarenal pressure; PTH, parathyroid hormone; VUJ, vesicoureteric junction.

Procedure

Operative parameters are summarised in Table 2. Pre-operative urine culture showed no growth. Under general anaesthesia, with intravenous gentamicin 240 mg prophylaxis and continued aspirin, rigid cystoscopy was normal. Semirigid ureteroscopy over a working guidewire showed a normal ureter, and retrograde contrast outlined the calculus in the upper and middle calyces. A 10-12 Fr access sheath was

placed in the renal pelvis, and a 7 Fr flexible ureteroscope was introduced (Figure 3C). Irrigation and aspiration were controlled with the i-MIMERsys™ system in flexible endoscopy mode, with an irrigation pressure setting of 160-200 mmHg, suction of −60 to −120 mmHg, and a cavity pressure limit of 30 mmHg.

Parameter	Value
Anaesthesia	General
Antibiotic prophylaxis	Intravenous gentamicin 240 mg
Antiplatelet therapy	Aspirin continued
Pre-operative urine culture	No growth
Ureteral access sheath	10–12 Fr
Ureteroscope	7 Fr flexible
Irrigation–suction system	i-MIMERsys™ (ZSR Biomedical, Dongguan, China)
Console mode	Mode 2, flexible endoscopy
Irrigation pressure setting	160–200 mmHg
Irrigation flow, set	240–300 mL/min
Irrigation flow, real-time	50–64 mL/min
Suction pressure setting	−60 to −120 mmHg
Cavity pressure limit	30 mmHg
Intrarenal pressure (displayed, sampled)	6–17 mmHg
Laser	Cyber Ho 100 W holmium:YAG (Quanta System, Samarate, Italy)
Fibre diameter	272 µm
Dusting settings	Virtual Basket mode, 0.3 J × 40 Hz (12 W)
Pop-dusting / pop-corning settings	Higher power, up to 18 W
Lithotripsy technique	Alternating dusting, pop-dusting, and pop-corning; Vapour Tunnel mode
Total laser energy	26.67 kJ
Laser-on time	29 min 52 s
Mean power (range)	14.9 W (12–18 W)
Total procedure time	96 min 6 s
Laser duty cycle	31%
Fragment retrieval	Zero-tip basket
Stent	6 Fr × 26 cm
Intra-operative / device complications	None

TABLE 2: Operative parameters.

Set values are those entered by the operator on the console; real-time values are those displayed by the console during the procedure, the irrigation flow achieved being lower than the set maximum because of the resistance of the scope and sheath. The laser duty cycle is the laser-on time divided by the total procedure time (29 min 52 s / 96 min 6 s). Displayed intrarenal pressure was sampled intermittently and not recorded continuously.

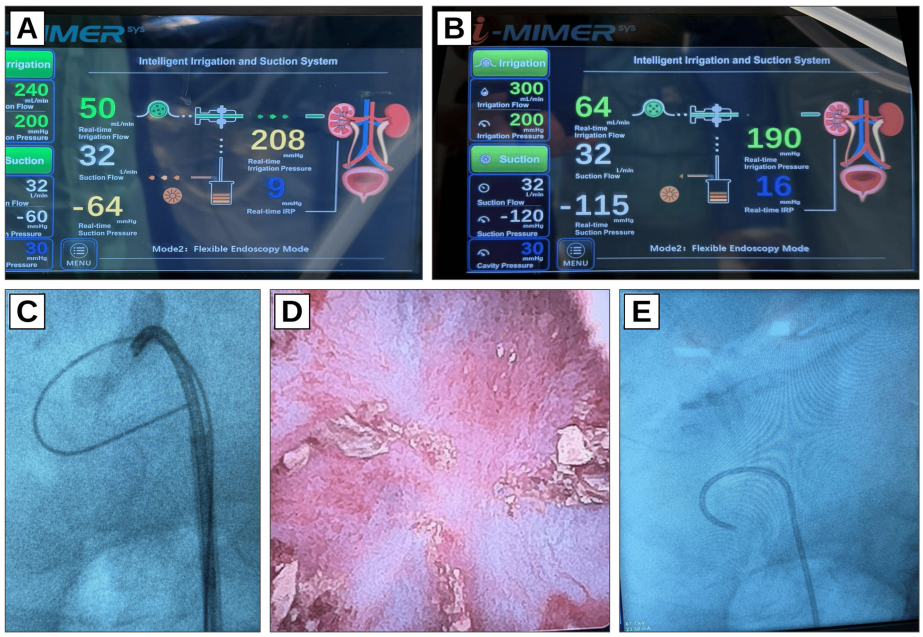


FIGURE 3: Intra-operative images.

(A, B) i-MIMERsys™ console at two time points during lithotripsy. In each panel, the left-hand column shows the operator-set irrigation and suction pressures, the centre shows real-time irrigation flow and suction pressure, and the figure on the right, labelled "Real-time IRP," shows the measured intrarenal pressure: 9 mmHg in (A) and 16 mmHg in (B). Measured IRP should not be confused with the irrigation line pressure (208 and 190 mmHg) displayed alongside it. (C) Fluoroscopy at the start of the procedure with a working guidewire coiled in the renal pelvis and the access sheath in position. (D) Collecting system after dusting, with residual dust and small fragments before basket retrieval. (E) Completion fluoroscopy showing the ureteric stent in a satisfactory position and no residual radio-opaque calculus.

IRP was observed intermittently on the console display during the case rather than recorded as a continuous dataset. All values noted by the operating team lie between 6 and 17 mmHg, and representative captures of 9 mmHg and 16 mmHg are shown in Figures *3A*, *3B*. These readings describe the time points at which the display was observed and cannot demonstrate that pressure remained within that range at every moment of the procedure.

Lithotripsy used a Cyber Ho 100 W holmium:YAG laser (Quanta System, Samarate, Italy) with a 272 µm fibre. Settings alternated between dusting, pop-dusting, and pop-corning: dusting used the Virtual Basket pulse mode at 0.3 J and 40 Hz (12 W), the Vapour Tunnel mode was also used, and pop-dusting and pop-corning were performed at higher power. This delivered 26.67 kJ over 29 min 52 s of laser time (mean power 14.9 W, range 12-18 W). The collecting system after dusting is shown in Figure *3D*. Remaining fragments were removed with a zero-tip basket and were not sent for compositional analysis. Systematic endoscopic inspection showed no residual fragments. A 6 Fr × 26 cm ureteric stent was placed, with satisfactory position and no residual radio-opaque calculus on completion fluoroscopy (Figure *3E*). Total procedure time was 96 minutes. There were no device-related problems.

Outcome

Recovery was uneventful, with no fever and no complications according to the Clavien-Dindo classification [13]. On the second post-operative day, the white cell count was 7.3 × 10^9/L, neutrophils 4.45 × 10^9/L, and creatinine 110 µmol/L (eGFR 41 mL/min/1.73 m^2), essentially unchanged from her pre-operative baseline, and she was discharged. Clearance at the end of the procedure was assessed endoscopically and by completion fluoroscopy; no post-operative cross-sectional imaging was available at the time of writing, so the result is reported as endoscopic clearance rather than confirmed stone-free status. Outcome assessment is therefore limited to the inpatient episode. Treatment of the left calculus is planned.

Discussion

Why ureteroscopy in this patient

On size alone, this stone belonged on the percutaneous list. Several features argued against it. She was 79 and took aspirin for ischaemic heart disease; ureteroscopy, unlike PCNL, can be performed without interrupting antiplatelet treatment [14], and we did not stop it. Her eGFR was in the low 40s, and by imaging appearance, most of her working parenchyma lay in the kidney we were about to treat, since the left side was

largely cyst. The cyst itself was contralateral and would not have obstructed percutaneous access on the right; its relevance was to functional reserve rather than to the feasibility of a tract. Shock wave treatment was unrealistic at this size, and a staged retrograde approach would have meant repeated anaesthetics in a woman with cardiac disease. The question was therefore whether the stone could be cleared in one retrograde sitting, and suction was central to attempting it.

What the system appeared to change

In our standard setup, irrigation runs from a pressure bag or hand pump through a plain access sheath, and IRP is unknown. Dusting a stone of this size produces enough debris to obscure the field within seconds, and the operation proceeds as a cycle of lasing, waiting, flushing, and basketing. With continuous aspiration through the sheath, dust was removed as it was produced, the view remained usable, and the scope stayed in the kidney, with only the largest fragments retrieved by basket. These are the operating surgeon's impressions; visibility, interruptions, and basketing episodes were not formally recorded, and they cannot be verified from the data presented. The dosimetry is consistent with an efficient case (26.67 kJ, with the laser active for 31% of a 96-minute procedure), but stone density was moderate at 677-771 HU, which makes any stone easier to dust [15], and the scatter in those readings suggests a mixed composition [16]. No causal attribution to the device is possible from one uncontrolled case.

Pressure

The more generalisable observation is that pressure was visible during the operation. Displayed readings ranged from 6 to 17 mmHg (Figures *3A*, *3B*), below the level at which backflow is described [4] and below values reported during unmonitored irrigation [5]. Her creatinine and eGFR on the second post-operative day were essentially unchanged, her inflammatory markers were normal, and her pre-operative urine was sterile, which excludes pre-existing bacteriuria as an explanation for the uneventful recovery. These findings indicate short-term stability rather than demonstrated renal protection, and with follow-up limited to the admission, they say nothing about longer-term function. In vitro work predicts this pressure pattern with suction and pump irrigation [8], the randomised comparison with mini-PCNL at this stone size showed comparable outcomes [9], and early clinical series using pressure-guided ureteroscopy report fewer infective complications [12]. Our observations are consistent with that literature but add no comparative evidence.

Metabolic context

Clearing a stone does not stop the next one from forming. Hypercalcaemia with a non-suppressed PTH, low phosphate, and replete vitamin D is suggestive of primary hyperparathyroidism, in which nephrolithiasis and an eGFR below 60 mL/min/1.73 m^2 are accepted indications for parathyroidectomy [17]. Three caveats apply. The results were obtained at different time points rather than simultaneously (Table *1*). Her urinary calcium was low, with a CCCR of 0.011, which falls in the range where primary hyperparathyroidism cannot be separated from familial hypocalciuric hypercalcaemia [18]. CKD itself reduces urinary calcium excretion and distorts the CCCR, so the ratio is of limited discriminatory value at this level of renal function, and the small collection volume in a volume-depleted patient reduces its reliability further. A repeat collection in a euvolaemic state, together with stone analysis from the planned contralateral procedure, would inform the differential diagnosis rather than resolve it; the diagnosis remains with the endocrinology team.

Limitations

This is a single uncontrolled case with no comparison group, so the operative figures describe one procedure rather than the performance of the device, and a favourable outcome in one patient may reflect case selection or chance. IRP was observed intermittently rather than logged continuously, so the reported range describes sampled readings; the values are also the console's own, although this platform has been validated against a urodynamic system [10]. Stone size derives from CT performed 11 months before surgery. Clearance was judged endoscopically, which overestimates clearance relative to CT [19], and no post-operative imaging was available at the time of writing. Follow-up extends only to the second post-operative day, so late complications, stent-related morbidity, renal functional trajectory, and recurrence are unknown. No stone was analysed. Finally, the equipment described is not universally available: intelligent irrigation-suction platforms and suction sheaths add cost and are currently concentrated in well-resourced centres, which limits generalisability where they cannot be obtained.

Conclusions

In a selected high-risk patient, a 28 mm renal calculus was cleared endoscopically in a single retrograde session, with intrarenal pressure displayed intraoperatively and sampled readings ranging from 6 to 17 mmHg, with aspirin continued and an uneventful inpatient recovery. This case demonstrates feasibility in these circumstances and nothing more; it cannot establish efficacy, safety, or superiority relative to PCNL or conventional RIRS. Comparative studies with continuous pressure recording, post-operative imaging, and longer follow-up are needed to determine whether intraoperative pressure monitoring translates into fewer infective complications or better preserved renal function.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Muhammad Danial Bin Rosli, Nur Farah Hanee Binti Mohammad Anuar, Abdelazem Elsherbeny

Acquisition, analysis, or interpretation of data: Muhammad Danial Bin Rosli

Drafting of the manuscript: Muhammad Danial Bin Rosli

Critical review of the manuscript for important intellectual content: Muhammad Danial Bin Rosli, Nur Farah Hanee Binti Mohammad Anuar, Abdelazem Elsherbeny

Supervision: Abdelazem Elsherbeny

Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

References

1. Skolarikos A, Davis NF, Gambaro G, et al.: EAU Guidelines on Urolithiasis. EAU Guidelines Office, Arnhem, Netherlands; 2026.
2. De S, Autorino R, Kim FJ, et al.: Percutaneous nephrolithotomy versus retrograde intrarenal surgery: a systematic review and meta-analysis. Eur Urol. 2015, 67:125-37. 10.1016/j.eururo.2014.07.003
3. Aboumarzouk OM, Monga M, Kata SG, Traxer O, Somani BK: Flexible ureteroscopy and laser lithotripsy for stones >2 cm: a systematic review and meta-analysis. J Endourol. 2012, 26:1257-63. 10.1089/end.2012.0217
4. Tokas T, Herrmann TR, Skolarikos A, Nagele U: Pressure matters: intrarenal pressures during normal and pathological conditions, and impact of increased values to renal physiology. World J Urol. 2019, 37:125-31. 10.1007/s00345-018-2378-4
5. Tokas T, Skolarikos A, Herrmann TR, Nagele U: Pressure matters 2: intrarenal pressure ranges during upper-tract endourological procedures. World J Urol. 2019, 37:133-42. 10.1007/s00345-018-2379-3
6. Bhojani N, Miller LE, Bhattacharyya S, Cutone B, Chew BH: Risk factors for urosepsis after ureteroscopy for stone disease: a systematic review with meta-analysis. J Endourol. 2021, 35:991-1000. 10.1089/end.2020.1133
7. Gauhar V, Traxer O, Castellani D, et al.: Could use of a flexible and navigable suction ureteral access sheath be a potential game-changer in retrograde intrarenal surgery? Outcomes at 30 days from a large, prospective, multicenter, real-world study by the European Association of Urology Urolithiasis Section. Eur Urol Focus. 2024, 10:975-82. 10.1016/j.euf.2024.05.010
8. Gadzhiev N, Aloyan A, Yuen SK, Zulkarnaev A, Gauhar V, Güven S: Intrarenal pressure variations during flexible ureteroscopy in a porcine kidney model: impact of ureteral access sheath types and irrigation methods. World J Urol. 2025, 43:501. 10.1007/s00345-025-05857-1
9. Zeng G, Jiang K, Liu S, et al.: Flexible ureteroscopy with a flexible and navigable suction ureteral access sheath versus mini-percutaneous nephrolithotomy for treatment of 2-3 cm renal stones: an international, multicenter, randomized, noninferiority trial. Eur Urol. 2026, 89:45-54. 10.1016/j.eururo.2025.06.001
10. Yuen SK, Chen Z, Yuen S, et al.: Novel non-invasive intrarenal pressure monitoring devices in flexible ureteroscopy: an in-vitro comparative study. World J Urol. 2025, 43:402. 10.1007/s00345-025-05761-8
11. Tzelves L, Triantafyllou P, Katsimperis S: Novel devices for intrarenal pressure monitoring: are they the future?. Curr Opin Urol. 2026, 36:599-604. 10.1097/MOU.0000000000001417
12. Gao J, Xu Z, Luo Z, Wang L: Intelligent pressure-guided flexible ureteroscopic lithotripsy improves stone-free rates and reduces infectious complications in upper urinary tract infectious stones. Am J Transl Res. 2026, 18:6411-20. 10.62347/KDBD1781
13. Dindo D, Demartines N, Clavien PA: Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg. 2004, 240:205-13. 10.1097/01.sla.0000133083.54934.ae
14. Sharaf A, Amer T, Somani BK, Aboumarzouk OM: Ureteroscopy in patients with bleeding diatheses, anticoagulated, and on anti-platelet agents: a systematic review and meta-analysis of the literature. J Endourol. 2017, 31:1217-25. 10.1089/end.2017.0253
15. Motley G, Dalrymple N, Keesling C, Fischer J, Harmon W: Hounsfield unit density in the determination of urinary stone composition. Urology. 2001, 58:170-3. 10.1016/s0090-4295(01)01115-3
16. Tailly T, Larish Y, Nadeau B, et al.: Combining mean and standard deviation of Hounsfield unit measurements from preoperative CT allows more accurate prediction of urinary stone composition than mean Hounsfield units alone. J Endourol. 2016, 30:453-9. 10.1089/end.2015.0209

17. Bilezikian JP, Khan AA, Silverberg SJ, et al.: Combining mean and standard deviation of Hounsfield unit measurements from preoperative CT allows more accurate prediction of urinary stone composition than mean Hounsfield units alone. J Bone Miner Res. 2022, 37:2293-314. 10.1002/jbmr.4677
18. Christensen SE, Nissen PH, Vestergaard P, Heickendorff L, Brixen K, Mosekilde L: Discriminative power of three indices of renal calcium excretion for the distinction between familial hypocalciuric hypercalcaemia and primary hyperparathyroidism: a follow-up study on methods. Clin Endocrinol (Oxf). 2008, 69:713-20. 10.1111/j.1365-2265.2008.03259.x
19. Macejko A, Okotie OT, Zhao LC, Liu J, Perry K, Nadler RB: Computed tomography-determined stone-free rates for ureteroscopy of upper-tract stones. J Endourol. 2009, 23:379-82. 10.1089/end.2008.0240