



Management of nephrolithiasis in pelvic kidneys: comparative outcomes of contemporary surgical modalities from 11 high-volume centers

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Abstract

Purpose To evaluate the effectiveness and safety of current surgical modalities for nephrolithiasis in ectopic pelvic kidneys, a rare congenital anomaly with limited available evidence.

Methods A multicenter retrospective study was conducted across 11 high-volume international centers, including 45 patients with congenital pelvic kidneys who underwent flexible ureteroscopy, multimodal-guided percutaneous nephrolithotomy, and laparoscopic pyelolithotomy. Stone-free rate (defined as 0 mm), need for ancillary procedures, and complications (Clavien–Dindo) were assessed.

Results Stones were classified as GUYS II in 51.1% of patients and GUYS III–IV in 48.9%. flexible ureteroscopy was the most common primary treatment (51.1%), followed by multimodal guided - PCNL (33.3%). Multimodal-guided PCNL achieved the highest stone free rate (86.7%) and the lowest requirement for ancillary procedures (OR 9.7; 95% CI 1.8–51 compared with other modalities). The overall final stone free rate for the cohort was 65.9% after a mean of 1.38 procedures per patient. Complications occurred in 13.3% of cases, with only one major event (Clavien-Dindo IVa).

Conclusions Our findings indicate that multimodal-guided PCNL achieved the highest success rates and required fewer ancillary procedures than other approaches when treating stones in ectopic pelvic kidneys. In contrast, flexible ureterorenoscopy showed lower efficacy and required more ancillary interventions. Complication rates were low and comparable to those observed in anatomically normal kidneys. Although larger cohorts would strengthen these observations, the very low incidence of ectopic pelvic kidneys inherently limits the ability to accumulate large patient numbers.

Keywords Nephrolithiasis · Pelvic Kidney · Percutaneous Nephrolithotomy (PCNL) · Flexible Ureteroscopy · Laparoscopic Surgery · Renal Stones

Introduction

The pelvic kidney (PK) is a congenital anomaly caused by failed renal ascent, occurring in approximately 1:2,200–1:3,000 individuals [1]. Malrotation, high ureteral insertion, and variable vascular patterns predispose these patients to hydronephrosis, urinary stasis, and stone formation while simultaneously complicating surgical management due to

distorted anatomical landmarks and collecting system configuration [1–3].

Flexible ureterorenoscopy (f-URS) for renal stones treatment in PK is often limited by ureteral tortuosity and restricted scope deflection, whereas shock wave lithotripsy (SWL) is hindered by poor drainage, yielding stone-free rates (SFRs) of ~ 75% but with inconsistent clearance [1–4]. Although percutaneous nephrolithotomy (PCNL) is the

standard for stones > 2 cm in normal kidneys, its use in PK is restricted by overlying pelvic structures and the difficulty of obtaining a safe fluoroscopic tract, often requiring ultrasound- or laparoscopic-guided access [5–9]. Other modalities such as ECIRS and laparoscopic pyelolithotomy (LP) may be useful in selected cases, particularly when ureteropelvic junction obstruction is present [10, 11].

Current evidence is limited to case reports or very small series—typically fewer than 26 patients—with heterogeneous populations and no consensus on optimal management [12, 13]. Clinical guidelines provide no specific recommendations for PKs, forcing clinicians to extrapolate from anatomically normal renal units.

To address this knowledge gap, we conducted the largest multicenter study to date focused exclusively on nephrolithiasis in PKs, aiming to evaluate the effectiveness and safety of contemporary surgical modalities in this anatomically distinct population.

Materials and methods

We conducted a multicenter, retrospective, comparative study involving patients with congenital PK who required surgical management for nephrolithiasis between January 2011 and May 2024. Pregnant patients and those undergoing nephrectomy were excluded. The study protocol was reviewed and approved by the research and ethics committees of the participating centers, with the principal investigator's center approval code CI/HRAEB/035/2024.

Endourologists were invited to participate via email, focusing on those with more than 10 years of experience in urolithiasis, who routinely perform PCNL, f-URS, and laparoscopy, and whose surgical volume would facilitate exposure to ectopic PKs. Eleven endourologists from centers across America, Europe, and Asia participated in the study. Data were collected through an Excel form, which participants returned to the principal investigator for analysis.

The surgeon selected the kind of procedure, which was carried out according to each institution's protocols. Sociodemographic and preoperative clinical variables included sex, age, body mass index (BMI), previous failed procedures due to stones, and stone characteristics: size, density, laterality, and Guy's Stone Score.

The effectiveness of each surgical procedure was assessed by comparing stone-free outcomes and the need for ancillary procedures according to the primary procedure type: f-URS, percutaneous procedures, LP, and SWL. Stone-free status was evaluated at three months with non-enhanced CT scan, ultrasound (USG), Kidney Ureteral and Bladder film (KUB) and KUB+USG, and categorized as follows: A (0 mm) for no residual stones, B for stone fragments ≤ 2 mm, and C for

stone fragments between 2.1 and 4 mm. For group comparisons, stone-free status was defined as the complete absence of stones (0 mm) and residual stones were considered as stone fragments > 4 mm.

Safety was analyzed using the Clavien-Dindo classification for postoperative complications. The severity and frequency of complications were also analyzed based on the stone complexity grade, as defined by the GUYS stone score. Considering that these are pelvic ectopic kidneys, they inherently have at least a GUY II classification due to anatomical variation. GUY II renal stones were categorized as simple stones, while GUY III and IV were categorized as complex renal stones.

The statistical analysis was conducted using the open-access software JAMovi version 2.3.21. Qualitative variables were reported as frequencies and percentages, and comparisons between groups were made using the Chi-square (χ^2) test. Quantitative variables underwent the Kolmogorov-Smirnov normality test; if normality was confirmed, data were reported as mean and standard deviation, with group comparisons made using an independent Student's t-test. For data that did not meet normality assumptions, results were reported as the median and interquartile range (25th–75th percentile). A p-value < 0.05 was considered statistically significant, and these findings were adjusted with logistic regression, reported as OR with the 25th–75th percentile.

Results

Forty-five patients with nephrolithiasis in congenital PKs, all requiring surgical intervention, were included in this study, with procedures performed by 11 expert endourologists. Table 1 details the sociodemographic and preoperative clinical characteristics based on stone treatment.

f-URS was the most commonly chosen surgical treatment, followed by PCNL (Table 2). Pure ultrasound-PCNL was done in two patients (13.3%), one of whom sustained an intestinal injury identified during the procedure. There were no differences in stone-free status or number of treatments required between the simple and complex stone groups (Table 3).

Multimodal-guided PCNL demonstrated greater efficacy in achieving stone-free status with a single procedure (Supplementary Table 5). Conversely, f-URS had the lowest SFR and frequently required additional interventions due to residual stones (Table 4).

Four patients underwent pure laparoscopic pyelolithotomy, 75% having ureteropelvic junction stenosis. Two patients (50%) needed further procedures for residual stones, resulting in a final SFR of 75%.

Table 1 Pre-operative sociodemographic and clinical characteristics

Variable	f-URS (n=23)	PCNL (n=15)	LP (n=4)	SWL (n=3)	Overall (n=45)	P value
Mean age (years)	54	36	31.5	52	45	0.02**
Body mass index (kg/m ²)	29.9±7.2	28.1±4.5	24.6±5.3	39.9±20.1	29.4±7.8	0.48*
Preoperative creatinine (mg/dL)	0.93	0.90	1.18	0.74	0.94	0.31*
Preoperative imaging modality						0.58**
Non-contrast CT	14 (60.9)	9 (60)	2 (50)	2 (66.7)	27 (60)	
Enhanced CT	9 (39.1)	6 (40)	2 (50)	1 (33.3)	18 (40)	
Maximal stone diameter (mm)	14.5	27	32	15	20	0.001*
Stone density (HU)	940	1200	1313	1272	110	0.16*
Stone location						0.03**
Renal pelvis	3 (13.0)	2 (13.3)	3 (75.0)	0 (0)	8 (17.8)	
Calyceal	14 (60.9)	6 (40)	1 (25.0)	1 (33.3)	22 (48.9)	
Staghorn	6 (26.1)	7 (46.7)	0 (0)	2 (66.7)	15 (33.3)	
Laterality—right, n (%)	13 (56.5)	6 (40)	4 (100)	2 (66.7)	25 (55.6)	0.18**
Hydronephrosis, n (%)						0.13**
None	13 (56.5)	5 (33.3)	0 (0)	2 (66.7)	20 (44.4)	
Grade I–II Grade	9 (39.1)	6 (40)	2 (50)	1 (33.3)	18 (40)	
III–IV	1 (4.3)	4 (26.7)	2 (50)	0 (0)	7 (15.6)	
UPJ stricture, n (%)	0(0)	0(0)	3 (6.7)	0(0)	3 (6.7)	<0.001**
Guy stone score						<0.001**
II	18 (78.3)	3 (20)	0 (0)	2 (66.7)	23 (51.1)	
III–IV	5 (21.7)	12 (80)	4 (100)	1 (33.3)	22 (48.9)	

Continuous variables are presented as mean±standard deviation or median, as appropriate. Categorical variables are presented as number (percentage)

f-URS flexible ureterorenoscopy, SWL shock wave lithotripsy, PCNL percutaneous nephrolithotomy, LP laparoscopic pyelolithotomy, CT computed tomography, HU hounsfield units

*One-Way ANOVA Test. **X² test

Finally, SWL was performed on three patients; of these, two (66.7%) achieved stone-free status, while one (33.3%) required two f-URS procedures, resulting in residual stones.

Postoperative complications occurred in 13.3% of cases, with no significant differences between simple and complex stones (Table 3). Most complications were low-grade, including postoperative fever in 11.1% of patients (3 PCNL, two fURS), and two patients (4.4%) required antibiotic treatment (1 PCNL, 1 fURS). One major complication (urinary sepsis, Clavien-Dindo 4a) occurred in one patient (2.2%) with complex stones after mini-tract PCNL. No transfusions or reinterventions were required to address complications.

Discussion

To our knowledge, this is the largest case series to report surgeons' treatment preferences and outcomes for stones in ectopic PKs. f-URS was the predominant treatment choice (56.5%) for patients with simple renal stones (GUY II), and multimodal-guided PCNL (combined with laparoscopy, ultrasound, and fluoroscopy) for patients with complex renal stones (GUY III and IV) Table 3.

Overall treatment success

After primary treatment, SFRs were 55.6% for grade A (0 mm), 62.3% for grade B (≤ 2 mm), and 71.2% for grade C (≤ 4 mm). Ancillary procedures were required in 31.1% of patients, with an average of 1.38 additional procedures per case. As expected, retreatment rates were higher than those reported for anatomically normal kidneys (15–21%) [7, 14].

These findings highlight the importance of recognizing the inherent complexity of renal stone surgical management in PKs, where anatomical variation can significantly limit access, visualization, and stone clearance. After ancillary procedures, final SFRs improved to 65.9% (grade A) and 80% (grade C), comparable to the 82.9% SFR reported by Singh et al. [13]. This underscores that, although initial clearance may be limited, acceptable overall outcomes can be achieved through staged multimodal treatment.

Flexible ureterorenoscopy

The anatomic characteristics of ectopic PKs—particularly ureteral tortuosity and stenosis at both the ureteropelvic and ureterovesical junctions—pose significant challenges when attempting f-URS [1]. These difficulties were reflected in our cohort, where 33% of patients previously to be included

Table 2 Main perioperative variables

Variable	Overall population <i>n</i> =45
First treatment performed <i>n</i> (%)	
f-URS	23 (51.1)
PCNL	15 (33.3)
LP	4 (8.9)
SWL	3 (6.7)
Mean treatments required (range)	1.38 (1–3)
PCNL guided by: <i>n</i> (%)	
Multi-modal	11 (73.3)
Ultrasound	2 (13.3)
Fluoroscopy	1 (6.6)
Laparoscopy	1 (6.6)
Percutaneous tract diameter	
Mini.PCNL ≤ 22Fr	12 (80)
Standard	3 (20)
Lithotripsy method <i>n</i> (%)	
Holmium YAG laser	28 (70)
Thulium YAG laser	5 (12.5)
Thulium fiber laser	3 (7.5)
Lithoclast	1 (2.5)
Dual single probe lithotripter	1 (2.5)
Laser + dual single lithotripter	2 (5)
Perioperative complications <i>n</i> (%)	2 (4.4)
Types of perioperative complications	
Intestinal injury	1 (2.2)
Ureteral injury (minor)	1 (2.2)
Postop urinary diversion <i>n</i> (%)	
DJ	37 (82.2)
Nephrostomy	6 (14.3)
Imaging modality for stone free evaluation	
CT	30 (66.6%)
KUB	8 (17.8%)
US	3 (6.7%)
KUB+US	4 (8.9%)

f-URS flexible ureterorenoscopy, PCNL Percutaneous Nephrolithotomy, SWL Shock Wave Lithotripsy, UAS ureteral access sheath, DJ Double-J ureteral stent, CT computed tomography, KUB kidney, ureter, and bladder X-Ray, US Ultrasound

in the study had undergone to unsuccessful f-URS (the target calyx or stone could not be reached). Similar failure rates ranging from 15% to 23.4% have been reported by Bozkurt et al. [12], underscoring the technical limitations of f-URS in PKs.

f-URS demonstrated the lowest SFR of 34.8% (OR 0.15; 95% CI 0.04–0.58) significantly lower than SFRs reported in previous (65.3%), smaller studies [4, 15]. Importantly, to stay that previous studies have included patients with horseshoe or malrotated kidneys, which generally offer more favorable access than congenital PKs. Reinforcing this conception a recent multicenter AI-based analysis of fURS in renal anomalies reported that PKs exhibited the greatest heterogeneity and the lowest predictability of stone-free outcomes compared with malrotated or horseshoe kidneys

[16]. Additionally, our strict definition of stone-free status—requiring complete absence of fragments (Grade A)—may partially explain the apparently lower SFR observed.

Due to the limited effectiveness of f-URS, 47.8% of patients required ancillary procedures (OR 5.8; 95% CI 1.35–33.3), with an average of 1.57 additional interventions per patient. These findings highlight the inherent limitations of f-URS in ectopic PKs and the frequent need for staged or multimodal management.

Percutaneous nephrolithotomy

Performing PCNL in ectopic pelvic kidneys is challenging because adjacent bowel and vascular structures commonly overlap the intended puncture route, increasing the risk of transperitoneal injury [17–20]. As a result, access in these cases demands meticulous planning and enhanced imaging guidance.

In our cohort, safe access typically required multimodal guidance (80%), combining laparoscopy with ultrasound (50%), fluoroscopy (33.3%), or retrograde endoscopic visualization (8.3%), illustrating the complexity of establishing a secure tract in this anatomy. Ultrasound-only access was used in a limited number of cases (13.3%); however, one bowel injury occurred due to unrecognized colonic interposition within puncture window, requiring immediate laparotomy with primary colonic repair without colostomy. Caution is therefore warranted when interpreting outcomes of pure ultrasound-guided access in ectopic PKs. This finding highlights that ultrasound-only access requires adequate training and experience and supports the use of combined imaging modalities to enhance safety [21–22].

Reported SFRs for PCNL in ectopic PKs range from 93% to 100% [10, 16–20]. In our series, the SFR was 86.7% (OR 9.7; 95% CI 1.8–51.0) using strict grade A criteria, with no need for ancillary procedures since all residual fragments were < 4 mm. Using grade C criteria (≤ 4 mm), the SFR reached 100%. These outcomes place to multimodal-guided PCNL as the treatment that provides the highest stone clearance in PKs.

Laparoscopic/robotic pyelolithotomy and shock wave lithotripsy

Laparoscopic pyelolithotomy achieves reported SFRs of 87–93% and allows simultaneous correction of associated conditions such as ureteropelvic junction obstruction [11, 23–25]. In our cohort, the initial SFR was 50%. After ancillary f-URS, the final SFR increased to 75%, with no anastomotic leaks, underscoring the usefulness of complementary procedures when adopting a pure laparoscopic approach.

Table 3 Surgical procedures and postoperative outcomes according to the Guy's stone score

Variables, n (%)	Guy II (simple stones) n=23	Guy III & IV (complex stones) n=22	Overall n=45	p Value
First type of treatment				
f-URS	13 (56.5)	10 (45.5)	23 (51.1)	0.169
PCNL	5 (21.7)	10 (45.5)	15 (33.3)	
LP	2 (8.7)	2 (9.1)	4 (8.9)	
SWL	3 (13)	0	3 (6.7)	
Stone free rate				
A (0 mm)	14 (60.9)	11 (50)	25 (55.6)	0.147
B (≤ 2 mm)	15 (65.2)	13 (59.1)	28 (62.3)	
C (2.1–4 mm)	15 (65.2)	17 (77.3)	32 (71.2)	
Number of treatments needed				
1	17 (73.9)	14 (63.6)	31 (68.9)	0.7
2	5 (21.7)	6 (27.3)	11 (24.4)	
3	1 (4.3)	2 (9.1)	3 (6.7)	
Final stone free rate*				
A (0 mm)	16 (72.7)	13 (59.1)	29 (65.9)	0.39
B (≤ 2 mm)	17 (73.9)	15 (68.2)	32 (71.1)	
C (2.1–4 mm)	17 (73.9)	19 (86.4)	36 (80)	
Postop complications	3 (13)	3 (13)	6 (13.3)	0.54
Clavien–Dindo				
1	3 (13)	0	3 (6.7)	0.11
2	0	2 (9.1)	2 (4.4)	
3	0	0	0	
4a	0	1 (4.5)	1 (2.2)	
4b	0	0	0	
5	0	0	0	

f-URS flexible ureterorenoscopy, PCNL percutaneous nephrolithotomy, SWL shock wave lithotripsy

*The stone free rate after ancillary procedures

Table 4 Success rates and likelihood of ancillary procedures for patients treated with f-URS and Multimodal - PCNL compared to other surgical methods

	Stone free rate (%)	Need for ancillary procedures	Mean surgeries performed
f-URS vs. others	34.8 vs. 77.3	47.8 vs. 13.6	**1.57 (+/- 0.6) vs. 1.18 (+/- 0.5)
Odds ratio	0.15	5.8	3.44
P value	0.004*	0.013*	0.04*
Multimodal-PCNL vs. others	86.7 vs. 40	0 vs. 46.7	***1 (1) vs. 1.57 (1–3)
Odds ratio	9.7	0.036	ND
P value	0.003*	0.001*	0.002*

*Statistically Significant, ***U Mann–Whitney**

Robotic-assisted pyelolithotomy has shown promising results in isolated reports [5, 26, 27], but none of our cases were treated with this modality, preventing comparison.

SWL was used in only three patients (6.6%), all with simple stones. Although two of the three achieved stone-free status, the sample size is too small to draw meaningful conclusions about the effectiveness of SWL in PKs. The transgluteal supine approach described for distal ureteral stones has not been evaluated for this anatomy and was not used in our cohort [28].

Complications

One bowel perforation occurred perioperatively (4.4%), and postoperative complications were observed in 13% of patients, most of which were minor (11.1%). These rates are comparable to those reported in anatomically normal kidneys, where PCNL complications reach 20.5% [10]. No transfusions were required. For f-URS, rates of postoperative fever (8.6%) and urinary infection (4.3%) were consistent with published ranges (0.2–15%) [27].

Final considerations

This study has important limitations that should be acknowledged. Its retrospective design introduces potential selection bias, while the small sample size and distribution across multiple treatment modalities limit direct comparisons. The long inclusion period entails an unavoidable temporal bias, as early and recent procedures are not directly comparable due to advances in all endourologic technology which may favor later cases (Supplementary Tables 6 and 7).

Moreover, the multicenter design increases heterogeneity in patient selection, surgeon experience, surgical technique, outcome assessment, and follow-up resulting in possible residual confounding, while variability in imaging for stone-free assessment adds further inconsistency, despite all methods are widely accepted.

Despite these limitations, this multicenter study represents the largest cohort to date focused exclusively on nephrolithiasis in ectopic pelvic kidneys and provides valuable real-world evidence from high-volume international centers (supplementary Table 7).

Finally, future prospective studies will be essential to refine management strategies for ectopic pelvic kidneys.

Conclusions

Our findings indicate that multimodal-guided PCNL achieved the highest success rates and required fewer ancillary procedures when treating stones in ectopic pelvic kidneys. In contrast, flexible ureterorenoscopy showed lower efficacy and required more ancillary interventions. Complication rates were low and comparable to those observed in anatomically normal kidneys. Although larger cohorts would strengthen these observations, the very low incidence of ectopic pelvic kidneys inherently limits the ability to accumulate large patient numbers.

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Availability of data and materials The datasets supporting the conclusions of this study are not publicly available due to ethical and institutional restrictions. Data sharing is not permitted outside the participating centers.

Declarations

Conflict of interest The authors declare that they have no competing interests.

Ethical approval This multicenter retrospective study was approved by the Ethics and Research Committees of all participating institutions. The principal approval was granted by the Research and Ethics Committee of the Hospital Regional de Alta Especialidad del Bajío (CI/HRAEB/035/2024). All procedures were performed in accordance with institutional guidelines, national regulations, and the principles of the Declaration of Helsinki.

References

1. Cinman NM, Okeke Z, Smith AD (2007) Pelvic kidney: associated diseases and treatment. *J Endourol* 21(8):836–842. <https://doi.org/10.1089/end.2007.9945>
2. Eid S, Iwanaga J, Loukas M, Oskouian R, Tubbs S (2018) Pelvic kidney: a review of the literature. *Cureus*. <https://doi.org/10.7759/cureus.2775>
3. Tan YK, Cha DY, Gupta M (2013) Management of stones in abnormal situations. *Urol Clin North Am* 40(1):79–97. <https://doi.org/10.1016/j.ucl.2012.10.001>
4. Weizer AZ, Springhart WP, Ekeruo WO et al (2005) Ureteroscopic management of renal calculi in anomalous kidneys. *Urology* 65(2):265–269. <https://doi.org/10.1016/j.urology.2004.09.055>
5. Skolarikos A, Jung H, Neisius A et al (2023) EAU Guidelines on Urolithiasis. European association of urology; ISBN 978-94-92671-19-6. Presented at the EAU Annual Congress Milan
6. Assimos D, Krambeck A, Miller NL et al (2016) Surgical Management of Stones: American Urological Association/Endourological Society guideline, part II. *J Urol* 196(4):1161–1169. <https://doi.org/10.1016/j.juro.2016.05.091>
7. De la Rosette J, Assimos D, Desai M et al (2011) The clinical research office of the endourological society percutaneous nephrolithotomy global study: Indications, complications, and outcomes in 5803 patients. *J Endourol* 25(1):11–17. <https://doi.org/10.1089/end.2010.0424>
8. Tailly T, Tsaturyan A, Emiliani E et al (2022) Worldwide practice patterns of percutaneous nephrolithotomy. *World J Urol* 40(11):2091–2098. <https://doi.org/10.1007/s00345-022-04067-3>

9. Abufaraj M, Al Karmi J, Yang L (2022) Prevalence and trends of urolithiasis among adults. *Curr Opin Urol* 32(4):425–432. <https://doi.org/10.1097/mou.0000000000000994>
10. Amato M, Piazza P, Deruyver Y et al (2022) Laparoscopic assisted mini-ECIRS for ectopic kidney lithiasis: a case report and literature review. *CEN Case Rep* 11(3):295–301. <https://doi.org/10.1007/s13730-021-00683-x>
11. Elbahnasy AM, Elbendary MA, Radwan MA, Elashry OM, Taha MR (2011) Laparoscopic pyelolithotomy in selected patients with ectopic pelvic kidney: a feasible minimally invasive treatment option. *J Endourol* 25(6):985–989. <https://doi.org/10.1089/end.2010.0521>
12. Bozkurt OF, Tepeler A, Sninsky B (2014) Flexible ureterorenoscopy for the treatment of kidney stone within pelvic ectopic kidney. *Urology* 84(6):1285–1289. <https://doi.org/10.1016/j.urology.2014.07.041>
13. Singh AG, Jairath A, Balaji SS et al (2019) Changing trends in the endourological management of urolithiasis in anomalous kidneys. *BJU Int* 123(2):318–327. <https://doi.org/10.1111/bju.14575>
14. Gauhar V, Chew BH, Traxer O et al (2023) Indications, preferences, global practice patterns and outcomes in retrograde intrarenal surgery (RIRS) for renal stones in adults: results from a multicenter database of 6669 patients of the global FLEXible ureteroscopy Outcomes Registry (FLEXOR). *World J Urol* 41(2):567–574. <https://doi.org/10.1007/s00345-022-04257-z>
15. Sarı Y, Çakıcı MÇ, Aykaç A et al (2020) Kidney stone treatment in the anomalous kidney with retrograde intrarenal surgery: A matched pair analysis. *J Urol Surg* 7(3):166–171
16. Nedbal C, Gauhar V, Adithya S, Naik N, Gite S, Sevalia H, Castellani D, Gregori A, Panthier F, Tanidir Y, Shrestha A, Sridharan V, Singh A, Soebhali B, Lakmichi MA, Hamri SB, Somani BK (2025) Flexible ureteroscopy in renal anomalies: an explainable AI model for surgical outcome prediction from EAU endourology. *World J Urol* 43(1):530. <https://doi.org/10.1007/s00345-025-05904-x>. PMID: 40892093
17. Desai MR, Jasani A (2000) Percutaneous nephrolithotripsy in ectopic kidneys. *J Endourol* 14(3):289–292. <https://doi.org/10.1089/end.2000.14.289>
18. Sharma LK, Venkatachalapathy VSS, Mishra DK, Agrawal MS (2022) Ultrasound-guided supine mini-percutaneous nephrolithotomy in ectopic pelvic kidney. *Indian J Urol* 38(1):68–70. https://doi.org/10.4103/iju.iju_364_21
19. Troxel SA, Low RK, Das S (2002) Extraperitoneal laparoscopy-assisted percutaneous nephrolithotomy in a left pelvic kidney. *J Endourol* 16(9):655–657. <https://doi.org/10.1089/089277902761402998>
20. Holman E, Tóth C (1998) Laparoscopically assisted percutaneous transperitoneal nephrolithotomy in pelvic dystopic kidneys: Experience in 15 successful cases. *J Laparoendosc Adv Surg Tech A* 8(6):431–435. <https://doi.org/10.1089/lap.1998.8.431>
21. Thummar H, Khater U, Joshi V, Gupta M (2015) Ultrasound-guided percutaneous nephrolithotomy for staghorn stone in crossed fused ectopic pelvic kidney. *J Endourol* 29(6):1–3. <https://doi.org/10.1089/vid.2015.0008>
22. Laxmi K, Vigneswara S, Dilip K, Agrawal M Ultrasound-guided supine mini-percutaneous nephrolithotomy in ectopic pelvic kidney. *Indian J Urol* 2022 Jan-Mar ;38(1):68–70; https://doi.org/10.4103/iju.iju_364_21
23. Ramakumar S, Segura JW (2000) Laparoscopic surgery for renal urolithiasis: Pyelolithotomy, caliceal diverticulectomy, and treatment of stones in a pelvic kidney. *J Endourol* 14(10):829–832. <https://doi.org/10.1089/end.2000.14.829>
24. Ganpule AP, Prashant J, Desai MR (2012) Laparoscopic and robot-assisted surgery in the management of urinary lithiasis. *Arab J Urol* 10(1):32–39. <https://doi.org/10.1016/j.aju.2011.12.003>
25. Ganpule A, Prashant J, Desai M (2012) Laparoscopic and robot-assisted surgery in the management of urinary lithiasis. *Arab J Urol* 10(1):32–39. <https://doi.org/10.1016/j.aju.2011.12.003>
26. El-Kappany H, El-Nahas A, Shoma A (2007) Ectopic Pyelolithotomy via a Combined Robotic and Endoscopic Approach. *J Endourol* 21(10):1131–1136. <https://doi.org/10.1089/end.2007.9930>
27. Edmonds A, Olson K, Humphreys M (2024) Robotic-Assisted Pyelolithotomy in an Ectopic Pelvic Kidney. *videourology*. Sep;36 (2) Published Online. <https://doi.org/10.1089/vid.2024.004>
28. Kamel M, Salem EA, Maarouf A, Abdalla M, Ragab A, Shahin AM (2015) Supine transgluteal vs prone position in extracorporeal shock wave lithotripsy of distal ureteric stones. *Urology* 85(1):51–54. <https://doi.org/10.1016/j.urology.2014.08.033>Epub 2014 Oct 28. PMID: 25440820

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