Robotic-assisted laparoscopic pyelolithotomy in a horseshoe kidney

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Nephrolithiasis is one of the most common indications for surgery in patients with a horseshoe kidney. Robotic-assisted surgery has become a staple in urologic practice, yet its application in stone management is largely undefined. We present a patient with a horseshoe kidney, who underwent a robotic-assisted laparoscopic pyelolithotomy (RPL) to treat a 3 cm stone burden. This procedure allowed for safe access that could not be obtained with percutaneous nephrolithotomy (PCNL) and stone removal without fragmentation, which would have been challenging with traditional laparoscopy. We advocate for the use of robotic-assisted laparoscopic pyelolithotomy in cases of aberrant anatomy complicating a heavy stone burden.

Key Words: horseshoe kidney, kidney calculi, robotic surgery, pyelolithotomy

Introduction

Horseshoe kidneys affect approximately 1:500 individuals, making them the most common congenital renal fusion defect.[1] Although patients are typically asymptomatic, abnormalities in vascular supply, renal position, and rotation can make treatment of subsequent pathology more challenging. The anatomy of a horseshoe kidney increases the risk for renal stone formation and decreases the likelihood of spontaneous stone passage, due to high insertion of the ureters into the renal pelvis.[2] For renal stones greater than 2 cm, treatment with percutaneous nephrolithotomy (PCNL) is the standard of care.[3] Variation in renal anatomy or location may indicate the need for an alternative approach to stone management with laparoscopic or robotic-assisted surgery.[4] Robotic-assisted laparoscopic pyelolithotomy (RPL) has been described in the literature as a safe and reasonable option in patients with unfavorable anatomy, such as a horseshoe kidney.[5] Advantages of RPL include complete stone removal without fragmentation and preservation of renal parenchyma, therefore reducing the risk of bleeding and need for retreatment. This case report presents a patient who underwent RPL with utilization of a robotic ultrasound probe to treat a 3 cm stone in a horseshoe kidney.

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Figure 1. Preoperative computed tomography scan of a horseshoe kidney with a stone burden in the right renal pelvis (coronal and axial views). Note almost retrorenal colon precluding safe percutaneous access.

Case report

A 63-year-old woman with congenital horseshoe kidney and bilateral nephrolithiasis complicated by recurrent febrile urinary tract infections was referred for possible pyelolithotomy. The patient was initially admitted at an outside hospital for sudden onset right flank pain, chills, and vomiting, and found to have septic shock secondary to extended-spectrum beta-lactamase (ESBL)-producing E. coli bacteremia from pyelonephritis with hydronephrosis from obstructive uropathy. Computed tomography (CT) scan demonstrated an obstructing 6 mm stone in the distal left ureter with severe left hydronephrosis and perinephric stranding. The patient was treated with antibiotics and subsequently discharged.

Upon further evaluation, a second CT scan showed a 3 cm stone in the right moiety renal pelvis and percutaneous access was found not to be feasible due to almost retrorenal colon and lack of what we interpreted to be a safe operative window for access, Figure 1. The patient elected to have a robotic-assisted laparoscopic pyelolithotomy (RPL). Intravenous ertapenem was given for antibiotic prophylaxis. The patient was transferred to modified flank position and a Foley catheter was placed. A Veress needle was used in the right upper quadrant for laparoscopic access with trocars subsequently placed just lateral and superior of the umbilicus, inferiorly, and a 12 mm assistant port placed at the level of the umbilicus. The robot was docked and used to reflect the right hemi-colon until the kidney was medially located. The robotic ultrasound probe was used to identify the stone and Gerota's fascia was entered. The pelvis was medial and anterior and there was difficulty identifying the ureter at the tail of Gerota's fascia due to its medial displacement near the great vessels. The pelvis was identified with ultrasound given the uncertainty, potential for misidentification, and associated morbidity of entering the incorrect anatomic structure. Upon entering, a large stone was immediately found. The renal pelvis was opened with cautery for 5 cm in length and the stone was removed intact. Flexible ureteroscopy was then performed in an anterograde fashion through the robotic assistant port and no additional stone fragments were visualized; however, the ureteropelvic junction (UPJ) could not be localized. The renal pelvis was then irrigated and after several unsuccessful attempts to place a stent in antegrade fashion, the decision was made to place it in retrograde fashion. The pelvis was closed with 4-0 Vicryl suture in a running fashion and Gerota's fascia was then closed over the pyelotomy with 4-0 Vicryl suture in interrupted fashion. A 19 French round drain was placed through the most caudal robotic port toward the surgical site and the trocars were removed under visualization. The umbilical incision was extended, and the specimen was removed. The fascia was closed with 0 PDS suture in running fashion and the skin incisions were closed with 4-0 Monocryl suture in subcuticular fashion. Dermabond was applied to the wounds and the drain was secured in place with 2-0 nylon suture. The patient was then repositioned in dorsal lithotomy and re-prepped in sterile fashion. The right ureteral orifice was identified and cannulated with a 0.035 sensor wire. The wire was passed to the right moiety of the kidney and confirmed on fluoroscopy. Retrograde pyelogram demonstrated no hydronephrosis or extravasation on the right side.

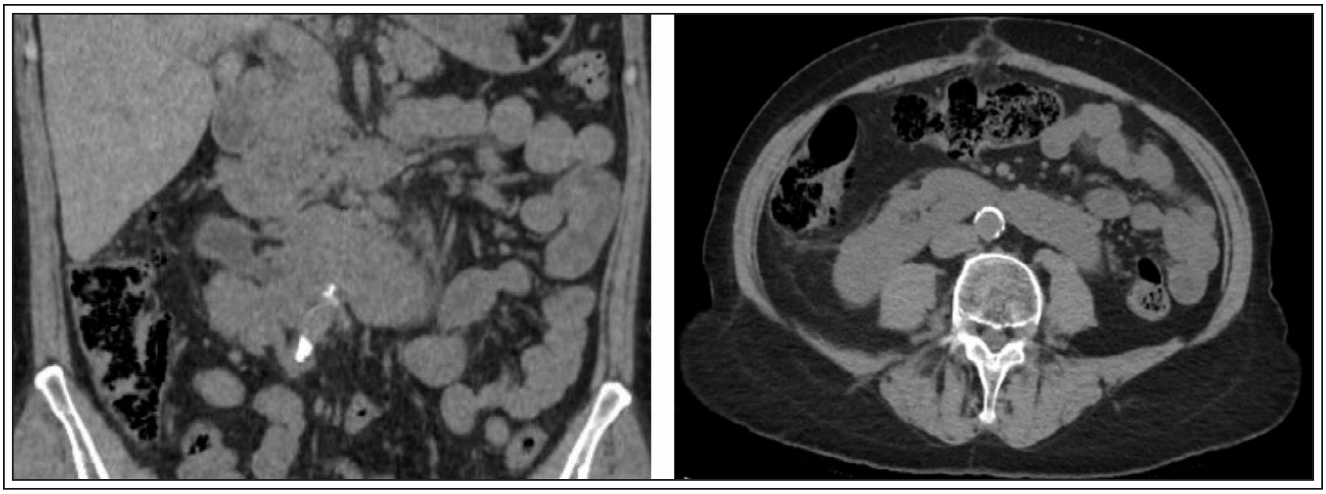

Figure 2. Three-month postoperative computed tomography scan of a horseshoe kidney with resolution of large renal pelvis stone (coronal and axial views).

The wire was then passed through the catheter to the kidney. The 5 French catheter was removed, and a 6 French x 24 cm double J ureteral stent was placed over the wire and confirmed to have proximal curl in the right collecting system with fluoroscopy. The drain was placed to suction, and a 16 French Foley catheter was placed. The bladder was emptied, and the scope was removed from the bladder. The patient was awakened uneventfully and transferred to the recovery room.

Postoperatively the patient had no complications; however, the patient was kept inpatient for a course of IV antibiotics given her history of sepsis and oral antibiotic-resistant strain of ESBL E. coli. The patient was discharged home on postoperative day 5 with a Foley catheter and amoxicillin-clavulanate and fosfomycin antibiotics per susceptibilities on urine culture. The patient was seen 1 week later for a postoperative checkup and Foley catheter removal and found to be recovering well with no new stone symptoms. The patient was seen again 1 month postoperatively for removal of the ureteral stent via cystoscopy and still had no stone symptoms. A follow up CT scan 3 months after the surgery showed resolution of large renal pelvis stone, Figure 2.

Discussion

Horseshoe kidneys are characterized by a highly variable vascular supply, malrotation, and aberrant location, often in close relation to the sigmoid colon

TABLE 1. **Summary of RPL case reports**

	Sellers et al 2023[7]	Rajih et al 2015[9]	Al-Yousef et al 2017[8]	Nayyar et al 2010[10]
Anatomic anomaly	Horseshoe kidney	Horseshoe kidney	Ectopic pelvic kidney	Ectopic pelvic kidney
Failed prior management	ESWL	NR	Flexible ureteroscopy	NR
Stone size (cm)	3.5 x 4.0	NR	1.2	1.3
Approach	RPL	Robotic trans-mesocolonic pyelolithotomy	RPL	RPL with concomitant pyeloplasty
Complications	None	None	None	None

RPL = robotic-assisted laparoscopic pyelolithotomy; ESWL = extracorporeal shockwave lithotripsy; NR = not reported and iliac vessels.[1] High insertion of the ureters into the renal pelvis of a horseshoe kidney increases the risk for renal stone formation and decreases the likelihood of spontaneous stone passage.[2] First-line treatment options for heavy stone burden (> 2 cm), such as PCNL, should be considered but may be ill-suited, especially when safe access cannot be obtained. Interventional radiology may be contacted to assist in cases with difficult access given their ability to utilize CT guidance. Wang et al compared outcomes of laparoscopic pyelolithotomy and PCNL in a 2013 meta-analysis and found a decreased risk of bleeding and a higher stone-free rate in the laparoscopic group, however, further data is needed to compare laparoscopic and robotic-assisted approaches.[6]

Indications for laparoscopic or robotic surgery include cases of unfavorable anatomy (horseshoe, pelvic, ectopic, or malrotated kidneys), large or complex stones, or patients requiring simultaneous reconstruction.[3] These minimally invasive approaches are generally preferred to open surgery. Table 1 summarizes recent case reports where RPL was utilized for stone management in cases of aberrant anatomy. It was not uncommon for these cases to have previously failed less invasive treatment options and the increased maneuverability associated with robotic surgery was cited multiple times as a reason for selecting robotic-assisted surgery over traditional laparoscopy.[7,8] A transmesocolonic approach was also described as an option in patients with thin mesentery in which extensive mobilization of the kidney is not required.[9]

Advantages of RPL include extended maneuverability that allows for preservation of the renal parenchyma and avoidance of stone fragmentation, with one study showing a 96% stone free/zero fragmentation rate (26/27 cases) and no incidence of injury to the renal parenchyma.[5] This approach is especially useful for large (> 2 cm), solitary, and dense stones as in this case. Minimizing residual fragments and therefore risk of retreatment is especially relevant in cases of aberrant anatomy that are already at a higher risk of complication from surgical intervention. We highlight the utilization of the robotic ultrasound probe that permitted safe localization of the stone and aided in planning of the incision. Flexible ureteroscopy through a robotic-assistant port allows for direct visualization of the renal pelvis and calyces to assess for residual stones; the use of intracorporeal stone basketing has also been described.[7] Drawbacks of RPL likely include potential for lack of availability in certain healthcare systems and the increased cost associated with robotic surgery compared to traditional laparoscopy.[4] This case demonstrates the successful treatment of a heavy stone burden in a horseshoe kidney using robotic-assisted laparoscopic pyelolithotomy, supporting use of this procedure in select patients, including cases of anatomic abnormalities. ☐

References

1. Taghavi K, Kirkpatrick J, Mirjalili SA. The horseshoe kidney: surgical anatomy and embryology. *J Pediatr Urol* 2016;12(5): 275-280.
2. Ölçücüoğlu E, Çamtosun A, Biçer S, Bayraktar AM. Laparoscopic pyelolithotomy in a horseshoe kidney. *Turk J Urol* 2014;40(4): 240-244.
3. Assimos D, Krambeck A, Miller NL et al. Surgical management of stones: American Urological Association (AUA) Endourological Society guideline. *J Urol* 2016;196:1153-1160.
4. Ganpule AP, Prashant J, Desai MR. Laparoscopic and robot-assisted surgery in the management of urinary lithiasis. *Arab J Urol* 2012;10(1):32-39.
5. Swearingen R, Sood A, Madi R et al. Zero-fragment nephrolithotomy: a multi-center evaluation of robotic pyelolithotomy and nephrolithotomy for treating renal stones. *Eur Urol* 2017;72(6):1014-1021.
6. Wang X, Li S, Liu T, Guo Y, Yang Z. Laparoscopic pyelolithotomy compared to percutaneous nephrolithotomy as surgical management for large renal pelvic calculi: a meta-analysis. *J Urol* 2013;190(3):888-893.
7. Sellers J, George A, Camacho J, Cammack JT, Medway A. Robotic-assisted laparoscopic pyelolithotomy with intracorporeal pyeloscopy in a horseshoe kidney. *Urol Case Rep* 2023;46:102305.
8. Al-Yousef R, Almarzouq A, Aldousari S. Robotic pyelolithotomy in a congenital pelvic kidney: side docking and robotic prostatectomy port - site approach. *Int Braz J Urol* 2017;43(2):374.
9. Rajih ES, Al-otaibi MF, Alkhudair WK. Robotic transmesocolonic pyelolithotomy of horseshoe kidney. *Int Braz J Urol* 2015;41(1): 179-180.
10. Nayyar R, Singh P, Gupta NP. Robot-assisted laparoscopic pyeloplasty with stone removal in an ectopic pelvic kidney. *JSLS* 2010;14(1):130-132.