Case Report

Transmesocolic robotic extended pyelolithotomy of a large gas-containing renal stone: Case report and review of the literature

Ted B. Manny, Julia S. Manny, Ashok K. Hemal[1]

Departments of Urology and [1]Pathology, Wake Forest University Baptist Medical Center, Medical Center Blvd, Winston-Salem, North Carolina 27157, USA

Abstract

We present the fifth case in the world literature of a gas-containing urinary stone. Our patient is a 31-year-old woman referred for left flank pain and gross hematuria who was noted on imaging to have a 6.5 cm left renal pelvis stone containing gas. Cultures revealed *Escherichia coli* from the urine and stone material. Chemistry revealed underlying gouty diathesis. The stone was removed using robotic extended pyelolithotomy. Overall, renal function remained unchanged while drainage improved on nucleotide renography. Review of the world literature suggests that gas-containing renal stones are invariably associated with emphysematous pyelonephritis commonly caused by *E. coli* and Klebsiella. Contributing factors to gas-containing stone formation include urinary stasis, metabolic mineral derangement and, in a minority of the cases, diabetes.

Key Words: Calcium phosphates, gases, kidney calculi, pyelonephritis, robotics

Address for correspondence:
Dr. Ashok K. Hemal, Department of Urology, Wake Forest University Baptist Medical Center, Medical Center Blvd, Winston-Salem, North Carolina 27157, USA. E-mail: AHemal@wfubmc.edu
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INTRODUCTION

Gas-containing urinary stones are a rare entity, and are associated with anaerobic fermenting organisms such as *Escherichia coli* and Klebsiella.[1-4] We present the fifth such case in the world literature and the first treated with robotic pyelolithotomy.

CASE REPORT

A 31-year-old Mexican-American woman was referred for a large left renal stone found on initial work-up for flank pain and gross hematuria. She was non-diabetic and denied prior medical or surgical history. Exam was significant for mild left costovertebral angle tenderness. Urinalysis revealed positive nitrite and a pH of 5.0. Complete blood count was normal and the patient denied recent febrile illness. Urine culture was positive for *E. coli* resistant to trimethoprim-sulfamethoxasazole. Axial imaging showed gas in the collecting system and within several compartments of a 6.5 cm lamellated renal pelvis stone without radiographic evidence of acute infection [Figure 1]. Renogram demonstrated 20% left relative function and significant obstruction, with a T½ of 65 min. Serum chemistry showed no metabolic acidosis, hypercalcemia or hyperglycemia. The Cockcroft-Gault calculated creatinine clearance was 177 mL/min. Options including nephrectomy, percutaneous nephrostolithotomy (PCNL) and robotic extended pyelolithotomy were discussed with the patient. She strongly desired nephron-sparing surgery. Given the stone was large but confined to the renal pelvis, without significant branching, we felt that a robotic approach provided the most efficient means of removal.

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The patient was taken to the operative suite and placed in a left-side up 60-degree flank position. A Veress needle was used to obtain pneumoperitoneum and a 12 mm camera port, three 8 mm robotic ports and two 5-mm assistant ports were placed. A bulge corresponding to the left kidney was easily identified in the left mesocolon. A 4-cm incision was carried through the mesocolon parallel to the vascular arcades. The renal pelvis was exposed and a transverse pyelotomy was made directly onto the stone [Figure 2]. Robotic forceps were used to manipulate the stone into a laparoscopic specimen retrieval bag. The renal pelvis was irrigated and found to be free of residual fragments. Inspection of the uretero-pelvic junction showed no obvious crossing vessels, narrowed segments or kinking. A 6 French ×28 cm ureteral stent was then placed in an anterograde fashion into the urinary bladder and verified by reflux of urine through the proximal stent lumen. The pyelotomy was then closed in two layers with running 3-0 poligecaperone, followed by an interrupted imbricating layer. A closed suction drain was brought into the retroperitoneum via the lateral most robotic port. The mesocolon was re-approximated and the specimen was removed by extending the inferior-most port site. Total procedure time was 120 min, with 63 min of robotic console time. The Foley catheter was removed post-op day 1. Drain output remained minimal and it was removed post-op day 2 as the patient was discharged home. The ureteral stent was removed in the office cystoscopically 4 weeks after surgery.

Grossly, the stone was hard and non-friable. Axial sectioning revealed several hollow compartments consistent with gas pockets on pre-op imaging [Figure 3]. Culture of stone material revealed *E. coli*, also resistant to trimethoprim-sulfamethoxasole. Compositional analysis showed the stone to be 100% calcium phosphate.

At 12 months post-op, the patient was well and had a single episode of dysuria, which was culture negative. Renogram showed resolved left obstruction and stable relative function while calculated creatinine clearance was unchanged from pre-op. Plain abdominal radiograph and renal ultrasound were without urinary calculi.

DISCUSSION

The first case of a gas-containing stone was reported by Simpson *et al.* in 1998 in a 68-year-old non-diabetic man with a history of ipsilateral untreated uretero-pelvic junction obstruction [Table 1].[1] Since that time, three other cases have been reported, including this case, bringing the total to five.[2-4] The most common presentation was urosepsis. All the patients survived, and four of five patients had their stone burden successfully treated using a variety of surgical approaches. Only

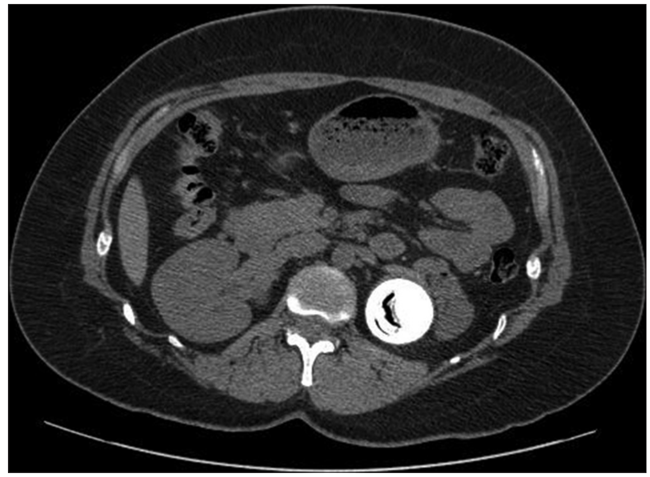

Figure 1: Computed tomography image of lamellated large left renal stone containing gas within several compartments

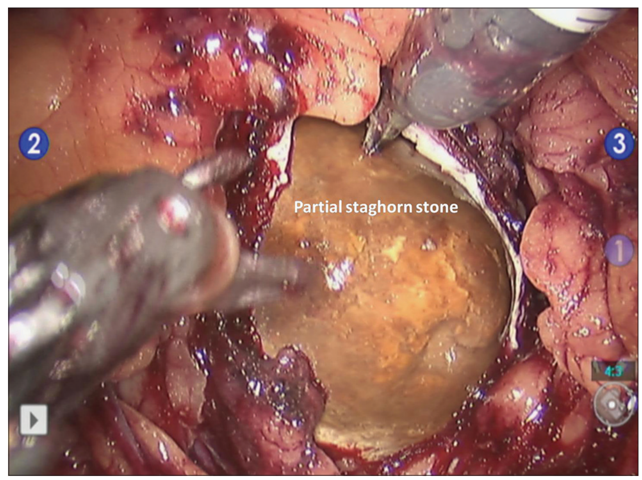

Figure 2: Intraoperative image during robotic assisted laparoscopic pyelolithotomy demonstrating transverse pyelotomy directly onto the left renal stone. A window was created through the mesocolon to gain access to the kidney

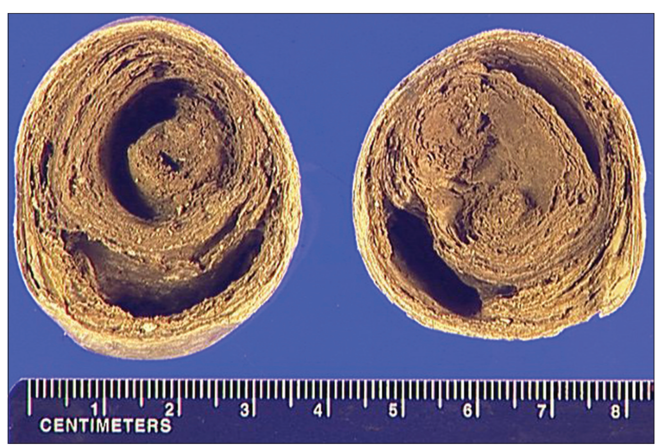

Figure 3: Axial section through the left renal stone demonstrating multiple hollow compartments within many lamellated layers. A central nidus is present. Compositional analysis revealed 100% calcium phosphate. Stone culture was positive for *Escherichia coli*

Table 1: Five cases of gas-containing urinary stones exist in the world literature. Many similarities in demographic, clinical, stone characteristics and microbiology exist. A variety of successful management strategies have been employed

Patient	Age	Sex	Side	Comorbidities	Presentation	Stone size	Stone composition	Stone culture	Urine culture	EPN† class	Urinary stasis	Management
1	68	M	Left	Left uretero-pelvic junction obstruction	Urosepsis	Multiple stones, largest 1.8 cm	Matrix	*E. coli*	*E. coli*	1	Yes	Simple nephrectomy
2	55	F	Right	Prior stone disease	Urosepsis	Multiple small stones	100% uric acid	N/A	*E. coli*	1	Yes	PCN‡, followed by PCNL§
3	46	M	Left	Primary hyperparathyroidism	Recurrent UTI pneumaturia	Multiple small stones	100% calcium phosphate	No growth	Klebsiella	1	Yes	PCNL§
4	65	F	Right	Diabetes, sarcoidosis	Urosepsis	Multiple small stones	N/A	N/A	*E. coli*	1	Yes	Ureteral stent
5	31	F	Left	Gouty diathesis	Flank pain, hematuria	6.5 cm single stone	100% calcium phosphate	*E. coli*	*E. coli*	1	Yes	REP*

†Emphysematous pyelonephritis; ‡Percutaneous nephrostomy tube; §Percutaneous nephrostolithotomy; Urinary tract infection;*Robotic extended pyelolithotomy

one patient required nephrectomy for a poorly functioning kidney.[1]

All patients described in the literature meet the criteria for Class I emphysematous pyelonephritis (EPN) as there was no extension of gas beyond the renal pelvis [Table 1].[5] This relatively mild form of EPN has an excellent prognosis with concomitant antibiotic therapy and relief of obstruction. Huang *et al*. have extensively studied the microbiology of EPN and have shown that all cases have been associated with anaerobic gas-fermenting organisms (*E. coli* 69%, Klebsiella 29%). The microbiology from the five cases of gas-containing stones mirror this trend, with *E. coli* in 80% and Klebsiella in 20% [Table 1].

Urinary stasis appears paramount in the formation of gas-containing urinary calculi. All patients in the literature had radiographic signs of obstruction at presentation [Table 1]. Stasis likely decreases renal perfusion, impairing the ability for formed gas to exit the renal unit, and predisposes to stone formation itself by allowing further supersaturation of solutes.

Metabolic factors also likely play a significant role in patients with gas-containing stones. Compositional stone analysis is available for four of five patients, with calcium phosphate being the most common [Table 1]. Our patient, who had 100% calcium phosphate composition, also met the criteria for gouty diathesis. She had persistent aciduria despite normal serum uric acid. Such patients are predisposed to uric acid, calcium oxalate and calcium phosphate stones.[6] Patient 3 had documented primary hyperparathyroidism, with a serum calcium level of 11.7 at the time of presentation, and also had 100% calcium phosphate stones. Patient 4 carried a diagnosis of sarcoidosis that was associated with elevated Vitamin D levels and hypercalcemia/hypercalcuria.

Nephron-sparing management was employed in four of five cases of gas-containing stones [Table 1]. PCNL was used in two patients.[2,3] As a high-volume center for both PCNL and robotic renal surgery, we elected to perform robotic extended laparoscopic pyelolithotomy as it was felt to be the most efficient and minimally invasive means of addressing the stone. Pre-operative imaging suggested a single large, unbranched stone within an extra-renal pelvis, which we felt was the ideal anatomy for a robotic approach.

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