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ORIGINAL ARTICLE

Robotic extended pyelolithotomy for complete staghorn calculus

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Abstract Staghorn stones represent a therapeutic challenge to urologists. We present our experience with laparoscopic extended pyelolithotomy for treatment of staghorn and complex renal calculi in highly selected cases. This approach provides the principles of open surgery with the advantages of minimally invasive surgery. We describe our experience with robot-assisted extended pyelolithotomy for complex coralliform calculi. Since January 2007, robotic extended pyelolithotomy has been performed by transperitoneal approach in two patients with complete coralliform lithiasis (calculi average size 8 cm). One patient had history of percutaneous nephrolithotomy. Demographic and operative data were collected. All procedures were technically successful without need for open conversion. Mean estimated blood loss was 175 ml (range 50–300 ml), and mean operative time was 150 min (range 120–150 min). A perinephric drain was employed in one patient with duration of 5 days. Postoperative imaging confirmed complete stone clearance. Robotic extended pyelolithotomy is a feasible and reproducible procedure for removal of complete and partial staghorn calculi in selected patients with complex nephrolithiasis. This approach might limit the role of open surgery for these calculi, but further publications with more cases are necessary to further define its utility.

Keywords Robotic · Pyelolithotomy · Staghorn calculus · Nephrolithiasis

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Introduction

Staghorn stones represent a troublesome therapeutic challenge to urologists. Staghorn calculi are branched stones that occupy a large portion of the collecting system, referring to any branched stone occupying more than one portion of the collecting system (i.e., renal pelvis with one or more calyceal extensions) [1]. These calculi can extend into two calyceal groups or into all calyceal groups involving at least 80% of the collecting system, being classified as partial or complete, respectively.

Current treatments for these stones include percutaneous nephrolithotomy (PCNL) and/or extracorporeal shock wave lithotripsy (ESWL); open surgery is reserved for patients with complex staghorn calculus [1]. We describe our experience utilizing robotic extended pyelolithotomy in the treatment of staghorn calculi, which duplicates the principles of the open extended pyelolithotomy with a minimally invasive approach, in two patients.

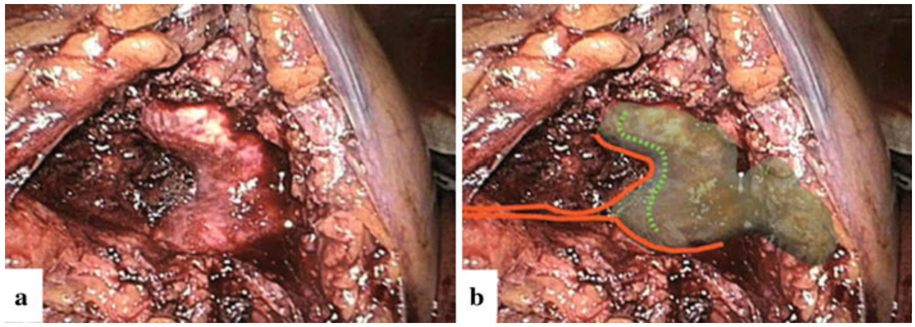

Fig. 1 **a** Identification of the renal pelvis with calculus inside. **b** *Line* of cut for calculi extraction

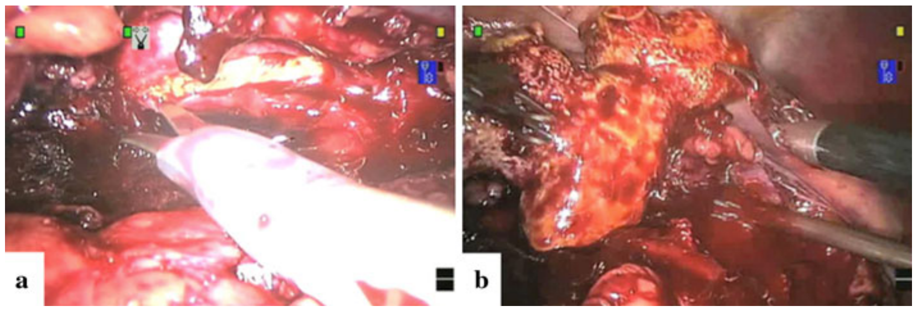

Fig. 2 **a** Cut with scissors on the pelvis. **b** Removing the stone

Patients and methods

Since 2007, two male patients with complete staghorn stones have been treated in our center; they underwent robot-assisted pyelolithotomy. Characteristics of the patients, stones, and surgical techniques were analyzed. Mean age was 63.5 years. The complex staghorn calculi had average size of 8 cm (range 7–9 cm). One patient had previous percutaneous nephrolithotomy.

Surgical technique

Surgical technique included: transperitoneal port placement, dissection of perirenal tissues, pyelotomy, extraction of the calculus, calyceal direct vision inspection by laparoscopic optic and/or flexible cystoscope, double-J stent placement if required, closure of the pyelotomy, and drain placement.

With the patient under general anesthesia, a nasogastric tube was placed as well as a urethral catheter, which was placed and connected to a straight drainage tube. The patient was then placed in lateral decubitus position at 45° angle. An 8-mm trocar was inserted at the lateral edge of rectus muscle at the level of the umbilicus. Pneumoperitoneum was maintained at 15 mmHg. Another two 8-mm trocars were placed under direct laparoscopic vision so that all of the trocars were in a “C” configuration. These ports were inserted at 30° angle in the anterior axillary line below the costal margin and in the anterior axillary line in the iliac fossa. A fourth port was placed if necessary. The line of Toldt was incised, the renocolic ligament was incised, and the colon was dissected and reflected medially to provide clear exposure of the ureteropelvic junction (Fig. 1a, b). The ureter was identified, recognizing its peristalsis, and dissected proximally to reach the inflamed renal pelvis. The renal pelvis was exposed by releasing adjacent structures with sharp and blunt dissection. A V-shaped incision was made away from the uretero-pelvic junction extending into the lower pole infundibula as necessary to facilitate stone retrieval (Fig. 2a). Stone was extracted using suction cannula and grasping and right-angled forceps, placed in a specimen retrieval bag, and removed at the conclusion of the procedure through an incision (Fig. 2b). Direct calyceal vision inspection was performed initially with the 30° optic, and the flexible cystoscope was placed through the 10-mm port, if required, to remove possible remaining stones. A ureteral double-J stent was placed, and the pyelotomy was closed in running fashion with absorbable suture. The perirenal fat was then approximated over the renal pelvis. A silicone suction drain was placed through a separate incision in the flank, and the skin incisions were closed.

Oral intake was resumed on postoperative day 1, and the Foley catheter was removed after 3 days, depending on the suction drain retrieved. The drain was discontinued when drainage was less than 50 cc per day. The double-J stent was removed 3 weeks postoperatively, and computed tomography (CT) was performed 6 weeks later (Fig. 3).

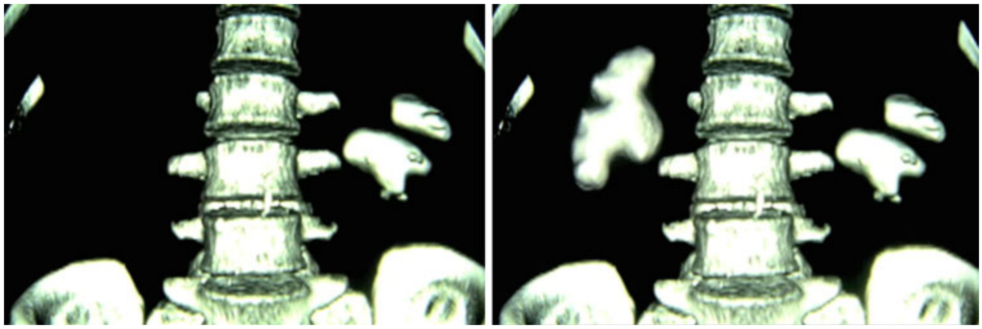

Fig. 3 3D reconstruction, before and after surgery

Results

Mean age was 63.5 years. The average size of complete staghorn calculi was 8 cm (range 7–9 cm). One patient had history of percutaneous nephrolithotomy, and the other patient underwent radical prostatectomy at the same time of surgery. Both were right calculi.

All procedures were technically successful with robot assistance and without need for conversion to open surgery. Mean estimated blood loss was 175 ml (range 50–300 ml), and neither patient required perioperative blood transfusion. Mean operative time was 150 min (range 120–180 min). A perinephric drain was inserted in one patient and was maintained for 5 days. Mean hospital stay was 4.5 days (range 2–7 days). Complete stone removal was achieved in both patients based on CT scan imaging obtained 6 weeks postoperatively.

Discussion

Treatment of renal and ureteral stones has undergone dramatic changes with the advent of ESWL, PCNL, and ureteroscopic laser lithotripsy. Treatment has progressed dramatically, and today, PCNL and SWL are the most commonly used procedures. These techniques have almost eliminated the need for pyelolithotomy to remove renal stones, although there are some patients who benefit from an open approach. Anatrophic nephrolithotomy to remove a large and complex stone was first described by Smith and Boyce [2]. Currently, open surgery is rarely needed to manage patients with staghorn calculi, although it may be considered for patients with extremely large staghorn calculi, unfavorable collecting system anatomy, body habitus abnormalities, morbid obesity, or skeletal abnormalities, patients requiring open surgery for another cause, stones that will require multiple percutaneous procedures and/or shockwave lithotripsy, and when other minimally invasive therapies such as PCNL or ESWL have failed in patients with stones resistant to fragmentation, such as those of cystine composition [1].

Minimally invasive approaches have garnered attention, and laparoscopy has been introduced as an additional tool for treatment and can be a useful alternative to open surgery. There have been reports of laparoscopic surgical techniques for renal calculi and, in recent years, technology has evolved, allowing successful reconstructive procedures and making laparoscopic stone surgery possible. In 1992, Lee and Smith first used laparoscopic as an adjunct to treat urinary calculi [3], although it was Gaur et al. who described the first laparoscopic pyelolithotomy in 1994, reporting five successful removals of eight stones utilizing a retroperitoneal approach [4]. Others have also described the retroperitoneal approach to kidney stones [5, 6]. Successful laparoscopic transperitoneal pyelolithotomy has been reported in ectopic kidneys with stones as large as 4 cm [7–9]. Laparoscopic anatrophic nephrolithotomy has also been described in several small series, with low morbidity and preservation of kidney function [10–12]. Kaouk et al. performed laparoscopic anatrophic nephrolithotomy in ten porcine models, including one staged bilateral anatrophic nephrolithotomy [13]. These authors then performed anatrophic nephrolithotomy clinically in three patients [14].

The laparoscopic approach for removal of staghorn calculus can be used transperitoneally, as described by Mariano et al. [15]. We prefer the transperitoneal approach, as there is limited working space and difficulty in closing the pyelotomy with the retroperitoneal approach. Also, it is difficult to inspect the calculi due to the angle from which the calyces can be approached. Traditionally, stone surgery has been performed retroperitoneally to avoid contamination of the peritoneum with infected urine; these factors have to be considered when performing a transperitoneal approach. Both of our patients received preoperative antibiotics, and drainage of urine was minimized using suction to avoid spillage during the procedure. With this technique, watertight closure of the renal pelvis is necessary to avoid urine leakage in the peritoneum, which is a risk factor for abdominal pain. This watertight closure can be improved using robotic technology due to the advantages of the hand-simulating Endowrist, as described by Menon et al. [16].

Stone-free rates after surgical management vary depending of the procedure used, with success rates of 78% with percutaneous nephrolithotomy (PNL), 54% with ESWL, and 71% with open surgery. Nevertheless, the calculated rate for combination therapy is 66% [1]. In our study, both patients were stone free, corresponding to a rate comparable to that achieved in Menon's studies (100%) [16].

Conclusions

Robotic extended pyelolithotomy is a feasible, reproducible procedure for removal of complete staghorn calculi in those patients who have indications and are candidates for open surgery, with the advantages of a minimally invasive approach. This procedure is advantageous to achieve complete removal without calculi fragmentation or with the minimum number of fragments, in a single procedure avoiding large incisions to the renal parenchyma. Robot-assisted pyelolithotomy permits watertight closure, diminishing the risk for abdominal leakage. This procedure combines the advantages of a minimally invasive procedure with the effectiveness of traditional open surgery. Our initial experience has been eased by the use of robotic technology. Further publications are expected with larger series. If proven beneficial, this may further limit the role of open surgery for nephrolithiasis.

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