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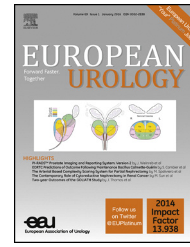

European Association of Urology

Surgery in Motion

Zero-fragment Nephrolithotomy: A Multi-center Evaluation of Robotic Pyelolithotomy and Nephrolithotomy for Treating Renal Stones

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Abstract

Background: Robotic pyelolithotomy (RPL) and robotic nephrolithotomy (RNL) may be utilized for treating kidney stones as an alternative to percutaneous nephrolithotomy or flexible ureteroscopy.
Objective: To describe the techniques of RPL and RNL, and present multi-center outcome data for patients undergoing these procedures.
Design, setting, and participants: This study was a retrospective analysis of 27 patients undergoing RPL and RNL at five tertiary academic institutions between 2008 and 2014.
Surgical procedure: RPL and RNL without use of renal ischemia.
Measurements: We assessed stone clearance by visual assessment and postoperative imaging. We also examined other factors, including complications (Clavien grade), estimated blood loss, operative time, and length of stay.
Results and limitations: Twenty-seven patients underwent 28 procedures for a mean renal stone size of 2.74 cm (standard deviation: 1.4, range: 0.8–5.8). The mean stone volume was 10.2 cm^3. RPL accounted for 26 of these procedures. RNL was performed in one patient, while another underwent combined RPL-RNL. Indications included failed previous endourological management (13), staghorn calculi (five), gas containing stone (one), calyceal diverticulum (one), complex urinary tract reconstruction (two), and patient preference (four). The mean patient age was 35.6 yr and mean body mass index was 25.5 kg/m^2. Mean operative time/console times were 182 min and 128 min, respectively. The mean estimated blood loss was 38 ml. The mean length of stay was 1.7 d. There was no significant change in preoperative and postoperative serum creatinine levels. The overall complication rate was 18.5% (Clavien 1 = 3.7%; 2 = 7.4%; 3b = 7.4%). The complete stone-free rate was 96%.
Conclusions: RPL and RNL are safe and reasonable options for removing renal stones in select patients. In particular, RPL allows the removal of stones without transgressing the parenchyma, reducing potential bleeding and nephron loss.
Patient summary: The robotic approach allows for complete removal of the renal stone without fragmentation, thereby maximizing chances for complete stone clearance in one procedure.

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1. Introduction

Percutaneous nephrolithotomy (PCNL) is the standard of care for the management of large renal stones greater than 2 cm in size [1]. Contemporary multi-institutional registry data demonstrates that stone-free rates (SFR) for nonstaghorn and staghorn stones treated with PCNL range from 77% to 83%, and 33% to 57%, respectively [2,3]. Common complications from PCNL include postoperative fever (8.7–14.8%), bleeding (7.8%), sepsis (0.9-4.7%), blood transfusion (5–18%), and hydrothorax (2%) [2,4–6]. Recent studies have revealed that retreatment rates after PCNL can be as high as 30–40% in patients with residual fragments (RF) [7,8].

Open nephrolithotomy may be considered when the stone cannot be removed by a reasonable number of less invasive procedures. Patients in this group include those with extremely large staghorn calculi, unfavorable collecting system anatomy, extreme morbid obesity, and skeletal abnormalities [9]. However, open surgery is rarely performed for stones in the modern era, and instead laparoscopic approaches are utilized as alternatives to PCNL. In a meta-analysis comparing laparoscopic pyelolithotomy with PCNL, laparoscopy had significantly lower rates of bleeding and sepsis, as well as a trend towards a higher SFR [10]. More recently, robotic pyelolithotomy (RPL) and robotic nephrolithotomy (RNL) have been shown to be safe and feasible options for removing large renal stones in toto as a single specimen, without stone fragmentation [11–13]. Compared with a pure laparoscopic approach, RPL and RNL may have advantages of improved dexterity for suturing and reconstruction. With robotics or laparoscopy, the lack of fragmentation limits the risk of RFs, and may have long-term benefits in avoiding surgical retreatment.

Previous reports of RPL and RNL have been limited to small studies from single institutions [3,12,13]. The purpose of our study is to evaluate patient outcome data for RPL and RNL from a multi-center collaborative of robotic surgeons, and evaluate its efficacy and safety. We also describe the technique with an accompanying video in this article, including tips and tricks for successful surgery.

2. Material and methods

We performed a retrospective review in five surgical centers performing robotic renal surgery for stone disease (Ann Arbor Veterans Affairs Hospital, Ann Arbor, MI, USA; Wake Forest Baptist Hospital, Salem, NC, USA; Henry Ford Health System, Detroit, MI, USA; Medical College of Georgia, Augusta, GA, USA; Mount Sinai Hospital, New York, NY, USA). The institutional review boards of all centers approved retrospective data collection; data were collected on 27 patients undergoing RPL and RNL performed by K.R.G., R.M., A.H, J.S.E., and K.B. from 2008 to 2014. Only procedures without the use of renal ischemia were included in this series. Patients with intrarenal pelvis are not suitable for RPL, and were excluded for surgical consideration. One center from our group has already published results of robotic anatrophic nephrolithotomy using renal ischemia, and are not included in this series [12]. Procedures were performed using either a transperitoneal or retroperitoneal approach. The approach was based on surgeon preference or stone location. Posterior stones are suitable for a retroperitoneal approach.

2.1. Surgical technique

2.1.1. Patient preparation

Patients undergoing transperitoneal RPL were instructed to be on a clear liquid diet the day prior to surgery. No bowel preparation was needed for retroperitoneal surgery. All patients received a preoperative type and screen.

2.1.2. Patient positioning

Procedures performed transperitoneally utilized a standard robotic approach for kidney surgery. Patients were positioned in the lateral decubitus position with the affected side up. For the retroperitoneal approach, the patient is placed in the full flank position with the table fully flexed to increase the space between the 12th rib and iliac crest. The spine and hip is positioned in a straight line. In both approaches, the dependent arm is padded and secured to an armrest, which is tilted towards the head as much as possible to avoid clashing with the robotic arms.

2.1.3. Port placement

Transperitoneal: A 12-mm camera port is placed lateral and superior to the umbilicus and three 8-mm robotic working ports were placed under direct vision in the ipsilateral upper quadrant, lower quadrant, and lateral abdomen. A 12-mm assistant port is usually placed close to the midline, midway between the camera port and the robotic ports. Some centers used a fourth robotic arm port to aid with retraction of the kidney and exposure of the renal pelvis and hilum.

Retroperitoneal: The camera port is placed above the iliac crest, lateral to the triangle of Petit. A 12-mm incision is made in this area, and the lumbodorsal fascia pierced to enter the retroperitoneal space. A balloon-dilating device (OMSPDBS2; Covidien, Mansfield, MA, USA) is inserted and expanded under direct vision using a 30° laparoscope. This is swapped for a 12-mm camera port for the robotic camera. Two 8-mm robotic ports are inserted, the first being above the erector spinae muscles just under the 12th rib, and the second port 7–8 cm superior and medial to the camera port. A 12-mm assistant port is placed in the anterior axillary line cephalad to the anterior superior iliac spine, and 7–8 cm caudal to the medial robotic port.

2.1.4. Docking

For transperitoneal surgery, the patient side-cart is docked in a 30–45° angle from the flank as per standard for robotic renal surgery. For retroperitoneal surgery, the side-cart is docked over the patient's head parallel to the spine.

2.1.5. Instruments

Robotic instruments include monopolar shears, monopolar hook, bipolar fenestrated grasper, Prograsp forceps, and needle drivers. We also recommend use of a robotic ultrasound probe (Hitachi Aloka, Wallingford, CT, USA) and availability of a flexible nephroscope.

2.1.6. Surgical dissection

Transperitoneal: The kidney is mobilized and the renal hilum exposed in a similar fashion as for robot-assisted partial nephrectomy. While we do not clamp the vessels, it is important to have the renal vessels exposed in case of the need to clamp due to excessive bleeding at the time of the nephrotomy incision. After hilar dissection, the renal pelvis is dissected and mobilized being careful to protect the upper ureter and avoid excessive mobilization.

Retroperitoneal: The Gerota's fascia is incised just above the psoas muscle, exposing the perinephric fat and the kidney. Dissection is then carried out along the psoas muscle, elevating the kidney and perinephric fat until the hilum and renal pelvis is encountered.