Robotic Laparoscopic Pyeloplasty

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ABSTRACT

Background and Objectives: We aimed to assess the feasibility and outcomes of complex ureteropelvic junction obstruction cases submitted to robotic-assisted laparoscopic pyeloplasty.

Methods: The records of 131 consecutive patients who underwent robotic-assisted laparoscopic pyeloplasty were reviewed. Of this initial population of cases, 17 were considered complex, consisting of either atypical anatomy (horseshoe kidneys in 3 patients) or previous ureteropelvic junction obstruction management (14 patients). The patients were divided into 2 groups: primary pyeloplasty (group 1) and complex cases (group 2).

Results: The mean operative time was 117.3 ± 33.5 minutes in group 1 and 153.5 ± 31.1 minutes in group 2 ($P =$ .002). The median hospital stay was 5.19 ± 1.66 days in group 1 and 5.90 ± 2.33 days in group 2 ($P =$ .326). The surgical findings included 53 crossing vessels in group 1 and 5 in group 2. One patient in group 1 required conversion to open surgery because of technical difficulties. One patient in group 2, with a history of hemorrhagic rectocolitis, presented with peritonitis postoperatively due to a small colonic injury. A secondary procedure was performed after the patient had an uneventful recovery. At 3 months, significant improvement (clinical and radiologic) was present in 93% of cases in group 1 and 88.2% in group 2. At 1 year, all patients in group 2 showed satisfactory results. At a late follow-up visit, 1 patient in group 1 presented with a recurrent obstruction.

Conclusions: Robotic pyeloplasty appear to be feasible and effective, showing a consistent success rate even in complex situations. Particular care should be observed during the colon dissection in patients with previous colonic pathology.

Key Words: Robotic assisted, Laparoscopy, Ureteropelvic junction obstruction, Secondary pyeloplasty.

INTRODUCTION

The traditional gold standard for the management of ureteropelvic junction obstruction (UPJO) used to be open pyeloplasty,[1–3] but in the minimally invasive era, novel approaches have become apparent alternatives to UPJO management.[4] In addition, in recent years, laparoscopic pyeloplasty has been moving rapidly toward replacing open surgery as the gold standard in the treatment of UPJO.[5]

Both the classic open approach and the minimally invasive options usually present good outcomes in favorable clinical situations (ie, normal renal anatomy and no previous UPJO operations); however, the presence of anomalous anatomy or failure after a primary attempt to manage these patients is always a concern, and dealing with these cases mandates a careful evaluation of the best technique for performing the procedure.

Classically, an open approach has been one of the preferred options in the aforementioned scenarios, but in the current urologic armamentarium, laparoscopic pyeloplasty has also been described as an option in the presence of complex anatomic cases[6–8] or after a failed attempt to manage UPJO.[9–12]

Although a laparoscopic approach seems to be a good and viable alternative for patients with UPJO, the learning curve for this procedure is steep, with some authors suggesting that a minimum of 50 surgical procedures with a high degree of complexity, performed for 1 year, with at least 1 procedure per week, is necessary to master the skills for this procedure.[13] In the presence of a recurrent UPJO, this procedure can be even more challenging and technically demanding.[11,14]

With the advent of robotic technology, the learning curve may be reduced. Moreover, nowadays, robotic techniques

have gained popularity, and a number of studies evaluating robotic pyeloplasty are currently available indicating favorable outcomes[15–17] even in the presence of challenging anatomic findings.[18] There are only a few studies showing the feasibility and outcomes of the robotic technique in a challenging scenario, including previously managed UPJO patients[19–22] or patients with anatomic anomalies.[8,18,20,22] Therefore we evaluated our experience using the da Vinci Surgical System (Intuitive Surgical, Sunnyvale, California) as an alternative for surgically managing UPJO in patients with either anatomic abnormalities or a recurrent obstruction after a previous procedure.

MATERIALS AND METHODS

From November 2001 through May 2009, 131 consecutive patients underwent robotic transperitoneal laparoscopic pyeloplasty at our institution. The procedures were all performed by a single surgeon (J.H.) using the da Vinci Surgical System.

Among the initial patient population, 17 cases were considered complex, consisting of either atypical anatomy (3 patients) or a history of UPJO management (14 patients).

The cases of atypical anatomy included 3 patients, 2 men and 1 woman (mean age, 44.6 years), presenting with UPJO in a horseshoe kidney. The 14 remaining patients, 3 men and 11 women (mean age, 46 years), had already been managed previously for the UPJO; the initial procedures performed were antegrade endopyelotomy (1 patient), an open subcostal approach (2 patients), an open retroperitoneal approach (lombotomy) (8 patients), and an open approach followed by antegrade and/or retrograde endopyelotomy (3 patients). Concomitant urinary stones were present in 6 patients (2 with atypical anatomy and 4 with a previous approach).

The patients were divided into 2 groups: primary pyeloplasty (group 1) and complex pyeloplasty (group 2). The variables examined included the operative time, estimated blood loss, length of hospital stay, and success rate.

The protocol before robotic-assisted laparoscopic dismembered pyeloplasty consisted of a confirmation of the diagnosis by intravenous urography (IVU) with furosemide and mercaptoacetyltriglycine (MAG3) renography to assess the degree of obstruction and level of renal function. The evaluation also included systematic multislice computed tomography, performed by the same radiologist, to assess the renal anatomy and identify the inferior polar crossing vessels. Computed tomography studies showed the presence of a polar pedicle crossing the anterior aspect of the UPJO in 53 patients in group 1 (46.5%) and 5 patients (29.4%) in group 2. Informed consent forms were obtained from all patients before surgery.

The standard indications for surgical intervention in patients presenting with UPJO were maintained in our series and included the presence of infection, recurrent stone formation, progressive loss of renal function, and relief of symptoms.

An Anderson-Hynes dismembered pyeloplasty technique with a transabdominal approach was applied in all patients. The patients were rolled into a dorsal decubitus position, with rotation of the operative side up by 45° axially using silicone pads underneath the patients and table tilting, leading to a semilateral decubitus position.

Potential pressure points were protected to prevent nerve compression injuries. A Foley catheter was inserted and clamped. The patients underwent a full preoperative urine analysis to exclude the possibility of infection, so prophylactic antibiotics were not given. After the creation of a pneumoperitoneum with a Veress needle on the left side (or use of an open approach for the right side or in the case of a previous transabdominal approach), 4 trocars were inserted. Two 8-mm ports (Intuitive Surgical) for the robotic arms were placed on the midclavicular line, subcostally, and in the iliac fossa; a 12-mm port (Ethicon Endo-Surgery, Albuquerque, New Mexico) was placed at the mid distance of the 2 previous ports and slightly laterally for the 0° camera; and an accessory 12-mm port (Ethicon Endo-Surgery) was created on the umbilicus for the assistant surgeon. All cases were performed by use of this same setting; no changes were necessary for the horseshoe kidney cases.

After inspection of the peritoneal cavity, by use of a bipolar forceps in the left hand and an electrocautery hook in the right hand, the posterior peritoneal reflection was incised and the colon reflected medially, with care taken not to directly manipulate the bowel with the grasper, so that the Gerota fascia could be dissected to locate the UPJO. The renal pelvis was transected with articulated scissors, and after excision of the redundant pelvis and the stenosed ureteric segment, the ureter was spatulated on its lateral side. In the 6 cases with pelvic or calyceal stones, the stones were extracted with the robotic instruments and/or an additional fibroscope introduced through the accessory port. In the case of an inferior pedicle, the ureter was uncrossed. By use of 2 microforceps, the posterior aspect of the pelvi-ureteric anastomosis was created with a No. 6–0 absorbable running suture. An 8-French, double-J, 28-cm stent was introduced in an

antegrade manner through the assistant's umbilical port over a hydrophilic guidewire (Terumo Medical Corporation, Tokyo, Japan); this was facilitated by the presence of a full bladder. After placement of the ureteric catheter, the bladder was emptied by use of the Foley catheter. The correct positioning was thought to be achieved distally when maintaining 4 to 5 cm in the renal pelvis.

The anterior aspect of the anastomosis was then completed. The suturing time was not recorded, but it is typically <45 minutes, including placement of the double-J stent.

After completion of the anastomosis, the peritoneal layer was closed with a No. 3–0 absorbable running suture to retro-peritonealize the urinary anastomosis. A suction drain was left in place in the first patient in this series. We had routinely used drains during our initial experience with this surgery (until case 7 among the 131 operated patients). After this initial experience, no drains were left in the following patients. The operative duration was defined from the initial port incision to the closure of all laparoscopic ports. The docking time for the robot was typically <20 minutes.

Patients were scheduled for follow-up at 4 to 6 weeks for stent removal with clinical examination and IVU/MAG3 scan at 3 and 12 months. A case was considered unsuccessful in the presence of either an obstructed ureteropelvic junction confirmed by a radionuclide diuretic renogram (MAG3), with a T1/2 >20 minutes, or recurrence of symptoms at clinical follow-up visits.

The Student t test was used to compare the groups' characteristics, with statistical significance indicated at $P < .05$.

RESULTS

All procedures were completed successfully with no need for conversion to open surgery. In some patients with a previously managed UPJO, a difficult dissection of the UPJO was present because of local fibrosis. The mean operative time was 117.3 ± 33.5 minutes in group 1 and 153.5 ± 31.1 minutes in group 2 ($P = .002$). The estimated blood loss was negligible (<100 mL) in all cases.

One patient in group 1 required conversion to open surgery because of technical difficulties (the 20th patient of the series). There were no perioperative complications except in 2 patients, 1 in each group. One patient in group 2, previously operated on with an open pyeloplasty and with a history of hemorrhagic rectocolitis, presented with signs of peritonitis on postoperative day 7, caused by a

small colonic injury during colonic manipulation and dissection during the initial portion of the procedure. This was resolved surgically, and the patient's recovery was uneventful after the procedure. After the 1-year follow-up visit, a total colectomy was deemed necessary to control this patient's extensive bowel disease. One patient in group 1 presented with a small traumatic lesion of a vast dilated renal pelvis after insertion of the first trocar. This was noted at the beginning of the procedure; the tear was sutured primarily, and the operation proceeded without any further difficulties.

An episode of pyelonephritis occurred in 2 patients in group 1 and 1 patient in group 2. The patients were treated successfully with antibiotics before discharge.

Ten patients in group 1 and 6 patients in group 2 had associated renal stones. These were removed endoscopically with the robotic instruments and/or a flexible cystoscope introduced through the umbilical trocar. No additional lithotripsy was needed during surgery, but there were residual calculi in 2 of the patients, which were successfully treated later with shockwave lithotripsy.

The surgical findings included 53 crossing vessels in group 1 and 5 in group 2. No crossing vessels near the horseshoe kidneys were identified. The apparent causes for the recurrences in the remaining group 2 patients were persistence of crossing vessels (5 cases), the presence of fibrous tissue (7 cases), and high ureteral reimplantation (2 cases).

Nonsteroidal anti-inflammatory drugs yielded satisfactory analgesia for the patients, and no morphine derivatives were necessary during the hospital course except in 1 patient (group 2) who needed morphine derivatives for analgesia during the first day after surgery. Physical activity and oral intake were resumed on the day after surgery. The median hospital stay was 5.19 ± 1.66 days in group 1 and 5.90 ± 2.33 days in group 2 ($P = .326$).

In the patient with peritonitis, a secondary urinary leak also developed, which was successfully treated by a 3-month double-J stent left indwelling. There were no problems related to the stent removal in any of the patients.

All patients had a minimum follow-up period of 1 year; the medium follow-up period was 50.6 months. At 3 months, significant improvement (clinical and radiologic) was present in 93% of cases in group 1 and 88.2% in group 2. Clinical improvement was noted in 2 patients in group 2 (11.8%) but their IVU studies showed delayed urinary excretion. Renal scans were performed and showed no

obstruction at 1 year in these patients. Seven patients in group 1 have been lost to follow-up. At a late follow-up visit (50 months), 1 patient in group 1 presented with a recurrent UPJO. No recurrences were present in group 2.

DISCUSSION

UPJO is a frequent congenital anomaly of the upper urinary tract. A surgical approach is commonly required, and since the first report of successful operative management in 1891,[23] different curative techniques have been developed continually.[4] Although several procedures have been described, open pyeloplasty is still one of the practiced approaches and one of the alternatives for treatment.[1–3]

A quest for less invasive methods drove Schuessler et al[24] to describe the first laparoscopic pyeloplasty in 1993. Nowadays, laparoscopic pyeloplasty has been shown to be safe and effective,[5,9,25] with consistent and favorable results, challenging the open procedures as the gold standard in the treatment of UPJO.[5] New technology developments allowed a robotic procedure to be introduced, and recent series have also described this method as highly successful and reproducible.[16,17,26]

Although the diverse treatment modalities consistently present encouraging results, an ideal method with a faultless cure rate is still to be sought after. Despite the fact that they represent only a minority of patients, treatment failures still occur, and they represent challenging cases for the urologist, mainly because of fibrosis and adhesions in the previously operated location. In a similar fashion the presence of unusual anatomy could also present a challenge for the urologic surgeon.

Few studies have addressed the feasibility and outcomes of robotic pyeloplasty in challenging scenarios. One of those reports was published by Hemal et al,[21] applying robot-assisted laparoscopic pyeloplasty in 9 patients with previously failed open pyeloplasties. Comparably with our series, all patients in their report presented with favorable outcomes. Atug et al[19] also described their experience, evaluating 7 patients presenting with recurrent UPJO and comparing them with primary pyeloplasty patients in the same series. The outcomes were favorable in all cases, and no conversions to open surgery were needed.

Studies have also been performed evaluating a pure laparoscopic approach in challenging cases, and a long operative time was associated with redo laparoscopic pyeloplasties after failed primary open procedures. In a series

reported by Sundaram et al,[11] the mean operative time for such cases was 6.2 hours. Similarly, Clayman and colleagues[14] reported their experience of laparoscopic pyeloplasty in 4 patients with secondary UPJO, and the procedures were also somewhat lengthy (9.05 hours). Though still difficult, robotic assistance allows more precise and meticulous dissection of the anatomic structures in fibrotic conditions than standard laparoscopy.

Our operative time was 153.5 ± 31 minutes in group 2, including intraoperative stent placement; this was slightly shorter than the operative time described by Atug et al[19] (mean, 279.8 minutes; range, 230–414 minutes) but longer than that presented by Hemal et al[21] (106 minutes). Although direct comparisons with randomized double-blind studies are still not available, robotic assistance appears to reduce the operative time for this procedure.

Regarding anatomic abnormalities related to UPJO, Bove et al[6] have reported a series of 11 patients with upper urinary tract anatomic abnormalities including 5 horseshoe kidneys treated with a laparoscopic approach, presenting an operative duration of 195 minutes (range, 85–403 minutes) and a success rate of 91% for their cases. Our group pioneered the use of the laparoscopic robotic approach in these challenging anatomic cases,[18] describing a portion of the data that are presented in the current report. A similar technique was later reported by Pe et al[22] in a case report of a previously treated UPJO in a patient with a horseshoe kidney, also performed with the robotic technique. More recently, a laparoendoscopic single-site approach was also described as a viable access method for pyeloplasty in horseshoe kidneys in a report of 2 cases with a mean operative time of 187 minutes.[27]

In our series 16 patients had undergone successful concomitant stone removal and robotic pyeloplasty. Similarly successful attempts were described previously by Atug et al[28] in a series of 8 patients who underwent robotic-assisted laparoscopic pyeloplasty and stone extraction. In the same manner as in our technique, a flexible fibroscope was inserted through the trocar and applied to evaluate the renal pelvis and collecting system under direct vision. All patients in their series were rendered stone free after the procedure. In our series 2 patients presented with residual stones, but they were resolved after shockwave lithotripsy treatment. In a case report published by Nayyar et al,[29] the robot-assisted laparoscopic approach was applied in a patient with UPJO and a 1.3-cm urinary stone in an ectopic left kidney; Fenger pyeloplasty and stone removal were performed in 94 minutes in this case.

No intraoperative complications were recorded in the 2 robotic series previously published studying patients with unsuccessful primary UPJO management attempts.[19,21] In our study, 1 patient, with a history of hemorrhagic recto-colitis, presented with peritonitis 7 days after the procedure, needing a secondary surgical procedure. Though a rare event, this complication has been described before when a pure laparoscopic approach was performed.[25,30] Furthermore, the presence of hemorrhagic rectocolitis could potentially increase the local fibrosis and edema, rendering the colonic mobilization more technically demanding. Our patient had an uneventful recovery, and although he presented with initial urinary leakage, treated conservatively with the double-J stent, a good outcome was shown during his subsequent clinical evaluations.

In our study, diuretic renography and/or IVU at 3 months showed unobstructed drainage in 15 patients in group 2. The 2 remaining patients were re-evaluated at 12 months and showed normal renal function on renal scans, with no clinical complaints. Only 1 patient in group 1 presented with a late recurrence of UPJO. Our results are similar to other laparoscopic robotic series both in normal situations[15,17,26] and in challenging situations.[18–21]

Our study has some limitations because it is retrospective in nature; this is explained mainly by the low volume of patients with recurrent UPJO and/or anatomic abnormalities associated with UPJO, rendering a prospective study with these characteristics rarely accomplished.

CONCLUSIONS

Robotic pyeloplasty is feasible and effective in complex and challenging patients with irregular anatomy or recurrent UPJO after previous endoscopic and open surgical repairs. Our results are similar to previous reported series showing the reproducibility and safety of this method, which now presents as an excellent alternative to the traditional open surgical procedure even in difficult scenarios. Particular care should be observed in patients with previous colonic pathology because of an increased risk of surgical complications.

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