Robotic Reconstruction of the Upper Urinary Tract

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Purpose: Reconstructive surgery of the upper urinary tract can be complicated. During the last 2 decades minimally invasive techniques have emerged as viable options for these complex procedures. We reviewed our experience with robotic surgery for upper urinary tract reconstruction.

Materials and Methods: Between May 2002 and December 2006, a single surgeon performed certain robotic reconstructions on the upper urinary tract in 26 males and 37 females (65 renal units), including dismembered pyeloplasty, dismembered pyeloplasty with stone extraction, ureteroureterostomy, ureterolysis with omental wrap, ureterocalicostomy, ureteral reimplantation and upper pole nephroureterectomy. We compared demographic, preoperative, intraoperative and postoperative data on patients undergoing these various procedures.

Results: Across all cases mean blood loss was 125 cc, mean operative time was 244.8 minutes and mean length of stay was 2.8 days. The rate of radiographic and symptomatic improvement was 97.3% and 100%, respectively. We observed 2 major complications during a mean followup of 18.7 months.

Conclusions: Our data illustrate that robotics can be successfully and safely used for virtually any type of upper urinary tract reconstruction. Robotic techniques are a viable option for upper urinary tract reconstruction.

Key Words: urinary tract; robotics; reconstructive surgical procedures; surgical procedures, minimally invasive

In 1998 the da Vinci® surgical system was approved by the Food and Drug Administration for use in operating rooms and was initially used for laparoscopic cholecystectomy.[1] Since its introduction, other surgical specialties have used this system to aid in certain surgical reconstructions, including colectomy, liver resection, gastric bypass, cardiac surgery and microvascular surgery.[1–6] Urology has embraced this technology for radical prostatectomy and for pyeloplasty, which each involve complex reconstructive maneuvers.[1]

After observing the success of robotics in these procedures we began to use the da Vinci robot surgical system for all of our reconstructive procedures involving the upper urinary tract. We describe our experience with robotic upper urinary tract reconstruction, including what is to our knowledge the first report in the literature of robotic ureteral reimplantation, ureterocalicostomy and ureteroureterostomy in an adult. We were previously the first to report robotic ureterolysis with omental wrapping and robotic partial nephrectomy.[7,8]

MATERIALS AND METHODS

Between May 2002 and December 2006 a single surgeon (MS) performed certain robotic reconstructions on the upper urinary tract in 26 males and 37 females (65 renal units), including dismembered pyeloplasty, dismembered pyeloplasty with stone extraction, ureteroureterostomy, ureterolysis with omental wrap, ureterocalicostomy, ureteral reimplantation with and without a psoas hitch, and upper pole nephroureterectomy of an ectopic duplicated system. Preoperatively all patients had documented obstruction on a functional study. We retrospectively collected data and organized it based on demographic, preoperative, intraoperative and postoperative end points. We compared renal scans with furosemide washout and/or computerized tomography with intravenous contrast material before and after repair to determine radiographic success. We present a description of each technique. Robotic ureterolysis with omental wrap, robotic partial nephrectomy and robotic pyeloplasty with and without concomitant stone extraction were previously described.[7–9] Except for cystoscopy in certain cases, every case was performed entirely with the robotic surgical system.

Robotic Ureteroureterostomy

This was performed in a patient who had acquired a dense mid ureteral stricture due to previous endoscopic procedures to remove an impacted calculus.

The patient is initially placed in the dorsolithotomy position and cystoscopy with retrograde pyelography is performed to delineate the ureteral stricture. A 5Fr open ended catheter is inserted to the distal level of the stricture and then secured to an indwelling Foley catheter. The patient is repositioned, similar to that described by Wong and Leveillee for nephroureterectomy,[10] with the legs in the low lithotomy position and the torso in a modified flank position. Trocars are then placed in a configuration similar to that of robotic pyeloplasty and the robot is docked (fig. 1).[9]

The console surgeon reflects the colon medial, identifying and isolating the ureter using a combination of sharp and blunt dissection. If required, the previously inserted 5Fr open ended catheter is identified using an intraoperative ultrasound probe. The diseased, strictured portion of the

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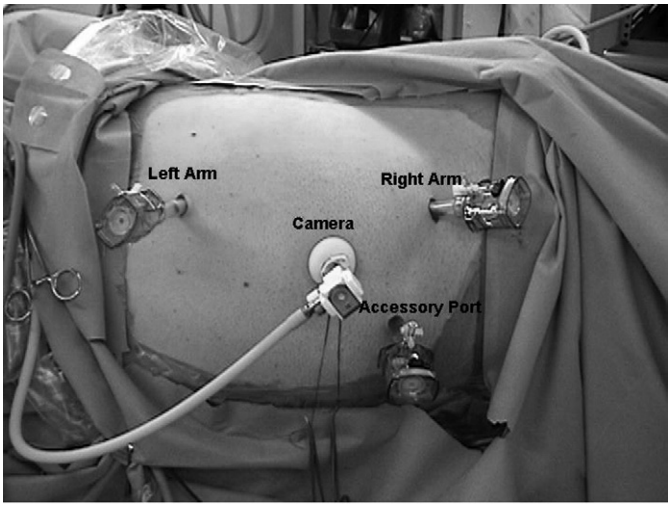

FIG. 1. Trocar configuration for robotic ureteroureterostomy

ureter is excised with Pott's scissors and the reanastomosis is initiated by placing 2 anchoring sutures medial and lateral between the 2 ureteral ends. If there is any evidence of tension on the anastomosis, the ureter can be further mobilized, the kidney can be mobilized inferior and fixed, a psoas hitch can be performed or a Boari flap can be created. After a tension-free anastomosis is confirmed the posterior wall is anastomosed in running fashion, as described by Hinman.[11]

After the posterior wall is complete a wire is placed through the ureteral 5Fr open ended catheter and this catheter is exchanged with a Double-J® stent under direct vision. The anterior anastomosis is now completed in running fashion. If available, omentum or a Gerota's fascia flap may be used to wrap the anastomosis.

Robotic Ureteral Transposition and Ureteroureterostomy

This was performed in a patient with a history of flank pain who had hydronephrosis secondary to a retrocaval ureter that was being compressed.

Patient positioning, trocar placement and robotic ureteral mobilization are similar to those described. The ureter is then isolated above and below the point where it crosses posterior to the vena cava and transected using Pott's scissors. The proximal and distal ends of the ureter are placed lateral to the vena cava. No attempt is made to dissect free the aberrant segment of ureter that remains posterior to the vena cava. Ureteroureterostomy is performed as detailed, including placement of the Double-J stent.

Robotic Ureteral Reimplantation

Three of the 4 patients presented with acquired distal ureteral strictures after gynecological surgeries and the other patient had a congenital ureteral stricture.

The patient is positioned in a fashion similar to that of robotic prostatectomy and a similar trocar configuration is used (fig. 2).[12] The colon is medialized, and the mid and distal ureter are dissected down to the level of obstruction. The ureter is transected just superior to the obstruction and spatulated using Pott's scissors. The bladder is then filled with 250 cc normal saline via the indwelling Foley catheter and mobilized, similar to transperitoneal prostatectomy.[13] In addition, the superior aspect of the contralateral bladder pedicle is clipped and divided. We currently perform a psoas hitch on all reimplants by suturing the posterior bladder wall to the psoas muscle with a 2-zero polyglactin suture after identifying and avoiding the genitofemoral nerve.

A small area of the bladder is isolated at the lateral dome and a 1.5 cm incision is made into the bladder mucosa using Pott's scissors. The bladder remains filled to help with this maneuver. With the bladder opened and the ureter spatulated an extravesical anastomosis is performed using 4-zero Monocryl® sutures in interrupted fashion, ensuring proper mucosal apposition.[14] The anastomosis is inspected to ensure no tension. A second anastomotic layer is performed with buttressing sutures between the serosa of the bladder and the adventitia of the ureter.

After completing the anastomosis the bladder is filled with 300 cc normal saline and the reimplant is inspected to verify that there is no leakage. At this point the robot is undocked and cystoscopy is performed to pass a Double-J ureteral stent into the reimplanted ureter under cystoscopic and laparoscopic guidance.

Robotic Ureterocalicostomy

This was performed in a patient with a proximal ureteral stricture secondary to numerous endoscopic procedures to clear his renal stones. He previously underwent endoureterotomy and balloon dilation of the strictured ureteral segment. The 2 procedures failed.

The patient is positioned similar to that described for ureteroureterostomy, while trocar placement is similar to that described for robotic partial nephrectomy.[8,10] The ureter is identified and isolated using a combination of sharp and blunt dissection. A Vessiloop™ is placed around the ureter to aid the side surgeon in performing atraumatic traction. Careful dissection is continued to free the ureter up to the area of fibrosis. The ureter is transected just below the level of the diseased segment. If present, an indwelling stent is removed robotically.

The ureter is then spatulated in preparation for the anastomosis. The renal hilum is isolated, the lower pole of the kidney is cleared of Gerota's fascia and an ultrasound probe is used to determine the level of the lower pole calix where the capsule is scored. A vascular clamp is applied to the renal artery to occlude it and lower pole transection is

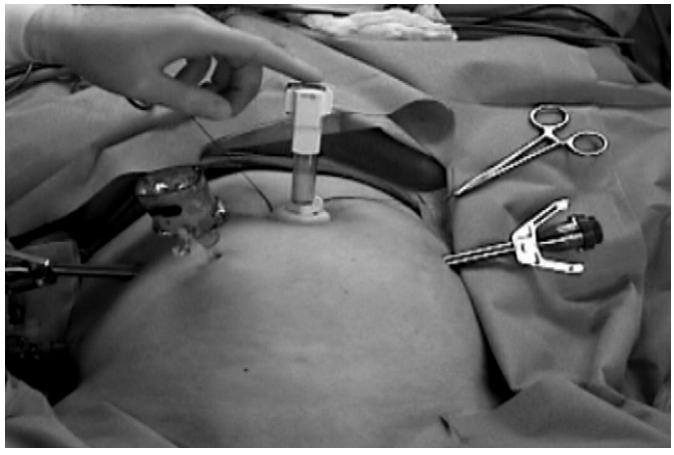

FIG. 2. Trocar configuration for robotic ureteral reimplantation