Ureteropelvic junction obstruction (UPJO) may develop spontaneously, or be the result of a familial genetic occurrence (Curhan, McDougall, & Zeidel, 2000; Taneja, Smith, & Ehrlich, 2001). Prenatal ultrasound testing now allows UPJO to be diagnosed in utero (Taneja et al., 2001). This awareness is enabling diagnoses of children at a younger age. Some children, however, may be asymptomatic and the condition may spontaneously resolve (Curhan et al., 2000). Adults may also be asymptomatic, but more often present with intermittent flank pain exacerbated by increased urine output associated with alcohol or caffeine consumption (Taneja et al., 2001). Less common presenting symptoms include hematuria, recurrent urinary tract infections, kidney stones, or hypertension (Curhan et al., 2000).

A crossing lower pole vessel(s), kinking of the ureter, formation of scar tissue around the kidney after surgery, or primary ureterovesical junction obstruction are all potential etiologies for the development of UPJO (Taneja et al., 2001). The actual cause of congenital UPJO is thought to be a dysfunctional section of a ureter (Curhan et al., 2000; Taneja et al., 2001). If any part of the ureter has ineffective peristalsis, urine can build up proximally, in the pelvis of the kidney (Curhan et al., 2000; Taneja et al., 2001). Over time this can lead to a dilation of the renal pelvis and ureter along with concurrent worsening of urine drainage from the renal pelvis (Curhan et al., 2000; Taneja et al., 2001).

Emergent treatment of UPJO requires placement of a ureteral stent or nephrostomy tube to allow for drainage of urine from the renal pelvis (Taneja et al., 2001). Before a patient considers pyeloplasty as a treatment option for UPJO, presenting symptoms, degree of obstruction, and concurrent medical problems should be assessed and analyzed. Having demonstrated similar results to open pyeloplasty with decreased morbidity (Klinger, Remzi, Janetschek, Kratzik, & Marberger, 2003), the surgical approach to the pyeloplasty procedure has moved to a laparoscopic minimally invasive approach (Mendez-Torres, Woods, & Thomas, 2005; Palese et al., 2005). The laparoscopic approach to pyeloplasty is best applied to cases involving intrinsic obstruction, high ureteral insertion, a redundant renal pelvis, or crossing vessel(s) (Gettman, Peschel, Neururer, & Bartsch, 2002). Laparoscopic pyeloplasty has comparable success rates with open pyeloplasty techniques (Bauer et al., 1999); however, the steep learning curve, and complexity of laparoscopic suturing make this a difficult procedure to...
master (Eichel, Ahlering, & Clayman, 2004; Klinger et al., 2003). These difficulties with the laparoscopic approach to pyeloplasty have led to the use of robotic surgical technology to assist in performing this procedure.

Benefits of Robotic Technology

Robotic surgical technology is rapidly being applied to many different procedures across many different surgical specialties. Robotic technology use in urology was first used in the early 1990s, when a robotic arm was used for transurethral resection of the prostate (Allaf, Patriciu, Mazilu, Kavoussi, & Stoianovici, 2004). Urologic use of robotic surgical technology has expanded since then. Because of the development of master-slave robotic surgical systems that require direct input from surgeons to function (Eichel et al., 2004), more and more surgeons at increasing numbers of sites are using robotic technology to perform procedures. For example, in our practice at the University of Iowa Hospitals and Clinics, robotic urologic cases increased by almost 30% between 2003 and 2004.

Performing a pyeloplasty by a laparoscopic approach has several benefits for the patient and surgeon (see Table 1). The pelvis of the kidney can be better visualized with the 10 to 12 time magnification capabilities of a laparoscopic endoscope system. The surgical approach through several small incisions, each approximately ten millimeters, rather than a much larger open incision, decreases the amount of surgical trauma the patient has to recover from and generally results in a better cosmetic outcome. Decreasing the amount of surgical trauma is also beneficial in terms of shorter hospital stay, quicker return to pre-procedure activities of daily living, decreased pain, and a potentially better postoperative immune function (Hanly et al., 2004; Lanfranco, Castellanos, Desai, & Meyers, 2004). Robotic surgery provides all the benefits of a laparoscopic approach, as well as (a) the computer in a robotic surgical system can filter out the physiologic hand tremor humans experience, (b) robotic instruments provide more degrees of freedom (six degrees of freedom + grip) of movement than lap instruments (four), (c) robotic surgical movement can be scaled to provide better control for microsurgery, and (d) robotic surgical systems currently on the market provide for three-dimensional vision (Lanfranco et al., 2004). All of these benefits directly relate only to the surgeon at this time. Further research is needed to identify clinical outcomes and potential benefits for patients undergoing robotic-assisted laparoscopic pyeloplasty (LRP) procedures.

### Table 1.
Benefits of Laparoscopic Approach to Pyeloplasty and Robotic Assistance

<table>
<thead>
<tr>
<th></th>
<th>Physician</th>
<th>Patient</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Laparoscopic Benefits</strong></td>
<td>1. Better visualization with magnification capabilities of a laparoscopic endoscope system</td>
<td>Four incisions of ≤1 centimeter, rather than a larger open incision facilitates:</td>
</tr>
<tr>
<td></td>
<td>2. Some tactile feedback</td>
<td>1. Shorter hospital stays.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Quicker return to pre-procedure activities of daily living.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Decreased pain.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. Potentially improved postoperative immune function.</td>
</tr>
<tr>
<td><strong>Robotic Benefits</strong></td>
<td>1. Improved ergonomics</td>
<td>1. Robotic pyeloplasty has been demonstrated to be safe and equivalent to open pyeloplasties.</td>
</tr>
<tr>
<td></td>
<td>a. Surgeon sits</td>
<td>2. Research needs to be done to demonstrate specific positive outcome claims such as decreased length of stay, decreased complication rates, cost effectiveness.</td>
</tr>
<tr>
<td></td>
<td>b. Fulcrum effect of laparoscopic instruments overcome by robot</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Improved dexterity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>a. Physiologic hand tremor filtered out</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b. Robotic instruments provide more degrees of freedom (6 + grip) of movement than lap instruments (4)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Motion scaling</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Three-dimensional vision possible</td>
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</tbody>
</table>

Pre-operative preparation.

Pre-operative preparation of a
patient for robotic surgery involves education regarding the robot and why the surgeon is using it. Informed consent should include all important information for laparoscopic pyeloplasty surgical procedure, including the possibility of the need to convert to an open procedure. Informed consent should also document that the use of the robotic surgical system was discussed with the patient. This follows standard protocols followed for more complicated medical devices such as lasers.

Blood should be drawn and sent for a basic metabolic screen and hemogram, along with a blood type and screen; in some instances, specific patient health concerns may warrant a full blood type and cross match. Patient preparation for a LRP procedure should start 24 hours before surgery with initiation of a clear liquid diet. In the early evening, a bisacodyl (Dulcolax®) suppository should be administered. The patient should be instructed to have nothing to eat or drink after midnight. Pre-operative orders should be written for antiembolism stockings and prophylactic antibiotics.

**Intraoperative considerations.**

A master-slave robotic surgical system requires pre-operative time to set up and drape, in preparation for use. At the University of Iowa, the surgical arm cart is draped and covered before the patient comes into the operating room. This helps prevent accidental contamination of sterile items, and prevents unnecessary anesthesia time for the patient. Orienting, and training staff to the robotic system, requires time and multiple exposures. Maintaining staff competency requires frequent cases, or reorientation sessions with a robotic system.

**Operative technique.** The patient is transferred from the transport cart onto the operating table. The patient should be positioned supine for induction of anesthesia. Before transferring the patient, pads of the operating table should be secured in some fashion to prevent shifting of the patient when the operating table is rolled (during the procedure). After induction of anesthesia, flexible cystoscopy is performed for insertion of a 5-French open-ended ureteral catheter over a guide wire which is either placed de novo or through an indwelling Double-J® ureteral catheter. The guide wire is then replaced by a super stiff wire. A urinary catheter is placed through the urethra alongside the ureteral catheter. The patient is placed in a modified decubitus position with minimal hyperextension at the level of the anterior superior iliac spine. A beanbag vacuum pac helps to secure the patient in a lateral decubitus position. The patient should be positioned in a secure fashion, padding all pressure points. The urinary catheters should be secured to the patient’s thigh and prepped into the operative field. The patient’s operative side arm should be positioned as low to the operating table, and as high toward the head, as can be safely done for the patient. Securing the patient’s arm with an elastic wrap to a well-padded arm support helps accomplish proper arm placement. To help maintain an adequate core body temperature, a warming blanket designed for upper-body use can be placed over the shoulders, arms, and upper chest. Careful attention must be paid to the position of the operating table in relation to overhead lights or other equipment that might interfere with moving the robotic system up to the operating table, or movement of the robotic operating arms once the system is in place. Robotic setup guides or photographs can be very useful in accomplishing this positioning (see Figure 1).

Port placement is one of the most crucial steps in robotic surgery (Hemal, Eun, Tewari, & Menon, 2004). Accurate placement of the robotic arm ports in relation to the telescope/camera port and the surgical anatomy is essential in providing collision-free, adequate access to the surgical site. For example, the robotic surgical system used in our operating room requires alignment of the center pedestal of the surgical arm cart with the surgical anatomy and the camera arm in a straight line. This provides for the direct triangular viewing of the surgical site. In the pyeloplasty procedure one must account for the pelvis of the kidney being slightly rotated caudally. To correct for this in positioning of the surgical arm cart, the operating table can be rotated 30 to 50 degrees with the foot away from the surgical arm cart (see Figure 1).

A transperitoneal approach to the ureteropelvic junction (UPJ) is used at our institution. A laparoscopic Surgineedle®, to deliver carbon dioxide (CO₂), is placed in the lower abdomen lateral to the rectus muscle (mid-clavicular line), rather than in the usual subcostal position. This location is used in patients with UPJO to avoid puncturing the often significantly hydronephrotic kidney. Pneumoperitoneum is created with CO₂, to a pressure of 15 mmHg. Four ports are used for the robotic pyeloplasty (see Figure 2). A 12-mm disposable camera port is placed at the umbilicus for the robot telescope/camera. A 10-mm disposable trocar for retraction and suture passing is placed in the suprapubic midline. Finally, two 5 or 8-mm nondisposable robotic ports are placed in the midclavicular line. These ports should be placed at least four to five fingerbreadths away from the peri-umbilical telescope/camera port. The size of these ports is dependant on the patient’s age, size, and surgeon instrument preference.

At the University of Iowa, the dissection of the UPJ is performed with conventional laparoscopic instruments and tech-
niques. However, it is certainly feasible to use a robotic surgical system to perform this dissection. For obese patients, the camera and working ports are shifted laterally. The colon and its mesentery are reflected medially. The gonadal vein is dissected and ligated if necessary. With wiggling of the end hole ureteral catheter, the ureter is quickly identified and dissected to the renal pelvis, paying close attention to crossing vessels, which are preserved. The renal pelvis is mobilized along with the ureter.

For dismembered pyeloplasty, the UPJ is transected, excised, and submitted to pathology. The ureter is then brought to the anterior side of the crossing vessels, spatulated laterally, and any redundant renal pelvis is excised. At this time the robotic surgical system is brought up to the patient’s side. Robotic assistance is used for the reconstruction, essentially replicating the conventional approach. The anastomosis is completed with simple interrupted sutures, using the robotic needle drivers. If no crossing vessels are present, either a flap (Scardino-Prince) (Scardino & Prince, 1953) or Fengerplasty technique (Kim & Jarrett, 2004) are options. The same robotic suture technique is used in both these procedures.

For both techniques, prior to completion of the reconstruction, the end hole ureteral catheter is removed and a Double-J® ureteral stent is advanced over the wire transurethrally under direct laparoscopic visualization. A 0.5-inch Penrose drain is placed through the port site at the anterior axillary line. All other port sites are closed using the Carter Thomason Closure® device. Flexible cystoscopy is repeated to confirm stent placement and the urinary catheter is also replaced.

Postoperative care. Postoperative care of the robotic pyeloplasty patient does not differ from the care given to a patient.
undergoing a traditional laparoscopic pyeloplasty.

In the first 48-hour postoperative period, output from both the urinary catheter and the Penrose drain should be measured and recorded. Any change in color to this output indicating bleeding or infection should be reported. Pain control should be a priority. Besides being unpleasant for the patient, pain is likely to cause a patient to breathe less deeply and to ambulate less. Anti-embolic stockings should be worn, but ambulation encouraged as well as incentive spirometry. Clear fluids should be encouraged starting as soon as bowel sounds return, and diet advanced as tolerated on postoperative day 1. Patients should be educated about possible residual CO₂ in their abdomen; while CO₂ may lead to an uncomfortable distended feeling and possible shoulder pain, the body will soon harmlessly absorb the gas. To minimize retrograde transmission of intravesical voiding pressure along the Double-J ureteral stent to the fresh anastomosis, the urinary catheter is left in place until postoperative day 2. The patient can be discharged, with the Double-J ureteral stent in place, on postoperative day 2, after removal of the urinary catheter. The Penrose drain is left in until the 5th postoperative day so as to drain any delayed leakage of urine at the reconstruction site, as edema of the renal pelvic and ureteral tissue subsides, thus potentially loosening sutures.

**Care and Instructions for Discharge to Home**

Discharge education should include any potential complications that could arise and what the patient should do about them. Instructions on care of the incision sites and surgical drain should include not showering/bathing for 3 days, not soaking the incisions sites in any manner in water for 2 weeks, and keeping a gauze or pad over the drain site. The patient should be instructed to report signs of redness; swelling; green/yellow, bright red, or foul-smelling drainage; and/or intense heat at the incision sites as well as a persistent fever higher than 100.4 degrees Fahrenheit or an increase in pain. The patient should be shown how to change the dressing on the drain site, and return a demonstration of understanding these instructions. Education should be provided in verbal and written form, including telephone numbers to call for questions and emergency. If possible, the patient should have a caretaker present for any home care instructions. Prescriptions for pain medication, stool softener, and a laxative of choice, if needed, should also be provided. Education regarding use of over-the-counter pain medications should be provided regarding type, timing of use, dosage, concurrent use with prescription pain medications, and optimum schedule for best pain control. The patient should be reminded not to operate any heavy machinery while taking narcotic pain medication. Instructions for restricted lifting (nothing over 10 pounds),

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**Figure 2.**

Robotic Pyeloplasty Port Sites and Size

Diagram for a left robotic-assisted laparoscopic pyeloplasty, 8-mm ports are special robotic ports.
exercise, and strenuous activity should be given, and the patient educated to follow these for the next 3 weeks. A followup appointment should be scheduled for postoperative evaluation and removal of the Penrose drain at approximately the 5th postoperative day.

Postoperative Followup Care

Assessment of the patient on postoperative day 5 should include estimation of daily output from wound drain, surgical incision site appearance, and pain levels. The Penrose drain is removed at this time. Patients should be reminded of restrictions to lifting (nothing over 10 pounds), exercise, and strenuous activity for the next 2 weeks. They should also be reminded to report signs of separation, redness, swelling, green/yellow, bright red, or foul-smelling drainage, and/or intense heat at the incision sites as well as a persistent fever higher than 100.4 degrees F, or a sharp increase in pain.

Patients are asked to return for removal of the Double-J ureteral stent 4 weeks postoperatively. At this time the first postoperative Lasix® renogram is scheduled for 7 weeks postoperatively. Obtaining a Lasix renogram demonstrates functionality of the kidney, rather than providing only a picture of the patient’s anatomy, and can demonstrate any current obstruction occurring in the kidney or ureter. Patients should be assessed for successful return to pre-operative activities of daily living, including work. If the patient’s work requires heavy lifting, it may be necessary to postpone his return to work for an additional 4 weeks following removal of the Double-J ureteral stent.

Conclusions

Using robotic technology to tailor the ureter and perform the anastomosis for a robotically assisted LRP procedure enables a surgeon to overcome the steep learning curve for laparoscopic surgical skills, and the complexity of laparoscopic suturing. Thus, patients can receive all the benefits of minimally invasive surgery, while the surgeon avoids the difficulties of laparoscopic techniques.

Nursing personnel involved in pre-operative care of the patient undergoing LRP should be knowledgeable about the reasons a robotic surgical system is being used. This will enable them to educate the patient, and answer some of the questions a patient might have about what to expect with robotically assisted procedures. Nursing personnel involved in intraoperative care of the patient undergoing LRP must be experts in set up, care of, and troubleshooting the robotic surgical system. They must also have expertise in the care and handling of robotic instrumentation. Nursing care must adapt to the shorter hospital stays patients have with minimally invasive surgical procedures.

Future research is needed regarding cost effectiveness and other clinical outcomes associated with minimally invasive surgical procedures such as LRP. Success with the robotic surgical approach will encourage more surgeons to perform minimally invasive procedures, thus benefitting a wider patient population.

References


