Robotic-Assisted Lower Genitourinary Tract Reconstruction

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KEYWORDS

• Robotic surgery • Lower tract • Reconstruction • Bladder • Urethra • Stricture • Urinary diversion

KEY POINTS

- Reconstruction of the lower urinary tract (LUT) is amenable to robotic approaches for several reasons including improved access to the deep pelvis, ability to perform concurrent procedures, and improved clinical outcomes while maintaining a minimally invasive approach.
- Several approaches have been described for robotic-assisted repair of complex posterior urethral strictures or bladder neck stenosis including Y-V plasty, buccal grafting, and Tanagho flap.
- While the learning curve for intracorporeal robotic-assisted urinary diversions is steep, mastery of the technique may lead to superior clinical outcomes.
- Various forms of robotic-assisted ureteral reimplantation and associated adjunct procedures produce durable results in both adults and children with minimal morbidity.
- Many of the previously described techniques for rectourethral fistula repair are amenable to a robotic approach, which facilitates both fistula takedown and harvesting/grafting of various flaps.

INTRODUCTION TO ROBOTIC-ASSISTED LOWER TRACT RECONSTRUCTION

Reconstruction of the lower urinary tract (LUT) poses unique challenges, such as narrow working spaces with limited mobility, poor blood supply to various parts of the urinary tract, and few reconstructive options based on disease pathology. Before the advent of laparoscopy, the LUT posed a therapeutic challenge, as our treatment algorithm was limited to endourologic or largely open surgical interventions.

Laparoscopy introduced a minimally invasive technique as an alternative to open reconstruction in challenging cases involving complex pathology. Robotic surgeries have been shown to decrease mortality, reduce postoperative pain, shorten hospital stay, and often have equivalent or improved clinical outcomes based on the pathology. The adoption of robotics has also led to tremor reduction, finer control, less blood loss, and shorter hospital stay.[1]

The most widely disseminated robotic-assisted surgical platforms to date are those using multiple instrument arms, and consequently multiple incisions for ports, such as the Intuitive da Vinci Si, X, and Xi devices. While multi-port architecture remains the most accessible and familiar to urologists across a variety of practice settings, limitations include the need to triangulate the ports strategically to maximize instrument range of motion and avoid collisions, especially in the narrow confines of the deep pelvis.

The da Vinci SP platform addresses some of these concerns by directing 3 double-jointed, independent arms through a 2.5 cm multichannel trocar from a single incision.[2] Further advantages

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include the ability to rotate the entire system completely while docked, visual feedback on the surgeon console of the location of each arm, and the ease of performing concurrent procedures (eg, combined transabdominal and perineal dissection).[3] Apart from the immediate benefits of fewer required incisions, which correspond to less morbidity and improved cosmesis, as well as potentially more rapid convalescence, a variety of LUT pelvic pathology can be approached with the SP system.[4,5] The operating distance of 15 to 25 cm for the instrument arms to articulate is ideal for a transabdominal approach to the deep pelvis. In cases whereby the target anatomy is closer to the abdominal wall than this distance, a “floating dock” or “air dock” technique using a GelPoint Mini retractor and AirSeal can effectively create a surrogate for pneumoperitoneum (**Fig. 1**A).[6] Limitations of the SP platform include limited instrumentation relative to its multiport counterparts, in particular lacking a vessel sealer or near-infrared fluorescence (NIRF)-mode camera at the time of this publication. While the double-jointed instruments facilitate dissection and suturing in narrow confines, less force can be applied correspondingly with an individual arm. Due to the need to triangulate the instrument arms from a single trocar, countertraction can be problematic, potentially necessitating the placement of an assistant trocar or the use of external aids such as magnetic retractors.[7,8]

Novel platforms produced by an array of manufactures and industry-academic collaboratives are on the horizon for clinical deployment and may prompt a diversification of the current offerings, from which surgeons will undoubtedly benefit.[9] For instance, the recent development of the DaVinci SP Access Kit allows for improved integration of the assistant port, increased extracorporeal working space, and increased stability (**Fig. 1**B). Of particular note, the Virtuoso Surgical/Vanderbilt concentric tube technology prototype, allowing for the articulation of instruments from a fixed endoscope tip, is an exciting development that possesses striking implications for traditional LUT reconstruction owing to the potential for endoluminal surgery.[10] The data underpinning these novel techniques are eagerly awaited and herald a bright future for surgical innovation.

POSTERIOR URETHRA AND BLADDER NECK PATHOLOGY

Bladder neck reconstruction and posterior urethroplasty have posed a major challenge in surgical reconstruction for urologic surgeons. Often, these patients present with the previous history of radiotherapy or ablative interventions for other pathologies that have resulted in obstructive or devastated bladder necks with poor function. Previous study from the Cancer of the Prostate Strategic Urologic Research Endeavor database has cited the rate of BNC to be 8.4% and the Prostate Cancer Outcome Study has cited the rate to be 16% in patients undergoing radical prostatectomy.[11,12] Many patients present with symptoms 6 to 24 months after their index operation.[13] Often these patients are managed with an initial endoscopic intervention such as dilation or incision of the vesicourethral anastomosis (VUA).[14] These interventions are often short-lived and may be inapplicable in cases of complete urethral obliteration. Furthermore, they may exacerbate dense stricture and lead to recalcitrant situations requiring more involved surgical procedures to salvage urethral voiding and maintain quality of life.

Robotic-assisted approaches to recalcitrant posterior urethral stenoses were developed in response to the sheer technical difficulty of visualization and precise suturing in the deep pelvis, as well as the close proximity of critical structures including the external urinary sphincter, cavernous nerves, and rectum. Maneuvers such as pubectomy and combined abdominoperineal dissection may be required to facilitate anastomosis. The functional outcomes of open reconstruction, even when technically successful (as quantified by urethral patency), demonstrate a high rate of de novo stress urinary incontinence.[15] For this reason, it is critical to counsel the patient preoperatively on the possibility of requiring an Artificial Urinary Sphincter as an adjunct procedure to reestablish continence. Furthermore, extensive urethral mobilization and bulbar artery transection are independently associated with increased risk of AUS cuff erosion.[16,17] Collectively, the morbidity of these historical approaches may discourage providers from attempting definitive surgical management, and consequently patients may be deemed “unreconstructible,” with the end-stage options of repeated endoscopic procedures, chronic catheter drainage, or cystectomy and urinary diversion.

In the past several years, novel techniques to address this pathology have been described. These procedures combine improved articulation and precision, with modalities such as NIRF imaging, to facilitate mucosal anastomosis with excellent short- and mid-term results.

Y-V Plasty

We start by first performing a cystoscopy to visualize the obstructed urethra and passing a wire

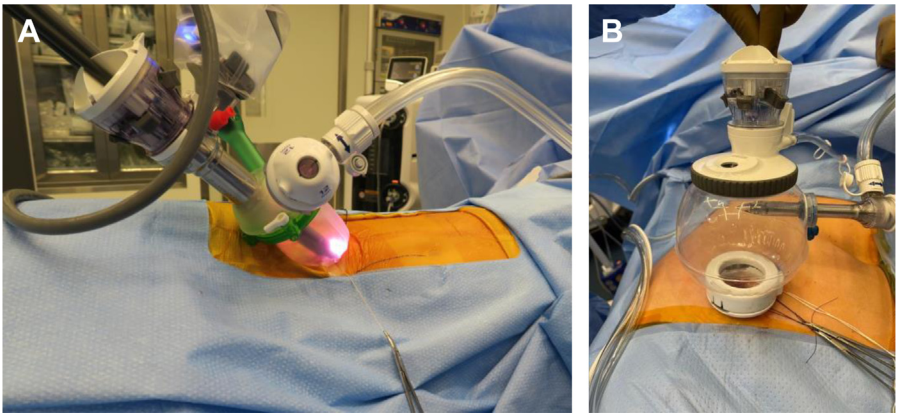

Fig. 1. Use of a "floating dock" technique with the SP robot via GelPoint Mini in a pediatric patient (*A*). DaVinci SP Access Kit with integrated assistant port (*B*).

into the bladder. If a wire cannot be passed, then the scope is left in the urethra at the point of obstruction and secured to the draping. The ports are placed similar to a robotic prostatectomy on the Xi system. With the SP robotic system, the port is docked in the midline, immediately above the umbilicus. The bladder is dropped from the anterior abdominal wall and mobilized. It is crucial to liberate the bladder on the anterior side to reach the distal-most segment. The proximal urethra is dissected and mobilized as distally as possible. At this point, the surrounding tissue and any sphincteric muscle is carefully dissected off the urethra. A Y incision is then made on the anterior side of the urethra and bladder: a longitudinal incision is made on the anterior urethra using scissors and carried past the point of obstruction. The Y limbs are made on the bladder, paying careful attention to the ureteral orifices. Next, the Y limbs are advanced to the apex of the urethral spatulation. We typically use a 3-0 Stratafix suture for this advancement to complete a watertight closure (**Fig. 2**). A foley catheter is placed at the end of the procedure and a drain is left in place. A 2018 study by Granieri and colleagues demonstrated well-preserved urinary function in a small series of patients with recalcitrant bladder neck contracture, and this operation has been well adapted by multiple other institutions for this pathology.[18]

Whereby the urethral lumen or vesicourethral orifice is completely obliterated, concomitant transrectal ultrasonography and flexible cystourethroscopy can facilitate circumferential dissection and excision of fibrotic tissue. For stenoses spanning the membranous urethra, combined robotic-perineal dissection to mobilize the distal urethra may be required.[19]

Buccal Graft Onlay/Interposition

A novel repair using buccal graft in the repair of posterior urethral fistulas involving the bladder neck or vesicourethral anastomoses greater than 2 cm in length was recently described in a small series with good outcomes.[20] A transvesical approach was used if there was a concern for significant abdominal adhesions with a large bladder capacity. A transabdominal approach is used if the abdomen is less hostile, with low-capacity bladders, or if flap interposition is anticipated. Sharp and electrocautery-assisted robotic dissection is performed into the urethra at the 9-o'clock position. Cystoscopy is used to assist with the initial robotic posterior dissection. After the BMG is passed into the surgical field, the anastomosis is created using 3-0 barbed polydioxanone sutures proximally at the level of the bladder neck. This is continued as far distally as feasible with the robot. The urethra is calibrated with a 22 French Bougie or foley catheter to ensure patency throughout the anastomosis. Distally, the graft is fixed to the mucosal edge with 5-0 absorbable monofilament and 4-0 absorbable braided sutures and quilted to the perivesical tissue using an 18-gauge hypodermic needle loaded with 4-0 absorbable biological monofilament suture and 3-0 absorbable barbed sutures via a "sewing machine" technique.

If necessary, adjacent tissue transfer is performed to bridge any defects in the repair, fill dead space, prevent fistulization, and bolster vascular supply, especially in areas of poor periurethral tissue quality (ie, patients with a history of radiation). A rectus abdominis, gracilis, or omental flap of the appropriate size is carefully

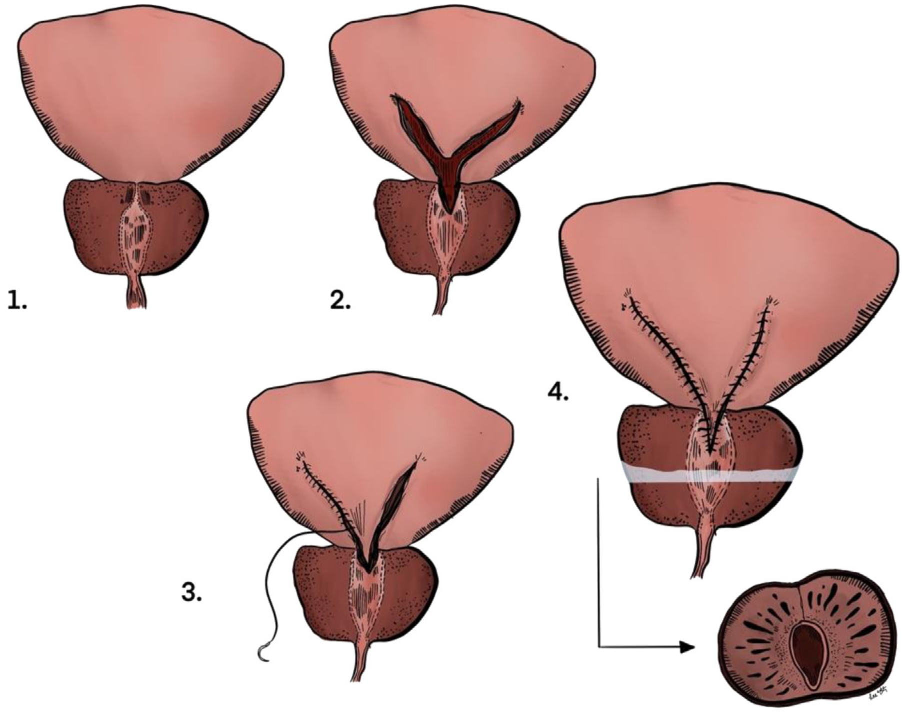

Fig. 2. Y-V plasty. Narrowed bladder neck (1) with Y-shaped incision on anterior bladder wall traversing the bladder neck to the proximal prostatic urethra (2). The Y limbs are advanced to the apex of the urethral spatulation and the cystotomy closed with running 3-0 Stratafix (3). A foley catheter is placed at the end of the procedure and a drain is left in place. The lumen of the bladder neck at the conclusion of the procedure is noted to be teardrop shaped (4).

dissected, translocated to the cavity, and sutured in place. A simple prostatectomy is performed to enhance the tissue to which the graft and anastomosis are sewn given there is no evidence of residual malignancy. An augmentation cystoplasty may also be performed in patients with low bladder capacity and high filling pressures evidenced by preoperative videourodynamics. Additionally, for longer strictures or additional distal strictures, concurrent perineal urethroplasty can be performed with or without buccal graft. In our technical case series of 9 patients with complex urologic histories undergoing a novel SP robotic-assisted posterior urethroplasty, we demonstrated 3 key findings: (1) the technique is effective with a urethral patency rate of 67% which is consistent with comparable open and robotic series, (2) the technique is safe, with no intraoperative complications and only 1 postoperative complication related to the technique itself, and (3) the technique is durable, with patency in 6 patients at a median follow-up of approximately 1 year.[20]

Tanagho Flap

A Tanagho flap can be used for bladder neck and posterior urethral reconstruction in cases whereby there is severe dystrophic calcification of the bladder neck and poor bladder neck tissue for anastomosis. The robotic setup for the procedure is similar to those described above. If the prostate remains in situ, a posterior prostatic dissection is performed similar to a robotic prostatectomy: a peritoneal incision is made directly beneath the vas deferens and dissected toward the prostate. The prostate is elevated from the rectum down to the genitourinary diaphragm. Then the bladder is dropped from the anterior abdominal wall. Of note, if a suprapubic tube is present, then the tract must be transected. The dissection is carried to the apex of the prostate at which point the proximal urethra is visualized and dissected as distally as possible. Sometimes placing a stitch into the distal aspect of the urethra allows the surgeon to pull the distal urethra further into the field of operation to fully resect the stricture. Care must be taken to avoid damage to the sphincter to preserve continence.

There are instances when the stricture may span further than anticipated and may require a combined abdominoperineal approach. In these cases, the urethra is dissected through a midline perineal incision in a typical fashion and mobilized circumferentially to facilitate passage of the proximal limb. The robotic surgeon should be prepared to grab the mobilized urethra internally through the urethrotomy made previously. Once the urethrotomy and adequate spatulation is performed, the native bladder neck is closed primarily. If the preexisting suprapubic tube site is unable to reach the urethral stump for a tension-free anastomosis a Tanagho flap is used. An anterior bladder flap is created similar to a Boari flap; however, this flap is generated to drop downwards toward the urethra rather than upwards toward the ureter. A primary anastomosis is performed in a standard running fashion with a 3-0 Stratafix suture over a 16 or 18 French catheter. The catheter is left in place for 3 weeks for the anastomosis to heal. A drain may also be left in place anterior to the anastomosis.

This flap has been used previously in patients with complex voiding pathology and neurogenic bladders. The application in this instance is expanded from its original usage, and there is a lack of robust evidence and long-term follow-up on these patients at this point; however, in our experience, these patients do well and have a high satisfaction rate from the procedure.[21,22]

The aforementioned techniques are significantly easier to perform with the working space of the SP platform, which facilitates dissection and suturing under the pubic bone and allows for concurrent endoscopic or transperineal manipulation. In terms of patency and continence, the short and mid-term outcomes reported thus far are highly encouraging,[23] though these patients should be counseled on the possible need for adjunct procedures to restore continence including slings or artificial urinary sphincters. Crucially, if a perineal dissection can be avoided, long-term durability and continence may be improved.

A similar approach may be taken for adjacent disease processes including rectourethral fistulae, or if salvage prostatectomy is clinically indicated. In these situations, the versatility of the robotic platform lies not only in the technical benefits it offers, but also in terms of adjunctive procedures such as the feasibility of minimally invasive flap harvest for vascularized tissue coverage, and the possibility of multiple surgical approaches that are performed concurrently. Further comparative studies of the long-term durability of these techniques are needed, especially with respect to operating efficiency and potential cost.

A schematic of the technique is shown in **Fig. 3**.

INTRACORPOREAL URINARY DIVERSIONS

With the recent publication of the RAZOR randomized trial, in which robotic-assisted radical cystectomy was demonstrated to be noninferior to open radical cystectomy in terms of oncologic outcomes, the safety of the robotic approach was underscored.[24] Urinary diversion, however, was accomplished via an extracorporeal approach in this and other studies. The precision of robotic-assisted ureteroenteric anastomosis, as well as decreased blood loss, lower insensible fluid loss, and more prompt recovery are potential advantages of intracorporeal diversions.[25] Nevertheless, complete intracorporeal approaches have not been adopted widely to date, and ileal conduits constitute most of the intracorporeal diversions.[26] Learning curve is thought to account for some of the lack of widespread utilization. In a large single-center comparison of open, robotic extracorporeal, and intracorporeal diversion, the anastomotic stricture rate was greatest for patients undergoing intracorporeal diversion, but after 75 cases, this rate declined to 4.9% which is significantly less than either extracorporeal (11.3%) or open (9.3%) procedures.[27] While operative volume influences operative time and subsequent development of complications and readmissions, a reasonably high-volume robotic practice may have the appropriate infrastructure and personnel to support routine intracorporeal diversion.[28] This approach may be particularly applicable to the construction of orthotopic neobladder, as performing a tension-free, watertight urethroileal anastomosis may be a challenging step during open surgery. Multiple techniques have been described with the aim of maximizing intraoperative efficiency and teachability. The method first reported and consequently with the longest follow-up is from the Karolinska group, for which the urethroileal anastomosis is performed before bowel detubularization and reservoir creation.[29] However, several alternative orders of steps have been reported with similar short and mid-term data with respect to continence and stricture formation. Larger studies with longer follow-up are warranted to define ideal parameters for this technically demanding operation.

The SP platform may also have a role to play in the realm of urinary diversion, not only in terms of reconstruction following radical cystectomy, as has been reported by Kaouk and colleagues, but also in populations with neurogenic or end-stage bladder.[30] Grilo and colleagues report a series of 10 patients undergoing complete intracorporeal supratrigonal cystectomy with augmentation cystoplasty, in which median operative time was 250 min, hospital stay was 12 days, and 1 year functional and urodynamic outcomes were acceptable.[31] Conceivably, within a high-volume robotic surgical practice, as refinements of the

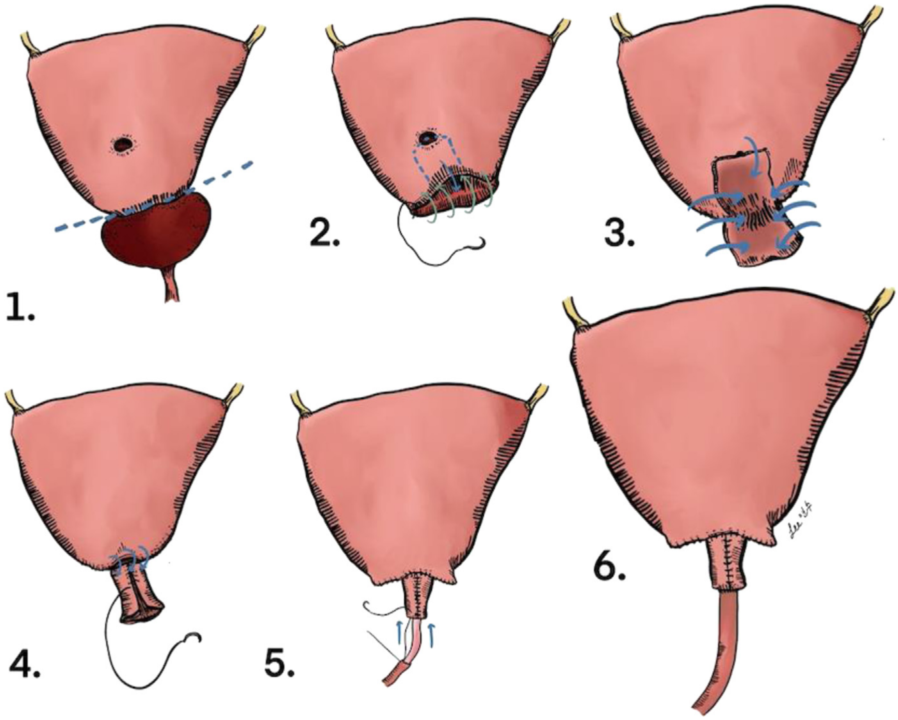

Fig. 3. Posterior urethroplasty with Tanagho flap. A simple prostatectomy is performed (if applicable) and the pre-existing suprapubic tube removed (1). The native bladder neck is closed (*green arrows*) (2). If the pre-existing suprapubic tube site is unable to reach the urethral stump to create a tension-free anastomosis, an anterior bladder flap is raised incorporating the prior cystotomy (*dashed blue line*) (2). The flap is then tubularized and the cystotomy closed (3, 4). The urethral stump is then anastomosed to the tubularized flap over a catheter with running 3-0 stratafix suture (5). The finished product is shown in 6.

technique accrue, the intracorporeal approach may fit into a niche that benefits both providers and patients. The complications of urinary diversions such as parastomal hernia may also be managed with a robotic approach as reported in a recent report of a small cohort of patients.[32]

URETERAL REIMPLANT

Robotic-assisted ureteral reimplantation and its associated adjunct procedures such as Boari flap, psoas hitch, and downward nephropexy have been studied and found to produce durable results in both adults[33,34] and children[35] with minimal morbidity.

For pathology of the distal ureter, the patient is placed in a low-lithotomy position with steep Trendelenburg and the robot is docked either between the patient's legs or at the patient's side. For pathology extending up to the mid-ureter, a lateral decubitus position can be used with the patient in the modified low-lithotomy position.

The peritoneum is incised longitudinally at the level of the iliac vessels, and the ureter is identified. With the aid of concurrent ureteroscopy, the peritoneum is incised over the ureter distally to the insertion of the ureterovesical junction and proximally until healthy proximal ureter is encountered. For male patients, whereby fertility is not a concern, the vas deferens can be ligated to improve exposure. For female patients, the ovary and ovarian ligaments are retracted anteriorly to facilitate exposure.

The ureter is transected just proximal to the diseased segment of ureter and spatulated. For patients with ureteral malignancy, a clip is placed on the distal ureter before ureteral transection to avoid tumor spillage.

If sufficient ureter is removed such that a psoas hitch is necessary, the bladder is filled with saline and subsequently mobilized off the anterior abdominal wall. Absorbable suture is used to fix the posterior bladder wall to the psoas muscle tendon in a longitudinal fashion, taking care to avoid the genitofemoral nerve. The bladder may also be affixed to the side of the peritoneum to achieve a similar effect. Should further bladder mobilization be necessary to reach the psoas muscle, the bladder may be incised horizontally and then closed vertically in a Heineke–Mikulicz fashion to stretch the bladder vertically toward the psoas muscle. Furthermore, transection of the contralateral superior vesical pedicle may be performed, though this is rarely necessary. In the largest prospective series of robotic psoas hitch, all 12 patients who underwent treatment with distal ureteral reimplantation with psoas hitch had successful outcomes with no obstruction on postoperative MAG-3 scan or IV urography.[36]

Should a Boari flap be necessary, the bladder is filled with saline and a pedicle of bladder is created starting 3 cm proximal to the bladder neck and extended toward the dome to create a flap of tissue with its base wider than its apex. The flap is fixed to the psoas, tubularized, and anastomosed to the spatulated ureter[37,38] in an interrupted or running fashion. A ureteral stent is advanced in a retrograde manner up to the kidney before completing the anastomosis. The defect in the bladder is closed using barbed suture in a running fashion. In the largest series of robotic ureteral reimplantation with a Boari flap, all 11 patients had durable repair of their distal stricture at 15 months of follow-up.[38]

In the event that the above maneuvers are insufficient to complete bladder mobilization, downward nephropexy is performed after ureteral dissection and before ureteral reanastomosis. An intra-Gerotal dissection is performed such that the kidney is dissected free from surrounding attachments in a circumferential manner. At this point, the kidney is only attached to the renal hilum and ureter. The adrenal gland is completely detached from the upper pole of the kidney The posterior kidney capsule is affixed to the psoas fascia using absorbable suture. The suture is fixed twice more to securely fasten the kidney. Alternatively, this stitch may be secured by clipping a Weck Hem-o-loc clip.

To perform a refluxing extravesical reimplant, the bladder wall and mucosa of the dome are incised for 1 to 2 cm. The distal ureter is anastomosed to the bladder dome with running absorbable suture to create a water-tight anastomosis. A double-J stent is passed into this incision before its completion. The second layer of closure is performed to include the bladder serosa and ureteral adventitia.

When performing a nonrefluxing reimplant, an incision is made in the detrusor muscle and extended distally for 5 to 7 cm to create 2 detrusor flaps. This incision is directed away from the ureter. The detrusor flaps are used to create a submucosal tunnel. The ureter is anastomosed to the bladder at the most distal aspect of this tunnel with 2 running sutures. A ureteral stent is advanced in a retrograde manner before the completion of the anastomosis. A second layer closure of detrusor muscle is then performed with interrupted absorbable suture to create a nonrefluxing tunnel.

Once anastomosis is completed, the pelvic peritoneum is closed over the anastomosis.

At any time during anastomosis using any of the aforementioned techniques, intravenous indocyanine green (ICG) can be administered to ensure vascularity.

We recently described a nontransecting side-to-side anastomosis as an alternative method to ureteral reimplantation in cases whereby ureteral excision is nonmandatory (**Fig. 4**). The strictured ureter is first identified and a vessel loop placed around to aid dissection without directly grasping the ureter. As the blood supply of the distal ureter originates from a posterolateral direction, the distal ureter is not mobilized in this area. Intravenous indocyanine green may be administered to help identify vascularity. The bladder is freed from its attachments to the anterior abdominal wall and pelvis until it is adequately mobilized to allow for a tension-free anastomosis. If needed, a psoas hitch or Boari flap can be performed in the manner described above. A longitudinal ureterotomy is made proximal to the ureteral stricture while leaving the distal strictured ureter *in situ*. A long ureterotomy (~3–4 cm) is preferred to ensure a widely patent anastomosis. A cystotomy is made in the posterolateral portion of the bladder. Anastomosis is performed using a running 4-0 absorbable suture. First, one wall of the anastomosis is completed in a running manner. Next, a double-J stent is placed in a retrograde manner into the ureterotomy and across the anastomosis. Once the stent is in position, the remaining portion of the side-to-side anastomosis is closed. After the anastomosis is complete, the bladder is filled with normal saline to ensure a watertight closure.

We reported on a series of 16 patients at 3 institutions who underwent robotic ureteral reimplant through nontransecting side-to-side anastomosis between 2014 and 2018. The median stricture length was 3 cm. The various etiologies for stricture development in our cohort were representative of the literature. Approximately one-third of patients had undergone previous endoscopic balloon dilation.

The median operative time and estimated blood loss were 178 minutes and 50 mL, respectively. Median length of stay was 1 day (IQR 1–2). No intraoperative complications or postoperative complications with Clavien score ≥3 were reported. A total of 15 of 16 (93.8%) patients were

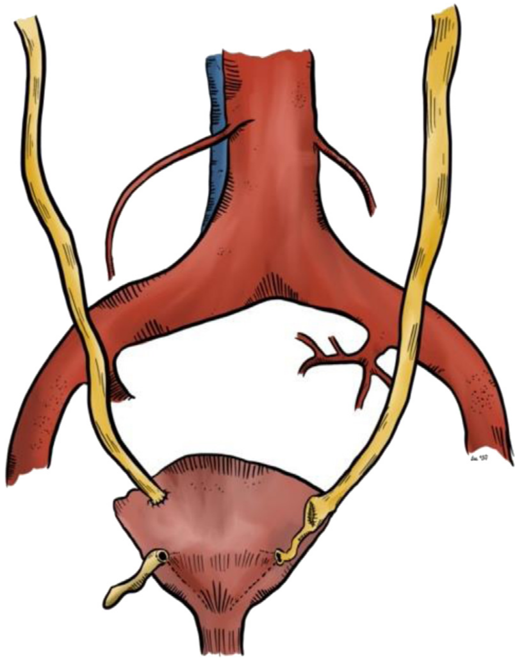

Fig. 4. A traditional transecting end-to-end ureteral reimplant is shown with the right ureter. A non-transecting side-to-side ureteral reimplant is shown with the left ureter.

found to have clinical success defined as the absence of flank pain, and 100% of patients with follow-up imaging had radiographic improvement at a median follow-up time of 12.5 months.[39]

RECTOURETHRAL FISTULA REPAIR

Rectourethral fistula (RUF) is an uncommon but devastating complication with significant deterioration in quality of life.[40,41] There are more than 40 different techniques described for RUF repair.[42] In the past, we preferred the da Vinci Robotic System Xi as it can more easily be side docked to better facilitate perineal access. More recently, we have shifted to the SP system as its narrow profile better facilitates access deep into the pelvis with less interference from the pelvic wall.

All cases begin with flexible cystoscopy. A guidewire or ureteral catheter is placed across the fistula. When feasible, the wire is grasped and externalized through the rectum for through-and-through access from urethra to anus. If the ureteral orifices are in close proximity to the fistula, it may behoove one to place ureteral stents at the beginning of the case.

The robotic dissection begins with a posterior approach. The vas deferens are identified and used to guide dissection to Denonvillier's fascia. Sharp dissection with judicious bipolar electrocautery is used to separate the rectum from the urinary tract. An EEA sizer can provide downward tenting of the rectum, aiding in the separation of rectum from bladder neck and prostate. If using the Xi system, the Firefly camera can aid in identifying the urethra as the white light of the cystoscope emits in the near-infrared spectrum, which penetrates a modest amount of tissue. As one nears the fistula, the assistant can perform a DRE to help guide the final approach. The fistula is then divided. One will see the wire, stent, or blue dye placed at the beginning of the case. The edges of the rectum are then freshened and closed primarily with barbed, absorbable suture. An air leak test is then performed to ensure a watertight closure. If the rectum does not seem to be salvageable, resection of the disease rectum followed by colo-anal anastomosis has been reported as a possible alternative.[43]

If the prostate is *in situ* and the fistula is small, one can attempt a primary closure. In situations whereby there is fistulization into prostate with radionecrosis, primary closure may be impossible. Salvage prostatectomy is often necessary to remove the necrotic tissue to allow for watertight closure. Bladder advancement flaps and complex urethral advancement techniques (as described above) may provide distal advancement of the bladder neck to allow for anastomosis to the urethral stump. If possible, a circumferential anastomosis is performed. Otherwise, an augmented anastomotic urethroplasty may be performed with buccal mucosa graft. One must be cognizant that urethral dissection will increase the risk of urethral erosion after AUS placement.[16]

If the fistula is distal, a gracilis flap may be harvested and tunneled into the pelvis and fixed in place between the rectum and the urinary anastomosis which has been shown to be effective with little morbidity[44]; however, this does add an additional surgical site and incision. Alternatively, an omental or rectus flap may be more practical. Omentum is in abundant supply and will reach into the pelvis with mobilization. In proximal and/or large fistulas, a rectus abdominis flap is a useful technique to provide an interposing layer between the bladder and rectum (Figure 5). Robotic harvest has eliminated the need for a large midline incision from xiphoid to pubis. Furthermore, the anterior rectus sheath is left intact, reducing the risk of incisional hernia. The robot is redocked contralateral to the rectus to be harvested. If there is a colostomy, the robotic arms should be carefully positioned to avoid injury. The posterior rectus sheath is incised at the level of the inferior epigastric artery taking care not to injure the pedicle. The posterior sheath incision is then advanced to the

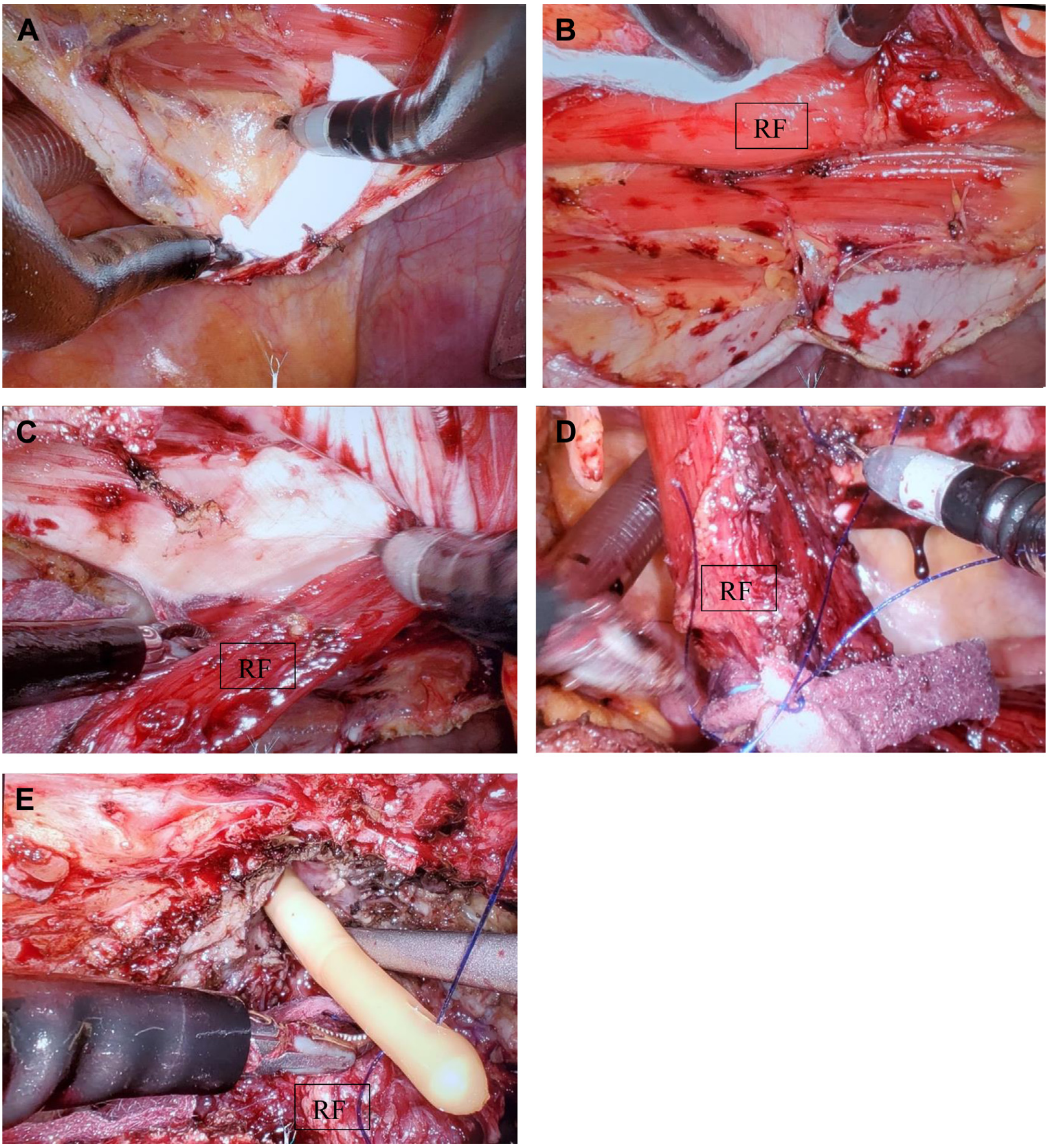

Fig. 5. The peritoneum is incised in the midline and dissected off the posterior side of the rectus muscle (A). The rectus muscle is dissected off the anterior fascia (B) to the aponeurosis laterally and cephalad to the xiphoid process at which point the muscle is transected (C) and dissection carried caudad to the inferior epigastrics maintaining a pedicle in the form of a pulsating perforator. The anterior and posterior fascia are sutured together to avoid Spigelian hernia (D). The flap is then passed posterior to the bladder and affixed using running 3-0 stratafix suture (F). RF = rectus flap.

costal margin. The rectus flap is then dissected circumferentially, and a Penrose drain is passed around it to aid in retraction. Circumferential dissection is then carried superiorly to the level of the costal margin. Close attention is required to the tendinous inscriptions to avoid the violation of the anterior sheath. Bipolar cautery is used to control perforating vessels. The rectus muscle is then amputated at the costal margin and 2 holding stitches are placed with 2 long tails for each suture. The Carter-Thomason suture device is then passed through the lateral perineum, entering the pelvis between the rectum and urethra whereby a single suture is grasped and externalized. The other tail is passed separately and the 2 tails are tied over a xeroform bolster to fix the rectus flap as far distally as possible. This is conducted on the left and right sides of the perineum. The posterior rectus sheath is then anastomosed to the anterior sheath to reduce the risk of intra-abdominal adhesions.

Another promising technique is robotic transanal minimally invasive surgery (TAMIS) for use in cases of simple RUF whereby the interposition of remote tissue is not necessary. An Access Channel is placed across the anus and affixed to the patient. Trocars are preloaded onto the GelSeal Cap, which is then attached to the Access Channel. With the robot now docked, the fistula is circumscribed sharply, and a full-thickness rectal flap is developed. A plane is then developed between the prostate and rectum. The urethra is closed with absorbable suture. A biologic material such as alloderm can be placed over the closed urethra. The rectum is then closed over the mesh with absorbable suture.[45]

SUMMARY

As robotic proficiency becomes more widespread, analogs and extensions of open procedures and operative maneuvers, previously perceived as technically challenging, will become more commonplace. Robotic-assisted procedures carry putative advantages in terms of anastomotic patency, identification and preservation of blood supply, and reduced perioperative morbidity. The role of the reconstructive expert who can leverage both robotic and traditional techniques in the management of complex upper and lower urinary tract pathology will be at the forefront of multidisciplinary management.

CLINICS CARE POINTS

- In cases of complete obliteration of the urethral lumen or bladder neck, the utilization of transrectal ultrasonography and/or flexible cystoscopy concomitantly with a robotic approach can aid in circumferential dissection and excision of the fibrotic tissue.
- For stenoses spanning the membranous urethra, combined robotic-perineal dissection to mobilize the distal urethra may be required.
- Buccal graft may be utilized during robotic repair of posterior urethral strictures and bladder neck pathology when there is presence of a fistula or long strictures (>2cm). The decision of transvesical versus transabdominal approach is dependent on bladder capacity, concern for abdominal adhesions, and whether a flap interposition may be needed.
- Tanagho flap is chosen when there is insufficient healthy bladder neck tissue for anastomosis.
- In cases where ureteral excision is non-mandatory, a side-to-side non-transecting distal ureteral reimplant is efficient and effective.
- In cases of rectourethral fistula where a prostate remains in situ, if the fistula is small a primary closure may be attempted, otherwise a salvage prostatectomy ought to be performed.
- In cases of a distal rectourethral fistula, gracilis, rectus, or omentum may be used as a flap. With proximal/large fistulas, a rectus flap is the best choice. Leaving the anterior sheath intact when harvesting rectus reduces the risk of hernia.

DISCLOSURE

The authors have nothing to disclose.

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