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– FOCUS ISSUE –

Robotics

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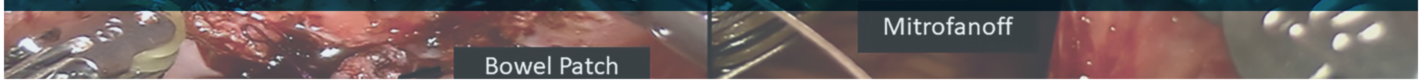

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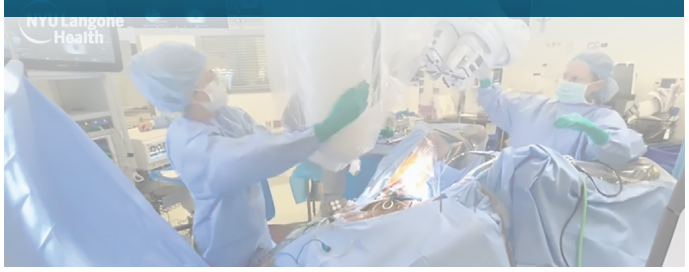

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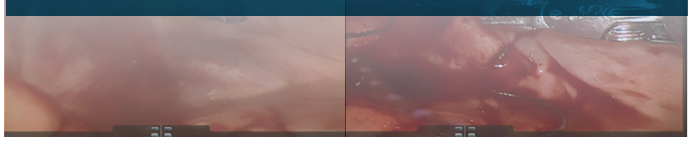

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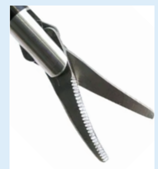

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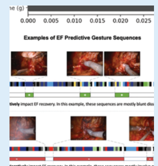

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ROBOTICS

Incorporating Robotics for Complex Lower Tract Reconstruction for Children With Neurogenic Bladder

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The utilization of robotic platforms in pediatric urology has experienced rapid growth in recent years. It offers many of the same advantages of straight laparoscopy including decreased pain and blood loss along with fast recovery and improved cosmesis. However, robotic surgery offers ergonomic advantages. Upper tract reconstructive procedures such as pyeloplasty are a key example of the robotic platform popularity where, at least in the US, it may have overtaken other techniques as the preferred choice.[1] This should come as no surprise, given the expedited learning curve to master complex reconstructive laparoscopic techniques with the robot as compared to conventional laparoscopy. This is especially true for cases requiring a significant amount of intracorporeal suturing, such as bladder augmentations. The combination of the abovementioned advantages with the improved ability to work in small places such as the pelvis makes this platform ideal for lower tract reconstruction. In the modern era, the surgical robot has opened the door for a minimally invasive approach to complex lower reconstructive cases such as bladder neck reconstruction, Mitrofanoff procedure, and bladder augmentation.

The expectation then becomes that children with neurogenic bladder requiring these types of procedures could benefit from the well-established advantages of minimally invasive surgery. The complex nature of these reconstructive cases, which often must be performed together, has been difficult to master using a straight laparoscopic technique. Robotic platforms have made these procedures feasible and safe, but it remains unclear if minimally invasive options indeed offer advantages when compared to open surgery.

> "In the modern era, the surgical robot has opened the door for a minimally invasive approach to complex lower reconstructive cases such as bladder neck reconstruction, Mitrofanoff procedure, and bladder augmentation."

As pediatric urologists continue to gain experience using the robotic platform, expanding the operative repertoire to complex reconstructive lower tract procedures is the logical next step. Yet this can be seen as daunting, and surgeons are often discouraged from attempting new procedures despite having the necessary skills. Most robotic lower tract reconstruction follows the same techniques as the open counterpart. However, the overall technique is not new. The only novelty is using the surgical robot to accomplish the laparoscopic technique. It is expected that a well-trained pediatric urologist would be able to perform open complex lower tract reconstruction, and robotic surgery has become a ubiquitous component of residency and fellowship training. Thus, combining these 2 skills should be all that is required to attempt robotic lower tract reconstruction in a pediatric patient with a neurogenic bladder.

Minimally invasive techniques to create a Mitrofanoff channel have been described with both straight laparoscopic techniques and the robot. The Mitrofanoff creation is the ideal fundamental case for a young surgeon looking to begin performing lower tract reconstruction (part D of Figure). Gundeti et al, in a multicenter study with 88 patients undergoing robotic Mitrofanoff, showed that the technique is reproducible across centers.[2] Additionally, this study demonstrated that the robotic technique had comparable complication rates and functional outcomes to previously published series using an open technique.

As the surgeon's experience increases, bladder neck reconstruction is the next logical step in advancing expertise in lower urinary tract reconstruction (parts A and B of Figure) This procedure, by its nature, makes catheterization via the urethra difficult and often requires the concomitant creation of a Mitrofanoff. Thus, it is important for the surgeon to be already comfortable with the Mitrofanoff creation. Grimsby et al showed that this procedure is feasible robotically and offers similar continence results compared to the open technique with similar complication rates.[3] As expected with the robotic technique, operative times were longer. In this study, however, hospital stay was not significantly

> "Ultimately, the surgeon will have to consider if the benefits of accomplishing the procedure using laparoscopic technique outweigh the significant increase in operative time associated with robotic-assisted bladder augmentation. Indeed, operative duration is a concern for most robotic-assisted lower tract reconstruction cases."

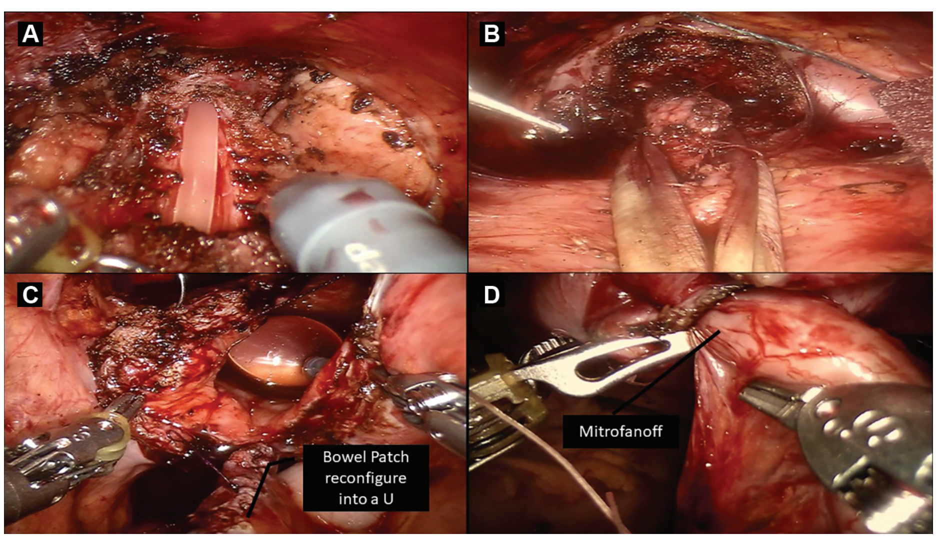

Figure. A, Bladder neck reconstruction anterior dissection. B, Bladder neck reconstruction prior to sling wrap. C, Bladder augmentation, starting to attach the bowel patch to the bladder. D, Mitrofanoff implanted in the bladder.

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INCORPORATING ROBOTICS FOR COMPLEX LOWER TRACT RECONSTRUCTION

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improved as compared to the open approach.

Finally, bladder augmentation is the most challenging, and thus advanced, procedure to attempt robotically (part C of Figure). This surgery is often long, even when done open, which makes finding a patient who requires an augmentation alone ideal for the first attempt of a robotic case. It comes as no surprise, however, that while robotic bladder augmentation is feasible and safe, it is associated with prolonged operative time as compared to the open technique.[4] Unfortunately, these patients often require concomitant bladder neck procedures, Mitrofanoff channel, and/or possible antegrade enema options, further prolonging operative duration. Ultimately, the surgeon will have to consider if the benefits of accomplishing the procedure using laparoscopic technique outweigh the significant increase in operative time associated with robotic-assisted bladder augmentation. Indeed, operative duration is a concern for most robotic-assisted lower tract reconstruction cases.

Ultimately, patients with neurogenic bladder, in particular myelomeningocele patients, are complex, often with multiple comorbidities, including neurogenic bowel, which increases the risks associated with any type of major surgical intervention. Patients often have prior abdominal procedures that do not preclude a minimally invasive approach but do make it more challenging, especially when a ventriculoperitoneal shunt is present.[5] Additionally, the number of patients requiring intervention is small and conservative management has further decreased the number of procedures done each year. These 2 factors limit the ability to perform the number of cases necessary to achieve mastery, as well as adequately study whether or not there is a significant benefit of the robotic approach over the open approach in lower tract reconstruction for these patients. Nonetheless, introducing robotic reconstructive techniques is feasible and should be done in a stepwise approach to build surgeons' skills, improve outcomes, and minimize complications. ■

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ROBOTICS

Robotic Simple Prostatectomy With Anastomotic Realignment

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Traditionally, large-gland benign prostatic hyperplasia (LGBPH)–defined as gland size > 80 to 100 mL–has been a particularly vexing problem for the practicing urologist. The gold standard surgical approach, open simple prostatectomy (OSP), is associated with significant blood loss and complication rates.[1] Robotic simple prostatectomy (RSP) has been a clinically relevant solution for LGBPH for over 15 years.[1] As techniques have evolved, complication rates and recovery times have improved, and perioperative outcomes of the modern RSP can be considered similar to other minimally invasive prostate procedures.[2]

The improvement in recovery time may be partially attributed to the use of a complete anastomotic realignment of the bladder neck and urethra. Traditional OSP typically involved only a few "retrigonizing" sutures to assist the reepithelialization of the urethra, which could only occur by secondary intent.[3] However, with the advent of robotic technology–which allows better access to the pelvis and improved visualization–a full anastomosis can now be a routine step in the operation.

First described by Coelho et al in 2012,[3] a complete anastomosis allows complete mucosa-to-mucosa apposition. The original description described a retropubic approach, which had been developed from the most popular approach for OSP. However, this technique can prove difficult at times, and a full anastomosis is not always possible. The posterior transvesical approach to RSP provides better visualization of the associated anatomy and better facilitates full anastomosis.[4]

> "As techniques have evolved, complication rates and recovery times have improved, and perioperative outcomes of the modern RSP can be considered similar to other minimally invasive prostate procedures.[2]"

The posterior transvesical approach commonly involves a linear incision in the posterior wall of the bladder, with or without use of stay sutures to keep the bladder open (Figure 1). After extirpation of the adenoma, the urethral stump and the bladder neck mucosa are well visualized (Figure 2). The complete anastomosis is thus easily completed, most commonly with a barbed suture (Figure 3). Once the cystotomy is closed, the prostatic fossa is essentially retroperitonealized, and any bleeding or minor urine leaks are thus contained within the prostatic capsule.

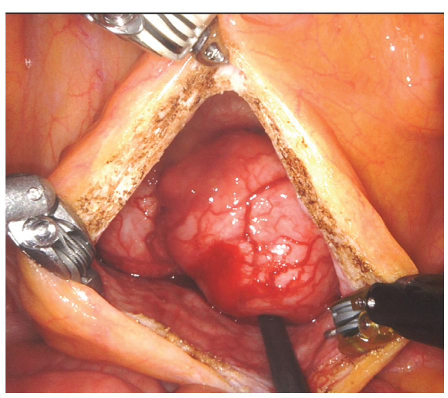

Figure 1. View of prostate adenoma prior to resection, with intravesical median lobe.

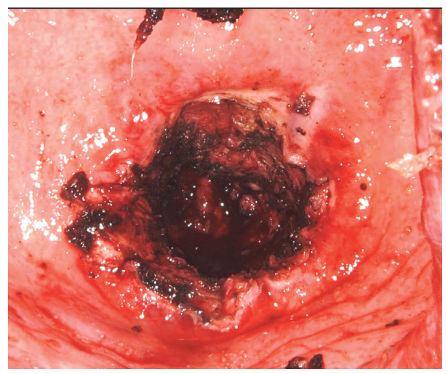

Figure 2. Prostatic fossa after resection of adenoma, prior to anastomosis.

Perhaps the most important benefit of a full anastomosis is the reduction in postoperative hematuria. The most significant limiting factor in a patient's recovery from OSP is postoperative hematuria,

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ROBOTIC SIMPLE PROSTATECTOMY WITH ANASTOMOTIC REALIGNMENT

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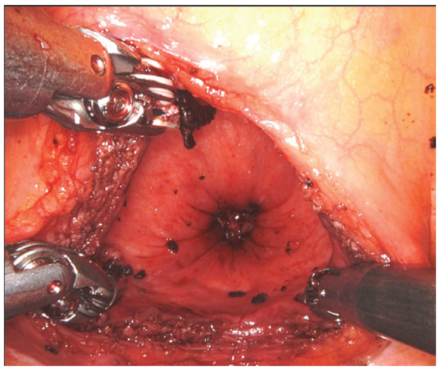

Figure 3. Prostatic urethra after complete anastomotic realignment.

which may require continuous bladder irrigation (CBI) for several days. In the era of RSP with complete anastomosis, CBI is rarely required, which makes the hospital stay shorter and potentially allows the procedure to be outpatient.

The improvements in perioperative outcomes have recently drawn multiple comparisons between RSP and transurethral laser therapy for LGBPH, especially holmium laser enucleation of the prostate (HoLEP). For many years, HoLEP has boasted better catheter duration, blood loss, and complication rates when compared to RSP.[5] However, more recent reports have indicated a closure of the gap in perioperative outcomes.

> "In my experience, the full anastomosis has allowed me to convert RSP to a completely outpatient procedure. In early 2021, I began discharging patients same day, and I have now done over 400 multiport RSPs as outpatient, without a significant increase in complications or readmission rates."

A prospective trial by Fuschi et al (2021) reported similar rates of hemoglobin drop, complications, and operative time between RSP and HoLEP.[2,7] A report by Kim and Byun (2022) indicated similar operative time and resected volume, with a lower rate of early incontinence after RSP.[6] Most studies continue to indicate shorter catheter duration and hospital stay in the HoLEP group.[2,5,6]

Further improvement in perioperative outcomes is expected with the growing popularity of single-port (SP) RSP. The da Vinci SP robot was first Food and Drug Administration approved in 2018 and is not yet as widely available as the da Vinci Xi, a multiport alternative. However, a growing number of centers are utilizing SP for RSP and reporting significant

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ROBOTIC SIMPLE PROSTATECTOMY WITH ANASTOMOTIC REALIGNMENT

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improvements in outcomes. The most commonly described technique avoids pneumoperitoneum by allowing transvesical access and insufflation of the bladder only, and yet still allows for a complete anastomosis. A recent retrospective study showed significant improvements in catheter duration, hospital stay, and opioid use when compared to traditional multiport RSP.[7]

In my experience, the full anastomosis has allowed me to convert RSP to a completely outpatient procedure. In early 2021, I began discharging patients same day, and I have now done over 400 multiport RSPs as outpatient, without a significant increase in complications or readmission rates. The improvements in cost, bed utilization, and patient satisfaction have been remarkable.

RSP has become a widely available, safe, and efficacious treatment for what was historically a very difficult patient. As anyone who does this surgery knows, the patient satisfaction is spectacular and is its own motivation for continued upgrades in technique. The advent of the complete anastomosis has allowed for improvements in perioperative outcomes through reduction in postoperative bleeding and avoidance of CBI. Further innovations such as SP technology will continue to fine-tune the perioperative outcomes. These updates, coupled with advantages in learning curve and incontinence rates, may eventually make this procedure the most desirable option for LGBPH. ■

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ROBOTICS

Robotic Ileal Ureter: Dealing With the Worst of the Worst Ureteral Strictures

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Historically, open ileal ureter replacement (IUR) was a reconstructive option for patients with long-segment ureteral strictures not amenable to primary excision and anastomosis. Although IUR has been shown to be an effective treatment, it is technically challenging to perform and requires bowel reconstruction. With technological advancements in the robotic platform and increasing utilization of more readily accessible substitution tissue, the paradigm has now shifted to favoring robotic substitution ureteroplasty using buccal mucosa graft (BMG) and/or appendix to manage most long-segment ureteral strictures.[1,2] Despite this, the most devastating long-segment ureteral strictures may not be suitable for reconstruction via robotic substitution ureteroplasty using BMG and/or appendix. With regard to BMG ureteroplasty, the technique requires a healthy plate of ureter to sew the BMG onto as the BMG should not be tubularized. Although an augmented anastomotic BMG ureteroplasty may be performed for obliterated defects, the technique still requires that a plate of ureter be anastomosed, which significantly limits the length of stricture that can be repaired using this technique.[2] With regard to appendiceal ureteroplasty, although the appendix may be interposed an obliterated ureteral defect, the technique is dependent on a patent and sufficiently long appendix, which may not be present.[1] For long-segment ureteral strictures not amenable to reconstruction via substitution ureteroplasty with BMG and/or appendix (Figure 1), IUR remains an important tool in the reconstructive urologist's armamentarium.

IUR was first described in 1906 by Shoemaker,[3] and was later popularized by Goodwin et al in the 1950s.[4] The technique, which is traditionally performed via a midline incision, involves interposing a segment of ileum across a ureteral stricture to allow for unobstructed flow of urine from the kidney to the bladder. IUR is technically challenging as it generally requires a large operative field (manipulation of upper and lower urinary tracts), ureteral identification and assessment of tissue viability (often in the setting of prior surgery, urinoma, and/or radiation), and harvesting a segment of bowel. Although large series have demonstrated that open IUR has been associated with excellent success rates ranging from 69% to 96%,[5,6] it has also been associated with a 29.8% to 42.9% 30-day postoperative complication rate.[5,7] The majority of reported postoperative complications have been infectious (ie, pyelonephritis and intra-abdominal abscess), incisional (ie, dehiscence and hernia), and bowel related (ie, obstruction, internal hernia, and ileus). Although there have been concerns raised about the risk of developing metabolic acidosis due to urinary reabsorption, the reported rate of this complication has been relatively low (2.9%-12%).[5,7] Additionally, most cases of metabolic acidosis may be treated with oral medications, and reoperation is rare.

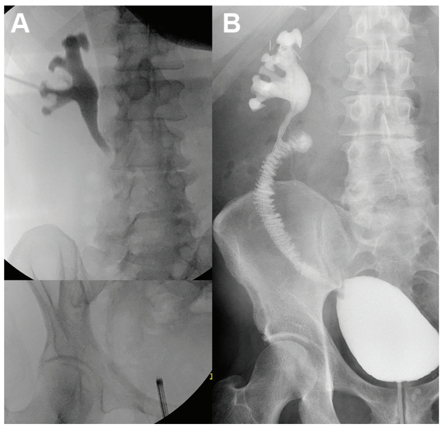

Figure 1. Long-segment ureteral stricture disease not amenable to substitution ureteroplasty with buccal mucosa graft and/or appendix before (A) and after (B) robotic ileal ureter replacement.

In an effort to decrease morbidity and improve outcomes associated with open IUR, there have been a handful of reports evaluating the safety and efficacy of robotic IUR. The robotic modality is well suited for complex surgeries such as IUR as it maintains the benefits of minimally invasive surgery such as improved cosmesis, reduced wound complications, and reduced postoperative pain, and enables the surgeon to see in magnified 3-dimensional vision,

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ROBOTIC ILEAL URETER: DEALING WITH THE WORST OF THE WORST URETERAL STRICTURES

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> "The robotic modality is well suited for complex surgeries such as IUR as it maintains the benefits of minimally invasive surgery such as improved cosmesis, reduced wound complications, and reduced postoperative pain, and enables the surgeon to see in magnified 3-dimensional vision, operate in limited anatomic spaces, and suture with precision."

operate in limited anatomic spaces, and suture with precision. Given the large incision that is generally necessary for open IUR, the robotic modality may reduce wound-related complications and discomfort (Figure 2). Additionally, as many patients requiring IUR suffered an iatrogenic ureteral avulsion and/or radiation damage, periureteral dissection and identification of the remnant ureter may be difficult. Instillation of intraureteral indocyanine green with subsequent visualization under near-infrared fluorescence may assist with identification of the viable proximal ureter/renal pelvis (Figure 3). Also, the complexity of the operation underscores the importance of performing reconstruction with well-perfused tissue. Injection of indocyanine green with subsequent visualization under near-infrared fluorescence may assist with assessment of ureteral perfusion after ureterolysis and bowel perfusion after harvest. We have found that checking perfusion of the harvested bowel to be used for reconstruction of the urinary system provides additional reassurance, especially when anastomosis of the ileum to the proximal ureter/renal pelvis is difficult and more extensive mesenteric mobilization is required. Despite the potential advantages of robotic IUR, the procedure remains technically demanding. The large operative field (Figure 4) may require multiple patient and/or port placement configurations to optimize robotic upper and lower urinary tract access. Additionally, robotic intracorporeal bowel work is associated with a significant learning curve. Although there are no data specifically pertaining to the learning curve for robotic IUR, the literature regarding robotic radical cystectomy with intracorporeal urinary diversion suggests that the learning curve is approximately 140 cases.[8]

The current body of literature regarding robotic IUR is limited to small, single-center case series. In the largest series to date, Yang et al reported 15 patients who underwent intracorporeal robotic IUR.[9] At a median follow-up of 14 months, they reported a subjective success rate (defined as absence of urinary hardware and symptoms, and no radiographic evidence of obstruction) of 100.0%. The authors reported no major (Clavien >2) complications. Although single-institutional reports regarding robotic IUR do provide some insight into the safety and efficacy of the procedure, further studies with larger patient cohorts are necessary. However, generating large robotic IUR series is difficult as patients with long-segment ureteral strictures not amenable to substitution ureteroplasty with BMG and/or appendix are rare. For this reason, we have formed a multi-institutional collaborative with New York University and the University of Colorado. Our unpublished cohort currently consists of 39 patients who underwent intracorporeal robotic IUR. At a median follow-up of 14 months, there was a 90.9% success rate. There was a 20.5% major (Clavien >2) complication rate, which is similar to those reported in the open IUR literature. Through our multi-institutional collaborative, we hope to include more surgeon members to enlarge study populations, assess long-term success rates and complications, and prospectively answer clinically meaningful questions. ■

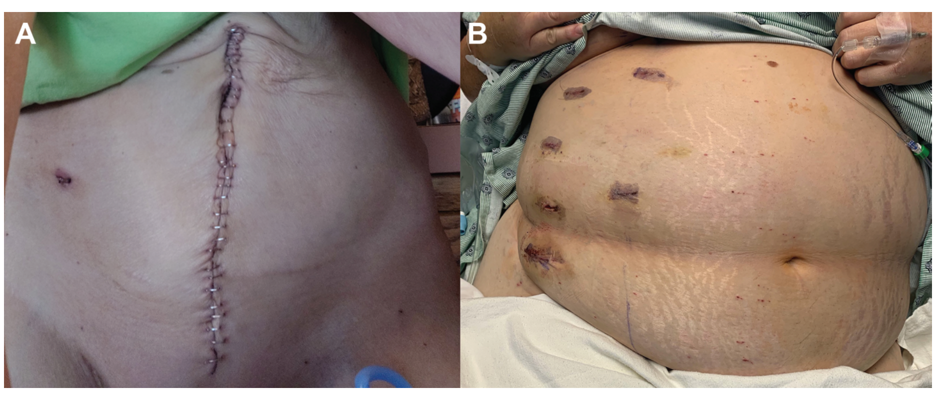

Figure 2. Incision made to perform open (A) and robotic (B) right ileal ureter replacement.

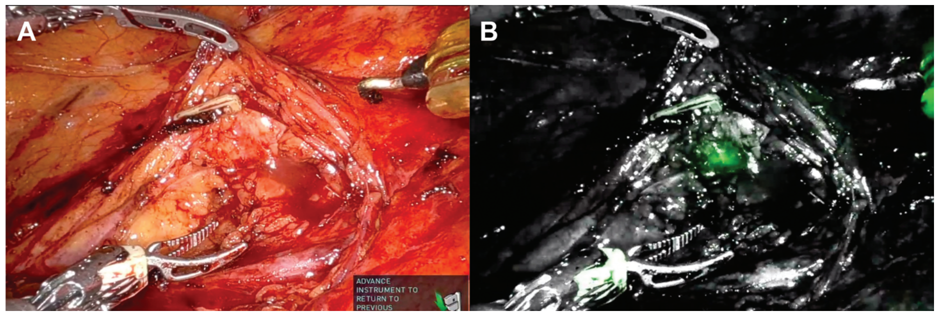

Figure 3. A, Difficulty with identification of ureter under white light due to severe periureteral fibrosis. B, Identification of proximal segment of ureter through severe periureteral scar after intraureteral injection of indocyanine green with visualization under near-infrared fluorescence.

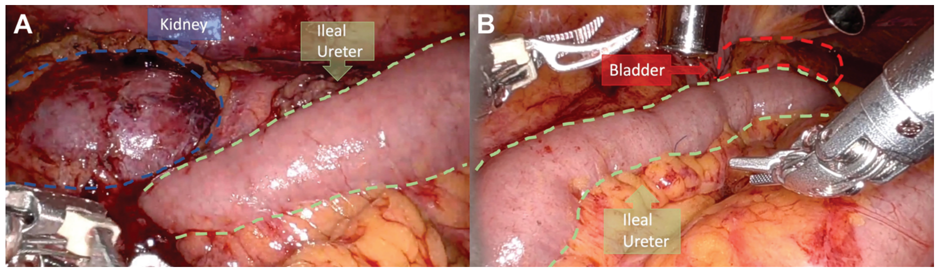

Figure 4. Completed ileal ureter demonstrating large surgical field. A, Anastomosis of ileal segment to renal pelvis. B, Anastomosis of ileal segment to bladder.

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ROBOTICS

Changing the Paradigm of Posterior Urethral Stenosis Using the Surgical Robot

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Posterior urethral reconstruction poses a challenge due to the need for visualization and repair in deep and narrow spaces, with close proximity to the external urethral sphincter. Posterior urethral stenoses commonly result from iatrogenic injury such as previous bladder outlet procedures or due to treatment effect of prostate cancer. Furthermore, patients often have significant compromise of their quality of life requiring regular dilations, intermittent catheterization, or suprapubic cystostomy.

Traditional treatment methods, including transabdominal and perineal approaches, are challenging and can lead to urinary incontinence, and frequently require pubic osteotomy. With the surgical robot, many of these difficulties can be circumvented due to dexterity and visualization in confined spaces. The advantages the robot offers are multifold: 3 double-jointed arms via minimally invasive trocars, enhanced 3D visualization, and adjuvant technology to assist with dissection and assessment of tissue viability. With the single-port robot, surgeons decrease the working space required for robot utilization, reduce operative times, as well as minimize the disruption of blood supply to the already scarred and diseased tissue. If perineal dissection is needed due to inability to reach the distal extent of the disease, the single-port robot can also be floating docked for deep perineal dissection (Figure 1). Multiple studies have shown improved and durable rates of success with lower rates of incontinence compared to open reconstruction.[1,2] Furthermore, surgeons have access to adjuvant technology to assist with tissue identification and assessment.

> “The advantages the robot offers are multifold: 3 double-jointed arms via minimally invasive trocars, enhanced 3D visualization, and adjuvant technology to assist with dissection and assessment of tissue viability.”

Key Adjuvant Technology With the Surgical Robot

Near-infrared fluorescent imaging helps to identify urinary tract structures through transillumination of the cystoscope. This can be particularly useful with urethral identification in patients with significant scar from previous surgery or urinoma. In case of a long-segment stricture, both antegrade and retrograde cystourethroscopy can be used to guide dissection of healthy proximal and distal urethra, respectively. Figure 2 shows near-infrared fluorescent imaging use for identification of the distal extent of the stenosis.[3]

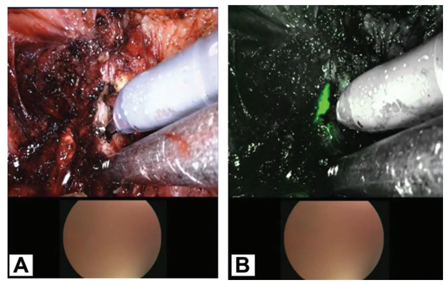

Figure 2. Near-infrared fluorescent imaging combined with cystoscopy can help surgeons safely identify the urethral lumen.

Indocyanine green is another useful tool. This is commonly used for ureteral identification via injection into the ureter (off label). For lower urinary tract reconstruction, indocyanine green may be given intravenously for assessment for tissue vascularity. This technique is useful to assess the health of the urothelium prior to anastomosis or health of the graft bed if a mucosal graft will be used for urethroplasty.

Hydrodissection during dissection can also be used to help separate tissue planes and avoid injury to adjacent structures, such as the rectum. Laparoscopic delivery of a small-gauge needle with bedside assistance for saline injection can greatly assist safe dissection of scarred planes, as seen in Figure 3.[3]

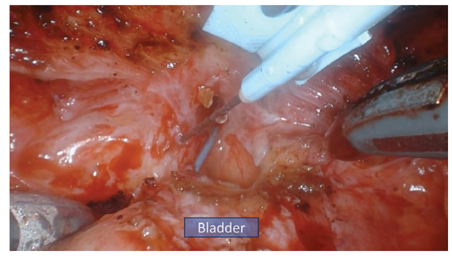

Figure 3. Hydrodissection can assist in safe dissection in scarred planes. Here, the vesicourethral anastomotic stenosis is hydrodissected to safely bring the urethra away from the rectum posteriorly.

Preoperative Considerations

Characterization of the stenosis is critical in identifying the best procedure. Is the urethra obliterated or narrowed? What is the gap that must be traversed for reconstruction? Does the prostate remain in situ? Is there necrosis or dystrophic calcification? What was the patient’s continence prior to development of stenosis? Is there concomitant disease in the anterior urethra?

Some of these questions may be answered preoperatively with fluoroscopic studies or exam under anesthesia. Though preoperative diagnostics can provide insights, surgeons must be prepared for complexities encountered during reconstruction. We outline a simplified algorithm for management of posterior urethral stenosis in Figure 4.

Techniques of Posterior Urethroplasty With the Surgical Robot

The techniques used to treat anterior urethral strictures can be applied to the posterior urethra based on the principles of robust blood flow for anastomosis or graft bed and a tension-free watertight closure. Transabdominal posterior urethral reconstruction lends more flexibility as the bladder is well perfused and its mucosa can be used for augmentation. Additionally, other bladder pathologies can be treated simultaneously. If the patient has a concomitant bladder diverticulum, this can be addressed through the same incision. Additionally, the mucosa of the bladder diverticulum can be utilized for urethroplasty if required.

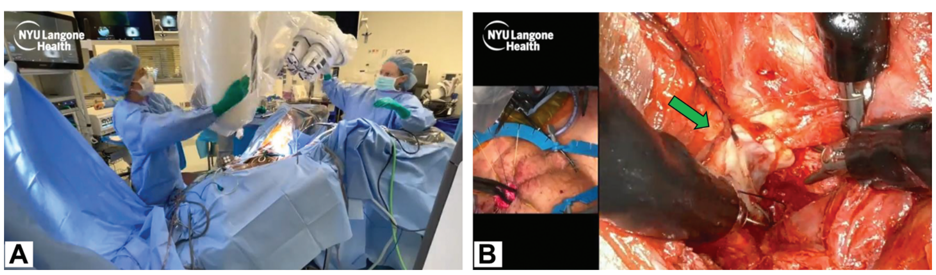

Figure 1. A, Perineal view. Float-docking with the single-port robot can be utilized to suture transperineally. B, Robotic view. The buccal graft (green arrow) is secured to the graft distally from the perineum using float-docking.

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CHANGING THE PARADIGM OF POSTERIOR URETHRAL STENOSIS USING THE SURGICAL ROBOT

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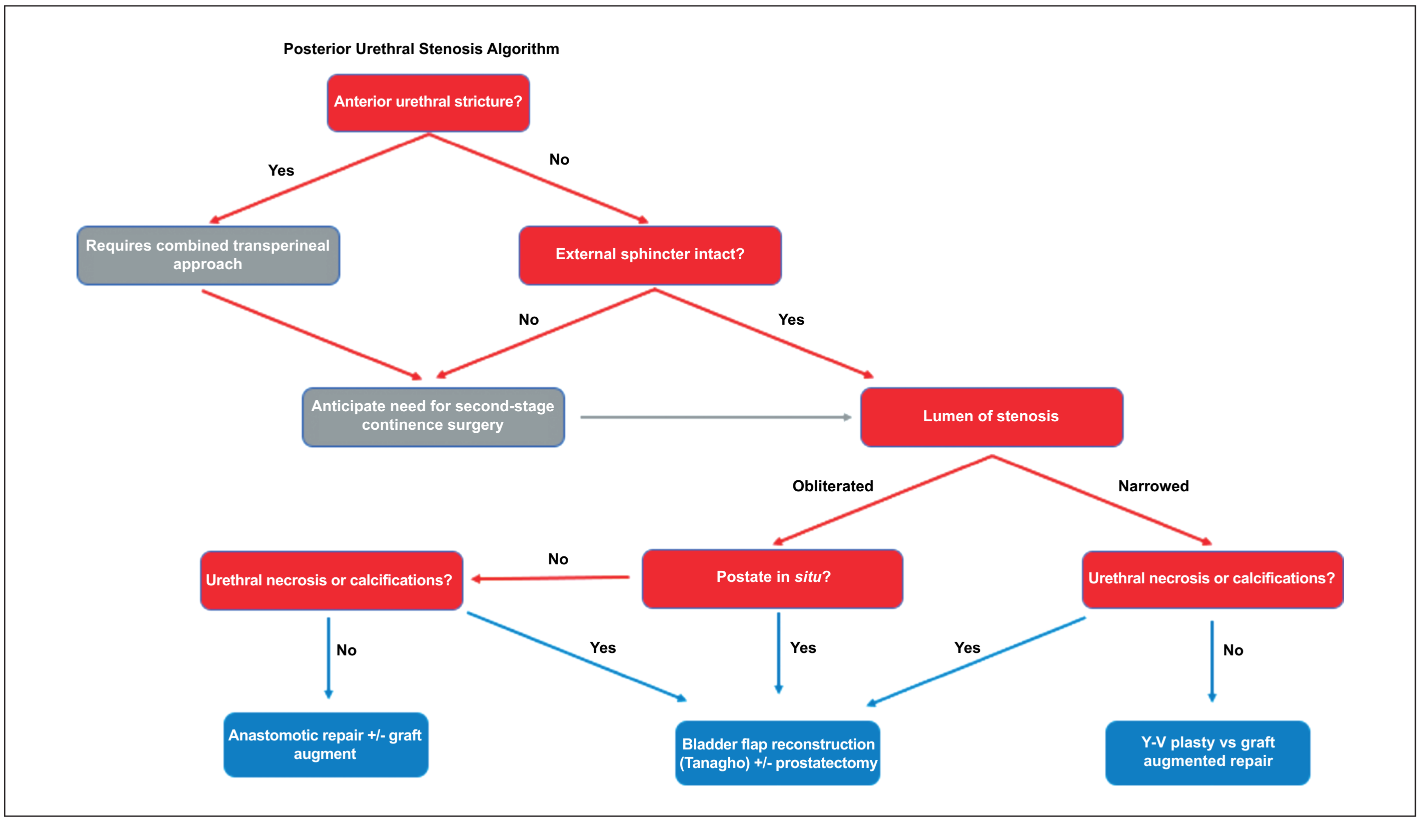

Figure 4. Simplified algorithm for management of posterior urethral stenosis.

An anastomotic urethroplasty can be performed if safe circumferential dissection can be achieved. This technique is required in instances of urethral obliteration and urethral or prostatic necrosis. In cases of necrosis or dystrophic calcification, we resect the diseased urethral segment, close the bladder neck, and perform a new anastomosis via a new, anterior cystotomy, as shown in Figure 5.[4,5]

In cases with a patent lumen without necrosis, the anterior bladder

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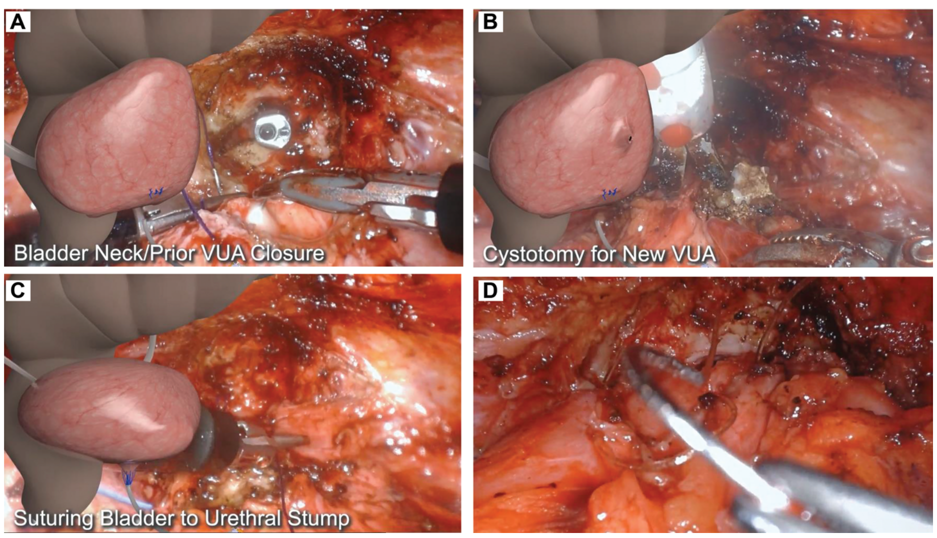

Figure 5. Bladder flap for new vesicourethral anastomosis (VUA) in cases of prostatic or urethral necrosis with a large remaining defect. A, The bladder neck is closed in 2 layers. B, A new cystotomy is made for the new anastomosis. C and D, The new anastomosis is secured to the urethral stump.

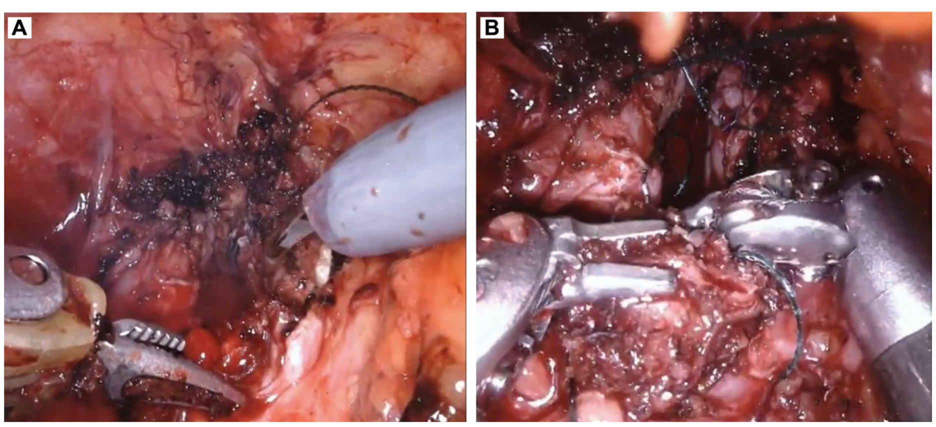

Figure 6. YV plasty for posterior urethral reconstruction can be useful for short stenoses without an obliterated lumen. A, After an anterior urethrotomy is made (Y), a V-shaped bladder flap is created. B, Advancement of the apex of the bladder flap into the distal extent of the urethrotomy.

> "The integration of robotic surgery in the management of posterior urethral stenosis marks a paradigm shift in urologic surgery by expanding the range of viable surgical techniques."

can be used as an advancement flap. An inverted Y-shape is incised across the stenosis with the wings of the Y forming the 2 sides of the bladder flap. This V-shaped bladder flap is then advanced tension-free to the distal extent of the urethrotomy, as seen in Figure 6.

In cases where YV plasty is not feasible, or if there is concomitant anterior stricture, buccal mucosa graft may be required for augmentation. This will often require concomitant perineal dissection, and securing the graft may be challenging. The robot can also be used for perineal dissection and urethroplasty, as seen in Figure 1.

The integration of robotic surgery in the management of posterior urethral stenosis marks a paradigm shift in urologic surgery by expanding the range of viable surgical techniques. Furthermore, the use of adjunctive technology can help with safe dissection in challenging and tightly confined spaces. ■

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ROBOTICS

Description of Robotic Early Postprostatectomy Anastomotic Repair Technique and Institutional Outcomes

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Introduction

Vesicourethral anastomotic leak (VUAL) is a known complication following radical prostatectomy. The incidence of VUAL is approximately 1% in the modern era of robotic-assisted radical prostatectomy (RARP).[1] The development of VUAL after RARP is multifactorial and risk factors likely include anastomotic technique, obesity, large prostate size or presence of a median lobe, and postoperative hematoma.[2-4] Clinically, patients present with pelvic pain, irritative voiding symptoms, or severe ileus before the VUAL diagnosis is made.[2]

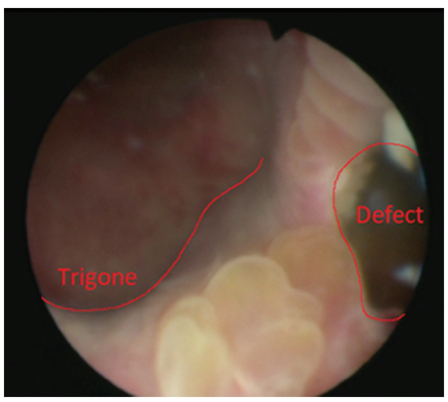

Figure 1. Cystoscopy demonstrating a partial view of the anastomotic disruption (labeled "Defect") at the 5 o'clock position of the bladder neck.

Sequelae of a VUAL include infection, incontinence, and vesicourethral anastomotic stricture. The VUAL management approach and duration are variable and without expert consensus. Management has traditionally consisted of conservative measures such as prolonged catheterization and intra-abdominal drainage.[5] If the VUAL is persistent, several techniques have been reported to aid in resolution. These include traction on the urethral catheter, a continuous needle vented suction system, ureteral catheter placement with externalization and suction system, as well as other modifications.[6-10] Surgical revision has long been regarded as a last resort intervention after conservative measures have failed.[2,8]

To our knowledge, early robotic surgical revision has not been explored as an option for definitive management of VUAL in a contemporary RARP cohort. We present a novel Robotic Early Postprostatectomy Anastomotic Repair (REPAiR) technique for early (<6 weeks of index procedure) intervention of men who developed VUAL after RARP. Our intention is to evaluate this approach's safety and short-term institutional results.

Materials and Methods

A retrospective review of a prospectively maintained database between July 2016 and October 2022 identified patients who underwent REPAiR. "Early" was defined as within 6 weeks of the index RARP. All index RARPs were completed in a multiport, transperitoneal fashion. No patients had a history of prior pelvic radiotherapy. Patients were diagnosed with VUAL on CT urogram or cystogram.

The primary outcome of interest was resolution of anastomotic leak, defined as no contrast extravasation on postoperative cystography. Secondary outcomes included postrepair catheter duration, 30-day readmission rates, and continence.

With respect to the surgical technique, the REPAiR technique is a transvesical approach and was implemented utilizing a multiport robotic platform for all cases under a single surgeon.

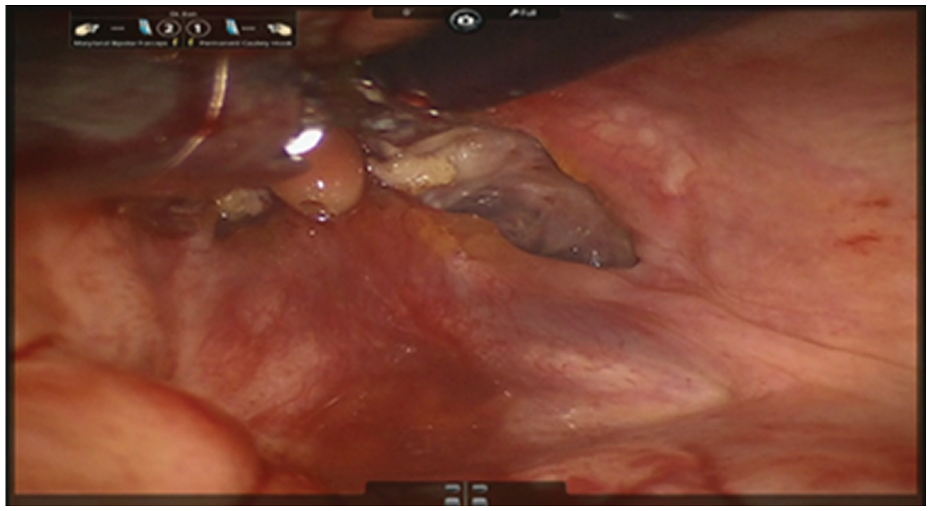

Figure 2. The vesicourethral anastomotic leak is inspected and anastomotic repair is performed by reapproximating the urethral mucosa with the bladder mucosa. The urethral catheter, or bedside assistant via cystoscopy, can facilitate with locating the urethral lumen. Fibrinous or necrotic tissue can be excised to aid in a tension-free mucosa-to-mucosa anastomosis.

Cystoscopy and Robotic Port Placement

A cystoscopy is primarily performed to visualize the extent and location of the VUAL (Figure 1). We reuse the ports from the prostatectomy, but without the lateral 12-mm assist port.

Dissection and Access

After lysis of adhesions and drainage of any posteriorly located, loculated urinomas, a small cystotomy at the bladder dome is created. The bladder mucosa is then examined, taking note to locate the ureteral orifices as well as any other anatomical aberrations to take into consideration during the repair.

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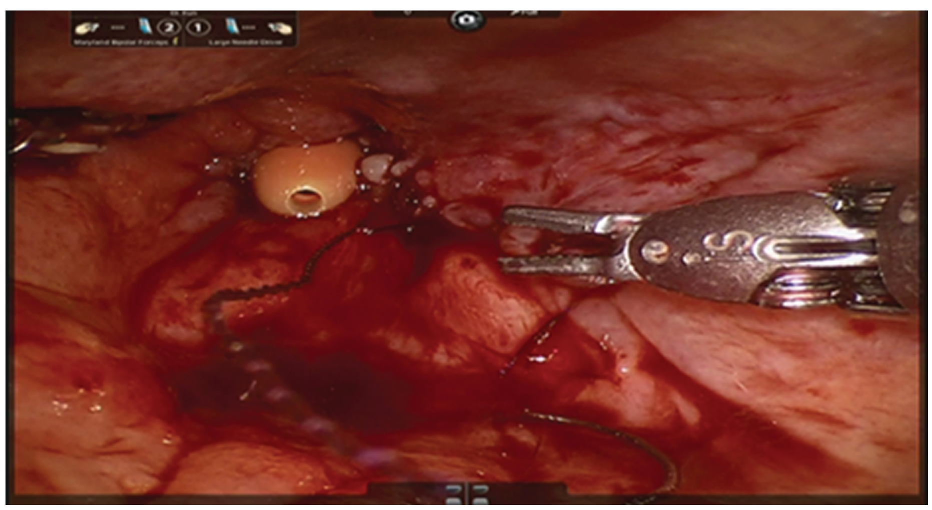

Figure 3. The anastomosis is completed and an 18F urethral catheter is inserted.

DESCRIPTION OF ROBOTIC EARLY POSTPROSTATECTOMY ANASTOMOTIC REPAIR TECHNIQUE

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"At median follow-up time of 24.9 months, 8 patients reported using no pads/d and 3 patients reported 1 pad/d. There were no readmissions from any patients at the 30-day postoperative timepoint and no major Clavien-class complications."

Table 1. Patient Demographics and Leak Characteristics

Patient	Age	BMI	Diagnostic modality	Location of defect	Days from index surgery to intervention
1	63	28.3	CT urogram	Posterior	49
2	75	28.3	CT urogram	Posterior	25
3	58	24.3	Fluoroscopic cystogram	Posterior	14
4	68	26.8	CT cystogram	Right posterior	11
5	50	26.4	CT urogram	Left posterior	19
6	65	33.8	CT urogram	Right and left posterior	14
7	57	32.3	CT cystogram	Circumferential	32
8	59	27.0	CT cystogram	Right	1
9	60	32.5	CT cystogram	Posterior	14
10	58	26.4	CT cystogram	Circumferential	22
11	55	27.4	CT cystogram	Posterior	35
	60.7 (±6.8)	28.5 (±3.1)			21.5 (±13.3)

Anastomotic Repair

Noting the location of the defect(s), the bladder mucosa is advanced distally toward the membranous urethra with a 3-0 barbed absorbable suture in a running fashion effectively closing the defect (Figure 2). Necrotic or fibrinous tissue can be excised to ensure the reapproximation of viable tissue. It is critical to obtain a tension-free, watertight mucosa-to-mucosa anastomosis. Following completion of the anastomosis, an 18F urethral catheter is inserted into the bladder for a duration of 1 to 2 weeks, depending on the quality of the repair (Figure 3).

Results

Eleven patients were identified and underwent REPAiR. All 11 patients had a component of posterior anastomotic disruption, ranging from a small localized segment to complete 360° disruption. Mean time to intervention after RARP was 21.5 days (Table 1).

Eight of the 11 patients (72.7%) had no evidence of extravasation on post-repair cystogram, which was the primary outcome of interest. The range from intervention to first cystogram was 7 to 20 days. Median catheter duration for those with successful intervention was 10 days. Three of 11 patients (27.3%) did have a leak on the postoperative cystogram and median catheter duration for this subset was 20 days (Table 2).

Secondary outcomes were length of catheter time and 30-day readmission rates. Mean console time was 107 minutes. There were no intraoperative complications. The mean length of stay was 2.0 days, with a range of 0 to 5 days (Table 2).

At median follow-up time of 24.9 months, 8 patients reported using no pads/d and 3 patients reported 1 pad/d. There were no readmissions from any patients at the 30-day postoperative timepoint and no major Clavien-class complications.

Discussion and Conclusion

VUAL is a feared complication of prostatectomy. Management of VUAL has long relied on prolonged catheter drainage and is without expert consensus.[2] In the era of robotic reconstruction, it is important to reconsider prior dogmas that were established in the era of open surgery. The vast majority of VUAL occurs at the posterior anastomosis and is readily accessible via a small posterior cystotomy. Once transvesical, the repair should be straightforward and reproducible. Complete anastomotic disruptions can be more complex as one may need to suture in a very tight and limited anatomic space. Overall, our REPAiR technique was successful with 72% of patients having resolution of their VUAL and median catheter duration of 10 days after their negative cystogram. This series additionally reveals that the REPAiR technique for VUAL repair is safe. There were

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Table 2. Results and Outcomes

	Hospital length, d	EBL, cc	Console time, min	Successful intervention	Foley length, d	Length of follow-up, mo	Continence, pads/d
Patient 1	2	50	60	Y	5	78	0
Patient 2	3	50	89	Y	8	37	0
Patient 3	1	50	120	Y	9	52	0
Patient 4	3	100	144	N	35	12	0
Patient 5	3	25	114	Y	11	10	0
Patient 6	1	50	138	Y	20	5	1
Patient 7	2	25	122	Y	21	38	0
Patient 8	1	30	80	Y	14	16	1
Patient 9	2	50	112	N	56	20	0
Patient 10	5	50	115	N	40	4	1
Patient 11	0	75	91	Y	8	1	0
	2 (±1.4)	50 (±21.8)	107 (±25.2)		20 (±16.3)	24.9 (±24.0)	0.3 (±0.5)

Abbreviations: EBL, estimated blood loss; N, no; Y, yes.

DESCRIPTION OF ROBOTIC EARLY POSTPROSTATECTOMY ANASTOMOTIC REPAIR TECHNIQUE

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no intraoperative complications, 30-day readmissions, nor Clavien class > 3 complications during a 2-year follow-up.

With increasing emphasis on patient-reported outcomes, catheter duration and VUAL are likely associated with significant short-term quality of life impairment and patient regret, although not directly measured herein. Early surgical repair options have scarcely been employed nor presented in the literature. Although REPAiR technique doesn't have a 100% success rate, it is a novel approach that is a departure from the traditional mantra of conservative management "till death do us part." Preoperative counseling is paramount as patients need to understand that this is a new approach without extensive experience. The REPAiR technique gives the urologic surgeon an additional tool in aiding patient recovery and potentially improving patient satisfaction, without adding significant morbidity in appropriately selected patients. ■

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ROBOTICS

A Quick and Effective Solution Prevents Postprostatectomy Lymphoceles: Are You Doing This Yet?

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Pelvic lymphoceles are a known adverse outcome following lymphadenectomy during extirpative pelvic urologic surgeries, most notably radical prostatectomy. The incidence of any lymphocele after radical prostatectomy with pelvic lymph node dissection (PLND) varies depending on how they are diagnosed (ie, clinically vs radiographically) and on the defined follow-up interval, with reported rates of 8.4% to 51%. Symptomatic lymphocele, which can be associated with infection and compression of pelvic structures, is seen in 2% to 8% patients after prostatectomy and lymphadenectomy.[1]

Lymphocele morbidity is well established and can include severe sequelae such as deep vein thrombosis and sepsis. If lymphatic fluid can be reabsorbed by peritoneal surfaces, then why does an intraperitoneal lymphocele occur after transperitoneal prostatectomy? We believe that lymphocele formation after a transperitoneal procedure with PLND occurs as a result of bladder adherence to the pubic bone and pelvic sidewall. A pocket of lymphatic fluid near the PLND bed is therefore excluded from the rest of the peritoneal cavity. As the lymphatic fluid accumulates within this space, it may be prone to infection or adjacent iliac vein compression. Thinking about it in this way explains why lymphoceles are so rare after radical cystectomy—the bladder is not there to exclude any fluid pockets, allowing lymphatic fluid to be absorbed by the peritoneum.[2]

> "Lymphocele morbidity is well established and can include severe sequelae such as deep vein thrombosis and sepsis."

When we first conceived of using the peritoneum to prevent this from happening, the key observation was simple: the visceral peritoneum of the bladder exists natively on its posterior surface, but not laterally. If we can affix peritoneum to the bladder's lateral surface (the part that scars to the pelvic sidewall) it cannot scar to the sidewall and sequester fluid. The peritoneal advancement flap (PAF) deliberately provides the bladder with lateral visceral peritoneum before exiting the case. This technique was nearly identical to the technique we employed when creating a peritoneal window in a patient with a preexisting lymphocele. So, our thought was, why not preemptively create a PAF window in all patients who have PLND?

Available peritoneal surface is rotated, advanced, and interposed between the bladder and the lymphadenectomy bed using a four-point fixation of 3-0 vicryl suture (Figure). With the peritoneum now covering the lateral aspect of the bladder, it can no longer "stick" to the pelvic sidewall due to its unique properties. Lymphatic fluid in that pelvic "gutter" will always have a clear pathway or funnel into the peritoneal cavity where it can be absorbed.

PAFs have been consistently shown to decrease the rate of lymphocele formation. Initial development of PAFs occurred at Lahey Hospital and Medical Center.[2] Our retrospective review of 155 patients in 2015 demonstrated that compared to patients undergoing robot-assisted laparoscopic prostatectomy (RALP) without peritoneal flap interposition, in which lymphoceles formed in 9 of 77 (11.6%), not a single patient who had peritoneal interposition developed pelvic lymphoceles after a mean follow-up time of 379 days (P=.003).

Since our initial report, numerous studies have replicated similar results, including randomized

Figure. Scan this QR code for a 7-minute video explaining the peritoneal advancement flap technique.[4]

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A QUICK AND EFFECTIVE SOLUTION PREVENTS POSTPROSTATECTOMY LYMPHOCELES

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control trials (PELYCAN), and meta-analyses. In a recent meta-analysis, patients who underwent PAF at the time of RALP+PLND had lower odds of lymphocele formation compared to their counterparts without flaps (OR 0.82, 95% CI 0.27-1.37).[1] Similarly, performing PAF during RALP+PLND was associated with fewer asymptomatic and symptomatic lymphoceles in the PELYCAN trial.[3]

The evidence is clear. A properly performed advancement flap either prevents or significantly lowers the risk of symptomatic pelvic lymphoceles. This begs the question: why aren't all surgeons doing this routinely? The technique required to perform this procedure step is relatively straightforward for robotic surgeons to learn and can take less than 5 minutes to perform

> "A properly performed advancement flap either prevents or significantly lowers the risk of symptomatic pelvic lymphoceles."

with experience. We recommend that surgeons dissect lateral to the obliterated umbilical artery when dropping the bladder. Doing so allows for additional peritoneum to be available for the flap.

Are there downsides? We can answer this anecdotally, as there are 2 theoretical issues worth mentioning. Like most "suture this to that" maneuvers in surgery, if one chooses the peritoneal flap position incorrectly (too medially), by advancing bilateral flaps it is possible to wrap the peritoneum too tightly around the bladder dome, potentially decreasing functional bladder capacity. Second, if the "near" suture fixation near the obliterated umbilical artery is aggressively taken too deeply, ureteral injury might occur. We have never seen this. Lastly, situations which may impede or prohibit this technique include cases of abundant perivesical fat and instances in which the peritoneum is not preserved during the bladder drop (ie, prior laparoscopic hernia repair with mesh).

Due to its established association with decreased lymphocele formation after RALP, its straightforward learning curve, and its negligible impact on surgical time, we agree with the studies calling for the incorporation of PAF into guidelines focused on the surgical management of prostate cancer.[1,3] Have you started doing this for your patients yet? ■

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ROBOTICS

The Evolution of Robotic Surgery in Urology: A Historical Perspective of the Preceding Laparoscopic Era

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The evolution of robotic surgery in urology began with minimally invasive surgery (MIS)/laparoscopic advances in the early 1990s across several subspecialties—but mainly general surgery. My chance encounter with my future career choice goes back to college days in the late 1980s when I was running errands with my father, who practiced many years in Atlanta as an internist/endocrinologist. We ran into one of his general surgeon colleagues in the parking lot who stopped to say hello, but then wanted to show us something exciting he had just acquired. We gathered around the trunk of his car as he showed us a large metal case full of laparoscopic instruments he had bought and described his plans to train and learn laparoscopic cholecystectomy. From a distance, I wondered if the 3 of us standing around a large open car trunk looked like we were doing "business" in a scene from *The Sopranos.* It was difficult to just look at the box of instruments and imagine the possibilities. As the surgeon described, with these small incisions, small instruments, and working on a camera, patients could have major surgery but fast recoveries—seemed simple enough.

Fast forward a few years to medical school rotations in 1993 and laparoscopic cholecystectomy was a real thing, but learning curves were going on throughout departments, and in training this was considered a "chief resident case." Fast forward again to general surgery internship in 1994, and now laparoscopic cholecystectomy was already a junior resident case, while pioneers in MIS were moving on to hernias and colon resections. Meanwhile in urology, MIS was a bit on the slow side of development—mainly due to the lack of a common/straightforward case like laparoscopic cholecystectomy to practice. It was a big leap in skills to just go right to laparoscopic nephrectomy or prostatectomy. Some highly skilled pioneers learned such difficult cases,[1] but while general surgery residents were performing laparoscopic cholecystectomy in high volumes, urology residents were just holding the camera for long laparoscopic nephrectomies.

> "Meanwhile in urology, MIS was a bit on the slow side of development—mainly due to the lack of a common/straightforward case like laparoscopic cholecystectomy to practice."

Three representative publications from the late 1990s stand out as examples of the challenges but opportunities ahead. Inderbir Gill published a concept paper in 1998 on using laparoscopy to isolate small renal masses, and rather than resect and get into complex reconstruction steps, just use an ablation method such as cryoablation.[2] These were much simpler cases and demonstrated that technology advances could likely simplify challenging learning curves. Looking back, I love the fact that his paper only had 11 patients but has been cited over 200 times—a great ratio! Meanwhile there were some bumps in the road, as the small fraternity of laparoscopic pioneers tackled

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THE EVOLUTION OF ROBOTIC SURGERY IN UROLOGY

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> "Overall, the robotic platform solves multiple needs that came out of the preceding laparoscopic era, including (1) 3D vision, (2) better surgeon ergonomics, (3) better/safer instrumentation with articulation (Figure 2), (4) faster operating room times, (5) reduced learning curve, and (6) a more successful roll out of technology into routine practice."

laparoscopic prostatectomy. They famously reported that it was feasible, but that the reconstruction was difficult and the outcomes showed no benefit.[3] However, as a lesson to future surgeons, papers describing a procedure as having "no benefit" should be interpreted carefully to discern whether the lack of benefit is solvable or not. Indeed, a group of French surgeons then came along and basically demonstrated that if you really practice the anastomosis and reconstructive skills required, you can reduce the operative times significantly and come up with an experience that mimics what we are more familiar with–reasonable surgery times, equivalent cancer control, less bleeding, and faster recovery.[4]

Bringing our narrative to the 2000 to 2002 era, there were 2 big problems that emerged: (1) instrumentation/vision limitations, and (2) a lack of training opportunities. In this era, laparoscopic was a real thing in urology. However, we were still operating with nonarticulating instruments with vessel sealing technologies limited to monopolar and bipolar. As demonstrated in Figure 1, the monopolar scissor could dissect well but could not handle larger vessels. In addition, the entire metal collar of the instrument was hot, and many surgeons described complications where bowel would get too close to the instrument and suffer a thermal injury. These complications really limited training opportunities until advances like the LigaSure would allow the safer sealing of larger vessels with protection of surrounding structures. Surgeons still had to learn how to operate on 2D cameras, and learning curves were long. There were actual narratives ongoing at the time that if urology did not fix the training and roll out MIS in the field, general surgery experts in MIS would start migrating into our turf. More than a handful of surgeons such as myself, Matt Gettman (Minnesota), and Jim Porter (Washington) all improvised various training rotations in Europe to navigate the difficult learning curves. There were only a few fellowships with high volume MIS training, and they could only train 1 to 2 a year each.

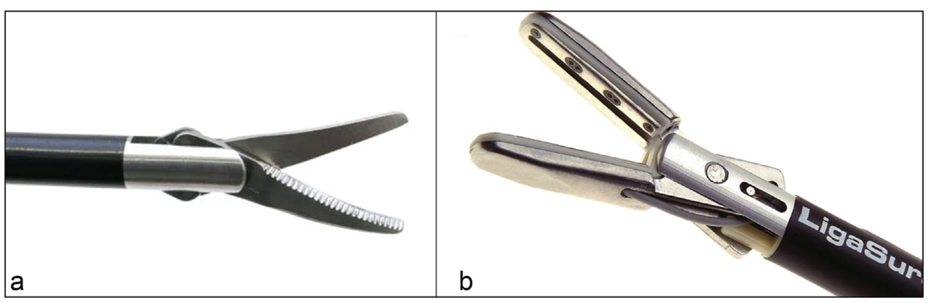

Figure 1. Early laparoscopic instrumentation advances. A, The simple laparoscopic scissors were useful, but the entire metal tip and collar were included in the monopolar current and adjacent organ injury could occur. B, The LigaSure instrument allowed for the sealing of larger vessels and the surrounding metal was not part of the current, which improved the safety profile of the procedures.

Figure 2. At Intuitive Surgical headquarters, they display their chronology of robotic platform arms from the various systems. Over the course of robotic platform and instrument upgrades, surgeons have access to longer instruments, articulating tips, and a library of different possibilities for cutting, grasping, sealing, and dissecting.

> "With this platform, many pioneers in robotics could tackle a large range of urologic procedures and optimize what the laparoscopic pioneers dreamed of 10 years before—effective surgery with faster recovery."

And then "The Robot"…

There were some precursors to modern robots. One was called Aesop, which was a single-arm robot that held a laparoscopic camera and could move with manual control or voice-activated commands. This certainly took a lot of the camera shake out of the operation from asking a medical student or junior resident to hold it in an uncomfortable position for several hours. Later, that company built a full-scale robot called Zeus that added a 3D open frame console and multiple arms. Da Vinci launched at that time and by comparison looked like a massive footprint to have in the operating room compared to Zeus. The companies spent a lot of time in litigation against each other before merging and marketing the original da Vinci platform. Of note, there was another fun narrative that was commonly described at meetings: the robot as a learning tool but not the end product. Many laparoscopic experts thought the robot would be good for beginners but that over time, they would gravitate back to laparoscopy.

Most current surgeons and residents know the benefits of robotics well at this point and can understand how laparoscopy is less utilized. Overall, the robotic platform solves multiple needs that came out of the preceding laparoscopic era, including (1) 3D vision, (2) better surgeon ergonomics, (3) better/safer instrumentation with articulation (Figure 2), (4) faster operating room times, (5) reduced learning curve, and (6) a more successful roll out of technology into routine practice. With this platform, many pioneers in robotics could tackle a large range of urologic procedures and optimize what the laparoscopic pioneers dreamed of 10 years before–effective surgery with faster recovery. ■

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ROBOTICS

Robotic Prostatectomy: A Game-Changer in Prostate Cancer Treatment

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Currently about 40% of men with newly diagnosed prostate cancer elect for curative-intent treatment with radical prostatectomy (RP), more than 90% of which are performed with robotic assistance (RARP). Improvements in RP outcomes have gone hand in hand with improvements in the anatomic understanding of male erectile and continence mechanisms. The evolution of the modern prostatectomy (Figure 1) is fully rooted in anatomy and augmented by tools which help visualize and preserve that anatomy, such as robotics.

The Early Years: 1866-1982

In 1866 Kuchler described the first radical perineal prostatectomy, which was subsequently modified and disseminated by Hugh Hampton Young in 1905. Although the perineal route provided good access and exposure to the prostate, most urologists had little or no experience with this approach, leading to a high incidence of urinary fistula and rectal injury and limited utilization. Forty years later Millin described the radical retropubic prostatectomy. Both techniques were exclusively performed in a few US centers, often palliatively, for relief of obstructive symptoms. Unsurprisingly, most men elected for radiation rather than curative-intent RP due to the debilitating side effects.

Introduction of Nerve-Sparing Technique (1982-1995)

In 1982, Patrick Walsh developed an anatomic approach to RP, incorporating early dorsal venous complex control and neurovascular bundle preservation which was quickly adopted by urologists leading to increased utilization of RP. Volumes peaked in the early 1990s, likely corresponding to introduction of widespread PSA screening.[1] During that time, in-hospital complication rates decreased from 38% to 30%, and mean length of stay decreased from 8.1 to 5.1 days.[1] The 3-year incontinence rate decreased from 20% in 1991 to 4% in 1995, although the rates of erectile dysfunction remained stable around 30%.[1]

The Minimally Invasive Era: Technology Dissemination (1995-2009)

The feasibility of laparoscopic prostatectomy was demonstrated by Clayman in 1991; however, prolonged operative times, a steep learning curve, and a failure to demonstrate major advantages over open surgery limited its widespread adoption in the US (although it continued to be performed in Europe).[2]

The game changer for the adoption of minimally invasive prostatectomy came with the introduction of RARP in the early 2000s with the Food and Drug Administration approval of the da Vinci robotic system. Shortly after, in 2001, the feasibility of RARP using the Montsouris technique was demonstrated.[3] The authors conclude that the "3-dimensional view of the operating field provides a real benefit for the surgeon, and the urethro-anastomosis is easier to perform. The benefit for the patient is presently not very clear… our initial results show that the robotically assisted procedure is at least as safe and effective as the conventional laparoscopic procedure."[3]

The technique spread rapidly, and by 2007, at least 40% of all prostatectomies in the US were performed robotically.[4] Yet, despite rapid uptake, studies generally failed to show that robot prostatectomy is overwhelmingly superior in terms of cancer control and cancer outcomes as surgeon heterogeneity and skill are crucial components.[5]

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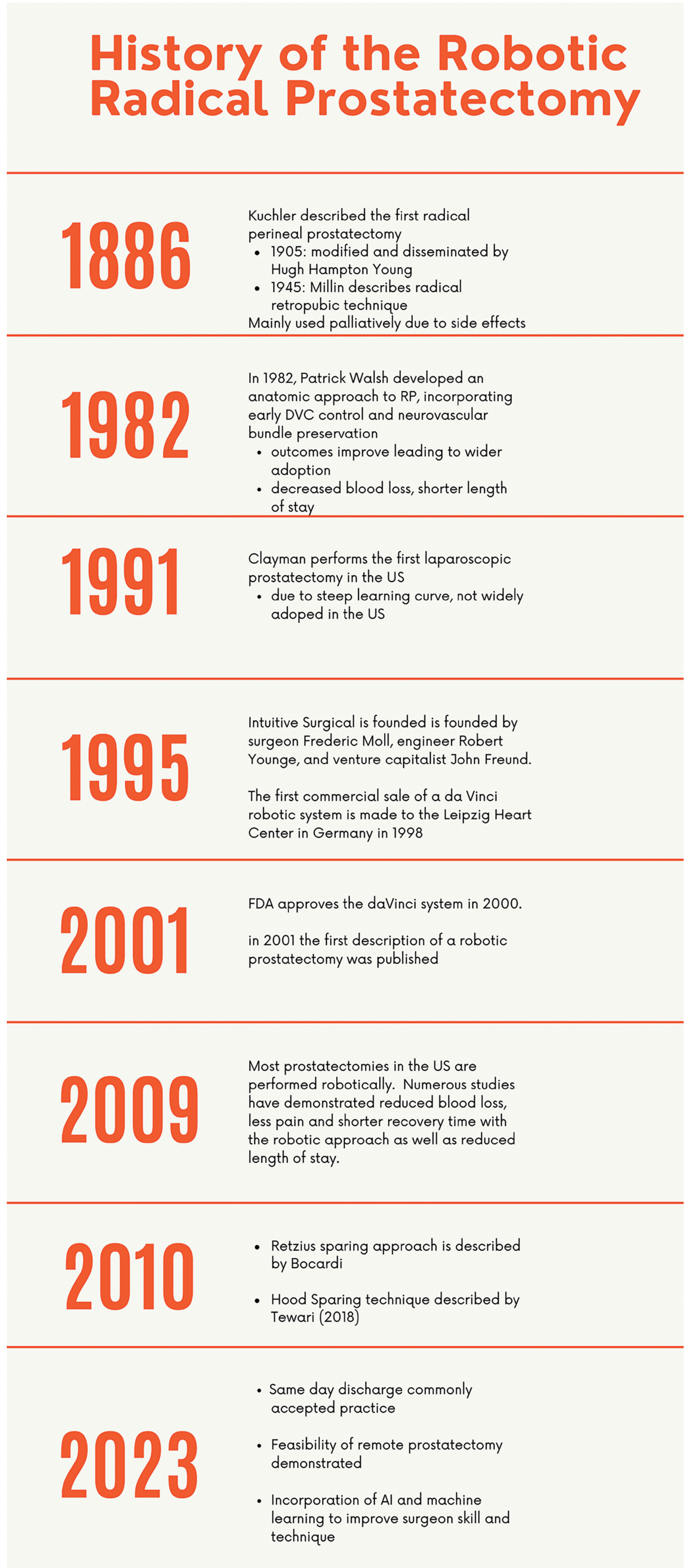

Figure 1. Timeline of the evolution of modern-day robotic prostatectomy. AI indicates artificial intelligence; DVC, dorsal venous complex; FDA, Food and Drug Administration; RP, radical prostatectomy; US, United States.

ROBOTIC PROSTATECTOMY: A GAME-CHANGER IN PROSTATE CANCER TREATMENT

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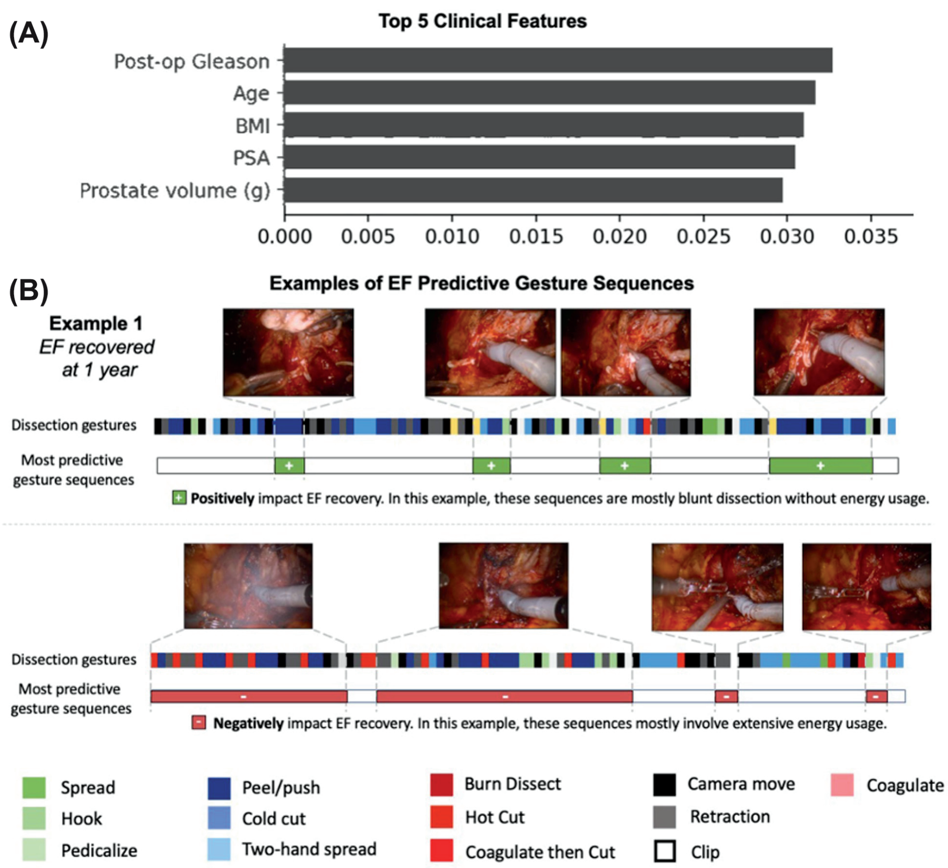

Figure 2. Important clinical features (A) and gesture sequences (B) for 1-year erectile function (EF) prediction. Reprinted with permission under CC BY 4.0. Ma R et al, Surgical gestures as a method to quantify surgical performance and predict patient outcomes. NPJ Digit Med. 2022 Dec 22;5(1):187. http://creativecommons.org/licenses/by/4.0/.

However, other perioperative measures favored the robotic approach. A patient undergoing robotic prostate surgery during this time could expect a 2-day hospital stay and a 2.2% to 3.5% risk of perioperative blood transfusion (compared to 4.3 days and 16.6%-18.3% risk of transfusion for open).[4]

The Minimally Invasive Era: Technique Dissemination (2010-Present)

Once the robotic approach was firmly entrenched as the primary method of performing RP, focus began to shift to the development and refinement of new, anatomically based robotic techniques to improve patient outcomes.

Although the anterior approach, akin to the open retropubic prostatectomy, remains the most common technique, numerous alternatives have been described. In 2010, the Boccardi or Retzius-sparing robotic-assisted laparoscopic prostatectomy, resembling the open perineal prostatectomy, was introduced.[6] By extracting the prostate posteriorly through the pouch of Douglas, this technique preserves the support structures vulnerable in the standard anterior approach.[6] Level 1 evidence indicates an enhanced early return of continence, although the effects on continence beyond 12 months remain somewhat uncertain.[7] In addition, Kowalczyk demonstrated less penile shortening, lower risk of development of Peyronie's disease, and lower inguinal hernia risk with this approach.[8] However, there is concern about a higher risk of positive margins, particularly early in the learning curve.

Tewari introduced an alternative method to Retzius-sparing robotic-assisted laparoscopic prostatectomy known as the "hood-sparing" approach. This technique, inspired by the research of Robert Myers, aims to conserve the periurethral support structures located in the space of Retzius while employing the more conventional anterior approach.[9] These fascial-sparing techniques are being studied in an ongoing clinical trial (NCT05155501) which aims to enroll and randomize 600 men to standard vs fascial-sparing RP.

Additional techniques include utilization of the da Vinci Single-Port robot, which has allowed for single-site (incision) surgery, extraperitoneal, and transvesical approaches.[10] Proponents note improved cosmesis, decreased opiate use, shorter length of stay, and faster recovery.[10]

Spurred by the COVID-19 pandemic, many surgeons have moved toward outpatient and same-day discharge for radical prostatectomy. A recent comparative analysis found that same-day discharge reduced costs by 20% without compromising patient safety or satisfaction in appropriately selected patients.[11] Others have moved from selective to universal same-day discharge. Abaza et al reported 99% success rate with same day discharge in 352 consecutive radical prostatectomy cases with a 2.5% readmission rate.[12]

Today, a man may undergo an outpatient prostatectomy with no narcotics and a reasonable expectation of immediate or early continence return (by 6 weeks) depending on the surgeon and technique used.

The Future: Remote Prostatectomy, Artificial Intelligence

Recently the team at Global Robotics Institute reported via social media successful completion of a remote radical prostatectomy, with the surgeon operating on a console 1500 km away from the patient. In addition, with the expiration of multiple da Vinci patents in 2019 several new robotic platforms are in various stages of development. Remote surgery and novel platforms may increase the availability of robotic surgery to more resource-constrained regions.

Others are incorporating robotic technology and utilizing infrared intraoperative imaging along with fluorescent dye (indocyanine green) to explore improvements in lymph node dissection and nerve sparing. The advent of artificial intelligence and machine learning has allowed teams to develop models to identify surgical gestures associated with improved erectile function recovery. Ma et al identified 34,323 individual gestures performed in 80 nerve-sparing robot-assisted radical prostatectomies, which were then classified into 9 distinct dissection gestures (eg, hot cut) and 4 supporting gestures (eg, retraction).[13] The authors found that less use of hot cut and more use of peel/push are statistically associated with better chance of 1-year erectile function recovery (Figure 2).

Looking to the future, technology holds continued promise for delivering improved outcomes to our patients. Robotics are a tool that can't negate surgical skill, but perhaps they will allow us to better understand surgeon and surgical heterogeneity and improve individual technique. ■

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