Robotic-assisted Proximal Perineal Urethroplasty: Improving Visualization and Ergonomics

Stephen H. Unterberg, Sunil H. Patel, Thomas W. Fuller, and Jill C. Buckley

OBJECTIVE To describe the use of the robotic platform for proximal suture placement during perineal urethroplasty in the posterior and proximal anterior urethra. Repair of posterior urethral and proximal bulbar strictures requires deep perineal dissection, making visualization and accurate placement of sutures challenging. The robotic platform has demonstrated benefits in these characteristics in deep pelvic surgery.

METHODS We report a retrospective review of 10 patients who underwent robotic-assisted urethroplasty at a single institution by a single surgeon in a 1 year period. All patients underwent a standard perineal dissection with robotic-assisted placement of proximal sutures. Postoperative outcomes include urethroplasty leak rate as determined by voiding cystourethrograms, urethroplasty success rate, and perioperative complications.

RESULTS The mean age of this cohort was 43 years old (14-68). Average stricture length was 2.2 cm (1.5-3.0 cm) and most frequently in the bulbar urethra (5/10). Seven patients underwent nontransecting urethroplasties while 3 underwent transecting anastomotic repair. At postoperative voiding cystourethrograms, no patient had urinary extravasation. Average set-up time for the robotic portion of the surgery was 15 minutes with 30-45 minutes needed for suture placement.

CONCLUSION Robotic-assisted urethroplasty provides excellent visualization and ergonomics for posterior and proximal bulbar urethral reconstruction. This is particularly helpful in patients with narrow pelvic anatomy and long distances from the perineal skin to the proximal urethral edge. Operative and postoperative outcomes are comparable to the standard approach with improved surgeon comfort and visualization. Additional follow-up is required to assess long-term outcomes in comparison to a standard approach. UROLOGY 125: 230−233, 2019.

Urethroplasty is the gold standard for durable repair of urethral stricture disease, especially after failed endoscopic management.[1] Short anterior urethral strictures in the bulbar urethra can often be managed with good visualization with a transecting, nontransecting, onlay or augmentation urethroplasty. In patients with posterior urethral or proximal bulbar strictures urethral reconstruction is often more challenging. It is not uncommon to encounter a long and narrow channel when attempting to place the proximal urethral sutures. This creates less than optimal visualization due to the distance and depth of dissection which may result in insufficient mucosal apposition.[2] The robotic platform has been used extensively in urology to improve ergonomics and visualization for conditions such as prostatectomy, cystoprostatectomy, uretero-pelvic junction obstruction, and ureteral stricture disease.[3] Other surgical subspecialties, such as colorectal surgery, have begun utilizing the robotic platform to improve visualization and treatment of rectal cancers, which similarly require excision and anastomosis in challenging locations.[4] We describe the use of the Da Vinci robot as a means to improve visualization of the posterior and proximal bulbar urethra and allow for confident suture placement during urethroplasty.

MATERIAL AND METHODS

We performed a retrospective review of 10 patients who underwent robotic-assisted urethroplasty at a single institution, University of California San Diego, by a single board certified reconstructive surgeon from July 2017 to July 2018. All patients had either posterior urethral strictures or bulbar strictures and were evaluated preoperatively with retrograde urethrogram and voiding cystourethrogram (VCUG). Collected preoperative demographics including age, etiology of stricture if known, and prior stricture treatment. Postoperative outcomes evaluated included postoperative VCUG leak rate, perioperative complications, operative time, estimated blood loss, and postoperative urethral patency as determined by ability to pass a flexible cystoscope at 3 months postoperatively. All patients had at least 3 months postoperative follow-up (range 3-12 months).

From the Department of Urology, University of California San Diego, San Diego, CA
Address correspondence to: Jill C. Buckley, MD, 200 West Arbor Drive, MC 7897, San Diego, CA 92103-7897. E-mails: jcbuckley@ucsd.edu; jillcbuckley@gmail.com
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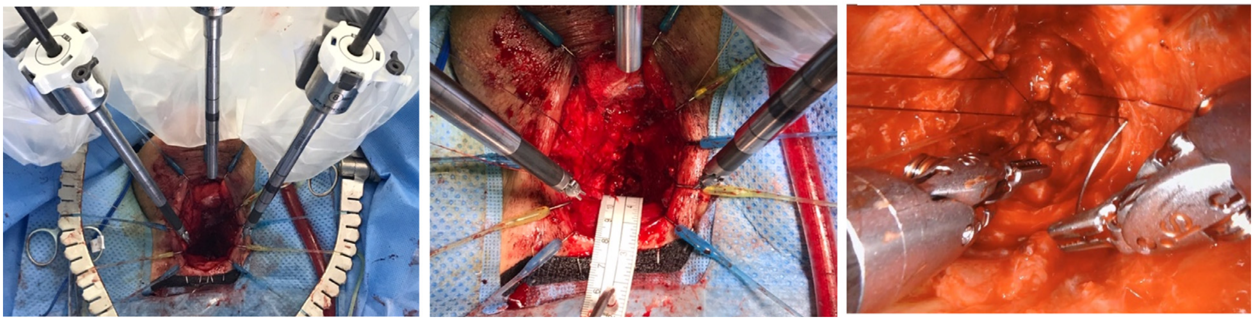

Figure 1. (**A**) Perineal robotic setup. Three 8 mm trocars are used centered on the perineal incision. (**B**) Close up showing the depth of dissection with a urethral suture thrown at the 10-o'clock position. (**C**) Deep perineal anastomotic suture placement. (Color version available online.)

Surgical Technique

Patients were placed in the high lithotomy position. A standard perineal dissection was performed until the area of urethral disease was encountered and opened dorsally longitudinally. No pubectomy or additional ancillary maneuvers were required in the cohort. The Da Vinci robotic platform (Xi and Si) was positioned after transitioning the patient to the low lithotomy position to allow entry of the robotic boom. Average set-up time was 15 minutes. Three free floating robotic arms were used (1 camera, 2 working) through 8 mm trocars in the perineum (Fig. 1).

For nontransecting urethral reconstruction, 7 sutures were placed with full thickness throws placed in the proximal urethra and then through the distal urethra closing the opening in a transverse manner. For complete urethral transection and more posterior urethral reconstruction 12 full thickness sutures were placed proximally. All sutures were numbered for later placement in the distal urethra after the robot was undocked. Sutures were tied by hand.

RESULTS

The average age was 43.4 years old (14-68). Stricture location distribution included: 1 prostatic, 4 membranous, and 5 bulbar strictures where the urethrotomy extended to the membranous urethra. The stricture etiology was trauma in 6 patients, idiopathic in 2, and prostate cancer with history of radiation in 1 patient. The average length of stricture was 2.2 cm (1.0-3.0 cm; Table 1). Half of men underwent prior endoscopic management (5/10) of their stricture disease including 3 patients who had greater than 1 DVIU (Direct Visual Internal Urethrotomy)/dilation. Seven patients underwent nontransecting urethroplasties while 3 underwent a transecting primary anastomotic repair. Average robotic operative time including set-up and suturing was approximately 45-60 minutes. There were no neuropathies or positioning injuries encountered in the entire cohort.

All patients underwent a VCUG at a median of 18 days (16-27 days) postoperatively prior to catheter removal. There was no evidence of extravasation. The standard postoperative follow-up of patients who have undergone urethroplasty at our institution includes 3- and 12-month cystoscopy to evaluate for patency. All urethroplasties were patent as demonstrated by the ability to easily pass a 16Fr cystoscope (Table 2).

DISCUSSION

The American Urological Association released their guideline statement in 2016 on the appropriate management for male urethral stricture disease. Based on their review of relevant literature the guidelines state that for patients with anterior stricture disease endoscopic management can be attempted in a select group of male patients with short bulbar urethral strictures <2cm in length. In those patients that fail endoscopic management or those with longer strictures in unfavorable regions of the urethra are best managed with urethroplasty.[5]

Posterior urethral and proximal bulbar stricture disease typically results from a trauma or an iatrogenic etiology in the form of transurethral surgery or radiation.[6] The proximal urethra has greater surgical challenges given the deeper dissection and limited visualization. Various maneuvers have been detailed in order to allow for

Table 1. Patient demographics and urethral stricture characteristics

Patient Demographics and Stricture Description	
Mean age (y)	43.4
Prior DVIU (*n*)	3
Prior dilations (*n*)	2
Mean stricture length (cm)	2.2
Location (*n*):	
Prostatic	1
Membranous	4
Proximal bulbar	2
Mid-distal bulbar	3

Table 2. Urethroplasty surgical technique and outcomes

Urethroplasty Technique and Outcomes	
Urethroplasty technique (*n*):	
Nontransecting	7
Transecting	3
Mean operative time (min)	240
Mean robotic set up time (min)	15
Mean estimated blood loss (cc)	44
Mean follow-up (mo)	7.2
VCUG leak rate (%)	0
Urethroplasty success rate (%)*	100

VCUG, voiding cystourethrograms.
* Seven out of 10 patients reached 3 months postoperative and underwent cystoscopic evaluation. All urethroplasty repairs (7/7) were patent at 3 months as evaluated by ability to pass a 16Fr flexible cystoscope.

adequate mobilization of the posterior urethra in order to perform a primary anastomosis off tension.[7]

The utilization of the Da Vinci robot within the field of Urology has impacted the way we perform and teach pelvic surgeries. Most notably, open retropubic prostatectomy requires deep pelvic dissection and difficult suture placement for the vesicourethral anastomosis. This was supplanted by use of the robotic platform to more easily visualize the male pelvic anatomy and allow for more confident mucosal to mucosal apposition during the anastomosis, which has reduced the rate of bladder neck contracture in some experiences reported in the literature.[8] The robotic approach has also led to improved ergonomics for the surgeon compared to both the laparoscopic and open arena, which has decreased the rate of musculoskeletal pain in urologists based on a survey of physician members of the Endourological Society and Society of Urologic Oncology.[9]

While numerous studies exist demonstrating the utility of the robot for upper tract disease and oncologic urologic cases, there is no literature documenting the use of the Da Vinci robot to assist in suture placement for lower urinary tract reconstruction.

In the field of colorectal surgery, resection of rectal masses utilizing a single-incision laparoscopic surgery port has been utilized and validated for the improved visualization of suture placement and dissection in transanal surgeries for rectal cancers.[10] This technique is especially beneficial for those rectal masses located beyond 8 cm from the anal verge signifying where the conventional transanal excision technique can be quite difficult.[11] Hompes et al further explored the use of the robotic platform for local excision of rectal neoplasms on 16 patients utilizing novel techniques to improve maneuverability of the robotic instruments while demonstrating the feasibility of this approach. This followed earlier literature describing the robotic transanal minimally anal surgery approach in cadaveric studies.[12]

A similar challenge exists in the repair of posterior urethral and proximal anterior strictures. A deep perineal dissection is often necessary to identify and incise or excise the urethral scar tissue confined to a very narrow space limited by the lateral aspects of the pubic rami and pubic symphysis anteriorly. The width of the space to perform the proximal urethral anastomosis can by extremely narrow while the depth to reach the proximal urethra can be well out of the range of vision. It requires special position of the bed and patient to achieve a partial vision of the area that must be anastomosed.

The surgeon, although often successful at placing the sutures, is situated in awkward and uncomfortable positions. The rate of surgeon work-related injury is reportedly as high as 30% with the majority (65.7%) receiving treatment. The ubiquity of surgeon fatigue and physical detriment was recently detailed in a survey dispersed to oncologic surgeons. In this study by Voss et al, they determined that independent risk factors for injury were length of surgery (>4hours) and pre-existing neck pain.[13] Surgeries that require this physically demanding positioning such as a challenging posterior or deep perineal urethropasty can lead to back and neck injuries with repetition. The robot is ideal in surgeries that are in difficult areas to access that limit visualization and adequate exposure. The advantage of the magnification is to bring the operative field to the surgeon. The small yet agile robotic instruments allow for optimal range of motion which combined with improved visualization allows for precise and successful reconstruction in (at times) a nearly inaccessible space.

As surgeons, we should welcome and strive to improve our operative ergonomics. Studies have shown that there is a decreased physical workload on the body when utilizing the robotic platform. Lee et al performed a comparative assessment of physical and cognitive ergonomics comparing robotic vs laparoscopic tasks.[14] They demonstrated that robotic surgery was ergonomically favorable compared to laparoscopy utilizing EMG (electromyogram) measurements of upper arm muscle activity while performing specific tasks. Furthermore, the ability to sit while placing deep perineal sutures may lend additional support to the surgeon's upper extremities as well.

However, the physical stressors of utilizing the robot can also take a toll on surgeon's musculoskeletal system. Lee et al discovered based on an anonymous questionnaire of 289 gynecologic surgeons who perform robotic surgeries that 54% reported experiencing physical symptoms or discomfort. Those surgeons with higher robotic case volume reported significantly lower physical symptoms rates in part due to their confidence in adjusting their settings to improve ergonomics.[15]

Limitations to our study include a small cohort at single center by a single surgeon. However, our goal for this technical paper is to describe the feasibility of utilizing the robot for suture placement in challenging deep narrow spaces. Long-term outcomes and large patient volumes will be required to determine whether a difference in surgical outcomes is realized. Furthermore, we did not focus on the added operative costs to implementing the robot for suture placement although this is an important consideration especially in communities and hospitals that do not already own a Da Vinci robot. Finally, improved techniques for knot tying and achieving pneumoperitoneum within the perineal space may allow for even more utility of the robotic platform, which will need to be further explored.

CONCLUSION

Urethroplasty remains the gold standard for definitive repair of urethral stricture disease. The robotic platform is a safe and effective technology to assist in the placement of sutures within the challenging anatomic space of the posterior and proximal anterior urethra. We demonstrate that utilizing the robot for suture placement is a valuable technique to assist in lower urinary tract reconstruction.

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