The Robotic-assisted Ureteral Reimplantation
The Evolution to a New Standard

Dana A. Weiss, MD*, Aseem R. Shukla, MD

KEYWORDS

• Robotic-assisted laparoscopic ureteral reimplantation • Extravesical • Intravesical

KEY POINTS

- Robotic-assisted laparoscopic ureteral reimplantation is a safe and efficacious alternative to open ureteral reimplantation.
- Careful attention to dissection of the distal ureter and creation of the detrusor tunnel can minimize postoperative urinary retention and bladder irritation.
- Robotic ureteral reimplantation can be used not only for vesicoureteral reflux but also for treatment of distal ureteral obstruction.

INTRODUCTION: NATURE OF THE PROBLEM

Vesicoureteral reflux, the retrograde flow of urine from the bladder into the ureters and the renal collecting system, is a commonly encountered anomaly in the pediatric urology practice. Diagnosis is generally rendered with a voiding cystourethrogram (VCUG) as a result of an evaluation for prenatal dilation of the urinary tract, or a febrile urinary tract infection (UTI). The incidence of vesicoureteral reflux has been shown to be 30% to 50% in children presenting with at least 1 UTI, and about 15% to 41% in children undergoing a workup for antenatally detected hydronephrosis.[1,2] Although not all cases of vesicoureteral reflux need to be repaired, in cases of recurrent infection or persistent high-grade reflux, surgical correction is a potential intervention to prevent pyelonephritis and renal scarring.[3,4]

Options for repair of vesicoureteral reflux include the following:

- Endoscopic injection (Deflux or other bulking agents; Salix Pharmaceuticals, Raleigh, NC, USA)
- Open intravesical reimplantation
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- Minimally invasive (laparoscopic or robotic-assisted) intravesical reimplantation
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Open intravesical ureteral reimplantation is widely considered the "gold-standard" approach for the correction of vesicoureteral reflux because of historical success rates that range from 95% to 99%.[5,6] The limitation to these statistics, however, is that some studies comprise cohorts without a postoperative VCUG and others had variations in patient selection. Indeed, some more recent studies imply a lower success rate of around 93%, when a VCUG was rigorously completed 3 months postoperatively.[7] Despite the popularity and widespread reliance on the intraoperative open reimplantation, commonly encountered postoperative symptoms inherent to a procedure relying on an open cystotomy—hematuria, bladder spasms, and irritative voiding symptoms—have encouraged surgeons to explore alternatives.[3,8] One such alternative has always been the open extravesical ureteral reimplantation. However, this too has drawback of requiring an open Pfannenstiel incision and carries the risk of postoperative

Division of Urology, The Children's Hospital of Philadelphia, Wood Building, 3rd Floor, 34th and Civic Center Boulevard, Philadelphia, PA 19104, USA
* Corresponding author.
E-mail address: weissd1@email.chop.edu

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urinary retention, thought to be due to a neuropraxia from dissection around the bladder.[9,10] Indeed, the urge to avoid this neuropraxia has led most urologists to prefer the open extravesical approach only in unilateral procedures rather than in bilateral procedures.

Urology, as a specialty, has traditionally positioned itself at the intersection of technology and surgery and has been an early adaptor of minimally invasive surgery, ever since the first lap nephrectomy in 1991. Not long after, the first pediatric laparoscopic extravesical reimplantation was described in 1994.[8,11] Following this, urologists further innovated with the laparoscopic intravesical Cohen cross-trigonal reimplant.[12] However, because of a steep learning curve and considerable physical strain on the surgeon—exacerbated in smaller children—the pure laparoscopic approach was not broadly accepted. Although variations in surgical technique have been reported, overall, results were not as consistent as the open technique and procedures were complicated by urinary fistulae and bladder leaks.[3,12–17]

The advent of the da Vinci Surgical System (Intuitive Surgical, Mountain View, CA, USA) revolutionized minimally invasive surgery. The da Vinci system, using a master-slave platform that is under the control of the surgeon, carries well-known advantages of 3-dimensional visualization (now in high definition), articulating instruments and dampening of tremor. The robotic-assisted laparoscopic (RAL) surgery concept has facilitated the use of minimally invasive approaches in both adults and children and is in widespread use for procedures ranging from the radical prostatectomy to reconstructive urology.[18] Peters and Woo[14] described the robotic-assisted transvesicoscopic approach, where only 1 patient of 6 initial patients had a complication of a urine leak. The inherent challenges of obtaining and maintaining pneumovesicum, and the challenges of limited articulation of robotic instrumentation in the bladder, limited popularity of the intravesical technique. However one of the earliest large series of RAL extravesical ureteral reimplantations in 2008 reported success equivalent to those generally expected by the open technique.[12] As demonstrated herein, the use of the RAL surgery has made the repair of vesicoureteral reflux a viable approach in comparison with antibiotic prophylaxis, even as the potential adverse events are mitigated by improved magnification and focused dissection.[9,14,19]

INDICATIONS/CONTRAINDICATIONS

For vesicoureteral reflux (VUR), indications for treatment include recurrent pyelonephritis/febrile UTIs, worsening hydronephrosis/parenchymal thinning, worsening function on renal scan, and desire by parents to come off of prophylactic antibiotics. However, the technique of RAL ureteral reimplantation (RALUR) is applicable for the correction of VUR and the same approach may be used for other interventions as well. Indications for RALUR also include management of obstructed megaureters and distal ureteral strictures resulting in loss of function, pain, UTI, and sepsis. For these, the repair of the obstructed distal ureter requires a dismembered reimplantation to excise the narrowed ureterovesical junction followed by reanastomosis of the ureter to the bladder and creation of a nonrefluxing tunnel.[20] There are very few definite contraindications to RALUR—primarily lung or heart anomalies that preclude insufflation. Even a history of previous abdominal surgery is only a relative contraindication to laparoscopy—a rare occurrence when significant adhesions preclude safe access to the abdominal cavity.

TECHNIQUE/PROCEDURE

Preparation

Preoperative assessment is the same regardless of whether the surgical approach will be vesicoscopic or extravesical. Appropriate imaging including ultrasound, VCUG, and dimercaptosuccinic acid (optional) should be reviewed before surgery. Routine preoperative laboratory tests are not required, but a urinalysis or urine culture is recommended if the patient has been symptomatic recently. Patient size does not limit the use of the robotic approach; however, for the intravesical approach, it is advisable that the patient be more than 4 years of age with a bladder capacity of at least 200 mL.[21]

Patient Positioning

The patient is placed supine in the low lithotomy position on Allen stirrups, which allow for preoperative cystourethroscopy in the same setting, if required. For smaller patients, the patient can remain supine with the legs on the table as well. The patient is secured to the bed with taping across the chest, with care to assure that all pressure points are well padded. In addition, it is recommended to be careful here to ensure that the head of the patient is turned to the side to avoid the robotic arms hitting the endotracheal tube. A sterile preparation of the abdomen from xyphoid down through perineum is performed, and the patient is draped, so that there is access to the urethra for cystourethroscopy or catheter placement during the procedure. The authors find a sketch