# Outpatient Robotic Unilateral Extravesical Ureteral Reimplantation in the Pediatric Population: Short-Term Assessment of Safety

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**Purpose:** Robotic extravesical ureteral reimplantation has been established as a viable option for surgical management of vesicoureteral reflux. Typically this procedure is associated with a hospital stay for routine postoperative care. We assessed the short-term safety of robotic unilateral extravesical ureteral reimplantation as a scheduled outpatient procedure in a pediatric population.

**Materials and Methods:** We retrospectively studied a cohort of patients who underwent robotic extravesical ureteral reimplantation between June 2012 and January 2018. No regional blocks were performed. Patients were discharged from the postanesthesia care unit as part of a scheduled outpatient procedure without an extended stay. Postoperative outcomes included 30-day emergency room visits, readmissions to the hospital and Clavien-Dindo grade I to V complications.

**Results:** Four male and 23 female patients were identified. Median age was 85 months (range 27 to 210) and median weight was 26 kg (13 to 97). Median robotic console time was 140 minutes (range 84 to 257). No patient required a hospital stay for management of pain. Two patients (9%) required unplanned antibiotic therapy postoperatively for bacterial cystitis and pneumonia (Clavien-Dindo grade II complications). The patient with pneumonia was diagnosed during a subsequent emergency room visit. One patient was rehospitalized on postoperative day 4 because of constipation. No Clavien-Dindo grade III or higher complication was observed in any patient.

**Conclusions:** Robotic unilateral extravesical ureteral reimplantation is safe as an outpatient procedure in the pediatric population. Further evaluation is warranted to assess its short and long-term outcomes on a larger scale.

**Key Words:** minimally invasive surgical procedures, replantation, robotic surgical procedures, ureter, vesico-ureteral reflux

**Abbreviations and Acronyms**

BBD = bladder-bowel dysfunction
CD = Clavien-Dindo
ER = emergency room
MIS = minimally invasive surgery
PACU = postanesthesia care unit
REVUR = robotic extravesical ureteral reimplantation
VUR = vesicoureteral reflux

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Study received institutional review board approval (2015-0177).

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Management of vesicoureteral reflux has changed dramatically during the last few decades. In the past evaluation for vesicoureteral reflux in children with febrile urinary tract infections and hydronephrosis was widespread, and the gold standard for surgical management was open ureteral reimplantation. Endoscopic correction of vesicoureteral reflux was first described in 1984 using polytetrafluoroethylene.[1] Use of dextranomer/hyaluronic acid was first described a decade later and subsequently gained popularity, becoming the only FDA (U.S. Food and Drug Administration)

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approved bulking agent for endoscopic correction of grade II to IV vesicoureteral reflux. The endoscopic procedure, despite a lower success rate (70% to 80%), has become a viable alternative due to its reduced morbidity, minimal postoperative pain and short convalescence compared to open ureteral reimplantation. The main disadvantage is the decreased success rate, especially with high grade vesicoureteral reflux. An additional concern is the potential for a more technically challenging antireflux reconstructive procedure after failed bulking agent injection.

Laparoscopic and robotic procedures have the advantages of MIS with the potential for success rates similar to open surgery.[2] Laparoscopic extravesical ureteral reimplantation was technically challenging during the early years of laparoscopic surgery in children and did not gain popularity at first. Challenges to this approach include visualization of the distal ureter and ureterovesical junction, ability to perform the detrusor dissection while preserving the integrity of the urothelium and ability to perform intracorporeal suturing of the detrusor reconstruction over the ureter. A robotic approach is better suited for pelvic surgery, as demonstrated with radical prostatectomy for management of prostate cancer. Robotic extravesical ureteral reimplantation was first described by Peters in 2004 and is becoming an increasingly commonly performed operation.[3–6]

Outpatient laparoscopic procedures have become standard in children undergoing orchiopexy, inguinal hernia repair, varicocelectomy and other procedures. Recently complex laparoscopic surgeries, including robotic upper urinary tract reconstruction, have been reported to be safe and feasible.[7,8] Robotic extravesical ureteral reimplantation can be performed as a tubeless procedure, and with the potential for minimized postoperative pain it is a good candidate for ambulatory surgery. Efforts have been made to progressively decrease the postoperative care for REVUR, reducing the health care burden of hospitalization and maximizing the benefits of MIS. We report the short-term safety of robotic unilateral extravesical ureteral reimplantation for VUR as a scheduled outpatient procedure in the pediatric population.

## MATERIALS AND METHODS

Following institutional review board approval (IRB No. 2015-0177) demographic information and perioperative data were prospectively collected in an institutional database for all patients undergoing robotic surgery. All patients who underwent outpatient REVUR between June 2012 and January 2018 were included for analysis as a retrospective review of a cohort from the prospectively maintained database. All procedures were unilateral due to the potential concern for urinary retention after bilateral extravesical surgery and were performed by a single surgeon (PHN).

The study population did not consist of consecutive patients. There was no selection bias, excluding presence of grade V reflux. Families who consented to robotic surgery with patients discharged immediately from the PACU were included for evaluation. Patient proximity to the hospital did not have a role in selection. Exclusion criteria consisted of any inpatient stay without routine discharge from the PACU, which included patients with end-stage renal disease and reflux in transplant ureters.

Indications for surgery included VUR associated with recurrent urinary tract infections, breakthrough infections on antibiotic prophylaxis, renal scarring and parental preference for operative intervention. Duplex collecting system was not a contraindication. All children underwent preoperative evaluation and treatment of BBD. BBD management was individualized and included scheduled voiding, alpha blockers, biofeedback, stool softeners and stimulant laxatives. In the absence of maintenance bowel management stool softeners were typically requested starting up to a week in advance of the surgical date, mostly to create an empty rectum to provide working space as well as for perioperative management. Postoperative outcomes included 30-day ER visits, readmissions and CD grade I to V complications.

The da Vinci® Si and Xi Surgical Systems were used during the study period. One camera trocar in the umbilicus and 2 instrument trocars were used without any bedside assistant ports. Typically 8 mm trocars were used. The SutureCut™ needle driver was used to minimize instrument changes during the antireflux detrusor tunnel reconstruction. A hitch stitch was selectively used to provide exposure during dissection and reconstruction.

The bladder was filled to plan the detrusorotomy. A detrusorotomy of 2 to 5 cm was performed, based on patient anatomy. Detrusorrhaphy was performed with interrupted absorbable sutures, typically beginning at the distal aspect of the detrusorotomy. Detrusorrhaphy was performed without a stent or catheter in the ureter. An advancement suture at the ureterovesical junction was not used.

No internal or external ureteral stents, drains or urethral catheters of any kind were used for postoperative care. Each trocar site was infiltrated with 0.25% bupivacaine or 0.2% ropivacaine at the end of the procedure for postoperative analgesia. No regional blocks were performed. Typically intravenous acetaminophen or intravenous ketorolac was administered during the procedure, but not both, in anticipation of the postoperative pain management plan for alternating oral acetaminophen and ibuprofen. Additional analgesics were administered if needed in the PACU, supervised by anesthesiology.

Each operation was scheduled and performed as an outpatient procedure. Patients were discharged from the PACU without an extended stay, per hospital PACU criteria, at typically less than 2 hours postoperatively. Patients had an empty bladder at the end of the procedure

and were not required to void before discharge home. A bladder scan was not performed.

For postoperative pain management families were advised to administer acetaminophen and ibuprofen. Families with children older than age 5 years were provided an oxycodone prescription and advised to use only as needed. There was no protocol for postoperative telephone calls. Families were counseled with postoperative instructions as typical for other outpatient procedures. Patient proximity to the hospital did not have a role.

## RESULTS

A total of 27 patients were identified. Demographic information and perioperative data are provided in the table. All patients were successfully discharged from the PACU as planned. No patient required a hospital stay for management of pain. Three study patients were excluded since their families requested overnight observation in the hospital because they were uncomfortable taking their child home despite being advised that PACU criteria were met for discharge as originally scheduled. These 3 patients were discharged home the following morning, without subsequent events during the 30-day postoperative period, including in 1 patient with grade V reflux.

Two patients (7%) required unplanned antibiotic therapy postoperatively for treatment of bacterial cystitis and pneumonia (both CD grade II). The patient with pneumonia was diagnosed during a subsequent ER visit. One patient was readmitted to the hospital on postoperative day 4 due to constipation, which was diagnosed clinically (including abdominal radiographs) as well as based on history of BBD. No CD grade III or higher complication was observed in any patient.

*Patient demographics and perioperative data*

| | |
|---|---|
| Median mos age (range) | 85 (27–210) |
| Median kg wt (range) | 26 (13–97) |
| No. gender (%): | |
| Male | 4 (15) |
| Female | 23 (85) |
| No. preop VUR grade (%): | |
| II | 8 (30) |
| III | 14 (52) |
| IV | 5 (18) |
| No. preop BBD (%) | 22 (81) |
| No. laterality (%): | |
| Rt | 13 (48) |
| Lt | 14 (52) |
| Median mins operative time (range) | 180 (130–321) |
| Median mins console time (range) | 140 (84–257) |
| No. preop dextranomer/hyaluronic acid injections (%) | 6 (22) |
| No. postop voiding cystourethrogram confirmed success with VUR resolution/total No.:* | |
| Preop grade II | 5/14 |
| Preop grade III | 6/14 |
| Preop grade IV | 3/14 |

* A total of 13 families declined study.

## DISCUSSION

An interest in laparoscopic and robotic surgery has been slowly growing in pediatric urology since the initial description of diagnostic laparoscopy for evaluation of nonpalpable testes in 1976. While it has become the preferred approach for pyeloplasty, the role of robotic surgery for management of VUR is not as well defined. Initial enthusiasm for laparoscopic extravesical ureteral reimplantation was tempered by its technically challenging nature, and the procedure did not gain popularity at first. A recent publication on trends in MIS revealed its increased used for pediatric urology procedures with data from the Nationwide Inpatient Sample.[9] In that analysis 85,760 ureteroneocystostomy and ureteroureterostomy procedures (MIS in 780 and open in 75,975) were performed between 1998 and 2012. Use of MIS for pediatric urology procedures reached a peak rate of 10% between 2006 and 2009 but then declined to 3% between 2010 and 2012. This finding was in contrast to other procedures with a constant increase in MIS rates.[10] Robotic surgery has expanded the availability of MIS to pediatric urologists and facilitated its application in more complex operations, including extravesical ureteral reimplantation.

Outpatient laparoscopic procedures have become standard in children undergoing orchiopexy, inguinal hernia repair, varicocelectomy and other operations. The benefits have been extended to robotic surgery. Finkelstein et al reported the safety and feasibility of early discharge home after stented robotic pyeloplasty in a small series of 13 patients.[7] All patients were successfully discharged within 12 hours with no subsequent ER visits or readmissions. Postoperative pain was managed with acetaminophen and ibuprofen with no need for narcotics. Fichtenbaum et al assessed the safety of outpatient tubeless robotic urinary tract reconstruction in a small series of 19 patients.[8] Patients were discharged from the PACU following a scheduled outpatient procedure without ureteral stents, drains or urethral catheters.

Robotic extravesical ureteral reimplantation has been reported with a variable success rate of 77% to 100%.[11] The procedure imitates the open technique described by Lich-Gregoir without violating the integrity of the urinary tract. A ureteral stent or urethral catheter often is not required, creating an opportunity for an outpatient procedure. The basis for considering robotic extravesical ureteral reimplantation as an outpatient procedure included the reported experience with outpatient open extravesical ureteral reimplantation almost 20 years ago.[12] Subsequently a large series of 250 consecutive patients who underwent open unilateral extravesical

ureteral reimplantation as a scheduled outpatient procedure showed a low complication rate.[13] A potential advantage for robotic surgery over open surgery includes decreased postoperative pain. More recently Harel et al reported reduced pain for robotic extravesical ureteral reimplantation compared to open surgery,[14] providing additional validation of the benefits of MIS. To our knowledge this is the first report specifically regarding outpatient robotic extravesical ureteral reimplantation in the pediatric population.

Limitations of the study include the potential for selection bias, given its retrospective nature. This approach may not be generalizable to more complex cases involving solitary kidney, obstructed megaureter, severe bladder and bowel dysfunction or higher stages of chronic kidney disease. In addition, this method may not be generalizable to bilateral extravesical ureteral reimplantation due to the concern regarding potential transient urinary retention. An opening in the urothelium with a watertight closure, an indwelling urethral catheter, a drain or a ureteral stent would not necessarily be an absolute indication for inpatient care. A single surgeon experience is a strength and limitation, considering the goal of achieving reproducible outcomes. Long-term outcomes were not assessed since they were outside the scope of a study regarding short-term outcomes. Anecdotally ureteral obstruction and recurrent VUR have not been observed.

## CONCLUSIONS

Robotic unilateral extravesical ureteral reimplantation is safe as an outpatient procedure in the pediatric population. Further evaluation is warranted to assess its short and long-term outcomes on a larger scale.

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## EDITORIAL COMMENTS

The authors deserve kudos for achieving the next milestone in minimally invasive surgery, robot-assisted laparoscopic ureteral reimplantation. Once an unknown entity, this method is rapidly evolving with the technique being standardized and multicenter collaborative efforts being made to improve outcomes.[1,2] Reducing morbidity while taking care of children with congenital anomalies remains the pivotal center point in delivering this new approach to management. In addition to decreasing morbidity, such an innovative care pathway allows children to recover safely in a familiar and comfortable environment, which is critical in the current era with 2-parent working households. This approach is a huge deviation from the regular care pathway and, as such, needs to be evaluated for formal application to our deserving patients across the board with various limitations of geosocial situations without jeopardizing outcomes and safety. Available technological devices, eg videoconferencing and "telehealth," are options better suited for this technique.[3] Of course, we have to strike a balance between advancing

science, setting new standards of care, implementing new methods safely and making sure the administrative authorities understand there will be deviations, which should not be penalized.

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Drivers driving new cars and surgeons trying new procedures tend to be a little more cautious until they are more comfortable with their new car or new procedure. Now that robotic surgery is more established, doctors are willing to see if their patients truly need hospitalization for monitoring and pain control. Robotic prostatectomy is now being performed safely as an outpatient procedure.[4]

In this article the authors demonstrate that unilateral REVUR can also be safely done as an outpatient procedure. However, this study begs the question of whether REVUR should be done, be it an outpatient or inpatient operation. New techniques must meet previously established standards of not only safety, but also efficacy. While there are reports of REVUR success rates of 97%,[5] there are also reports of lower success rates, ranging from 72% (in a study that included bilateral reimplantation) to 82% to 88% (reference 4 in article).[1,6] This success rate of 100% in the current study is encouraging but reflects a small cohort operated on by a single surgeon at a tertiary center. Clouding the issue is that several of the authors referenced are included in several of these articles, making the data a bit harder to sort out. Additionally extravesical ureteral reimplantation done in an open fashion takes about an hour and can be performed as ambulatory surgery (reference 14 in the article).

REVUR done as an outpatient procedure seems to be safe. Evidence is accumulating that it may also be as efficacious as open ureteral reimplantation. More evidence is needed for the acceptance of REVUR to equal that of pediatric robotic pyeloplasty.

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