



Prospective multicenter study on robot-assisted laparoscopic extravesical ureteral reimplantation (RALUR-EV): Outcomes and complications

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Summary

Background

Robot-assisted laparoscopic extravesical ureteral reimplantation (RALUR-EV) is a minimally invasive alternative to open surgery. We have previously reported retrospective outcomes from our study group, and herein provide an updated prospective analysis with a focus on success rate, surgical technique, and complications among surgeons who have overcome the initial learning curve.

Objective

To assess the safety and efficacy of RALUR-EV in children, among experienced surgeons.

Design and methods

We reviewed our prospective database of children undergoing RALUR-EV by pediatric urologists at eight academic centers from 2015 to 2017. Radiographic success was defined as absence of vesicoureteral reflux (VUR) on postoperative voiding cystourethrogram. Complications were graded using the Clavien scale. Univariate regression analysis was performed to assess for association among various patient and technical factors and radiographic failure.

Results

In total, 143 patients were treated with RALUR-EV for primary VUR (87 unilateral, 56 bilateral; 199 ureters). The majority of ureters (73.4%) had grade III or higher VUR preoperatively. Radiographic resolution was

present in 93.8% of ureters, as shown in the summary table. Ureteral complications occurred in five ureters (2.5%) with mean follow-up of 7.4 months (SD 4.0). Transient urinary retention occurred in four patients following bilateral procedure (7.1%) and in no patients after unilateral. On univariate analysis, there were no patient or technical factors associated with increased odds of radiographic failure.

Discussion

We report a radiographic success rate of 93.8% overall, and 94.1% among children with grades III–V VUR. In contemporary series, alternate management options such as endoscopic injection and open UR have reported radiographic success rates of 90% and 93.5% respectively. We were unable to identify specific patient or technical factors that influenced outcomes, although immeasurable factors such as tissue handling and intraoperative decision-making could not be assessed. Ureteral complications requiring operative intervention were rare and occurred with the same incidence reported in a large open series. Limitations include lack of long-term follow-up and absence of radiographic follow-up on a subset of patients.

Conclusions

Radiographic resolution of VUR following RALUR is on par with contemporary open series, and the incidence of ureteral complications is low. RALUR should be considered as one of several viable options for management of VUR in children.

Summary Table Outcomes, overall and by preoperative vesicoureteral reflux (VUR) grade

Radiographic resolution by preoperative VUR grade	n ^a	(%)
I	15/16	(93.8)
II	24/26	(92.1)
III	49/52	(92.4)
IV	38/41	(92.7)
V	10/10	(100.0)
Overall	136/145	(93.8)

^a Number of ureters without VUR present/number of ureters studied with voiding cystourethrogram or radionuclide cystogram.

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Introduction

The ideal management of vesicoureteral reflux (VUR) is controversial, although there is a consensus that its primary objectives are to: prevent febrile urinary tract infection (UTI), avoid deterioration of the upper urinary tract, and minimize morbidity [1]. Surgical intervention is indicated to protect the upper urinary tract in patients who fail conservative measures [2]. In an effort to reduce morbidity, less invasive treatment options than the gold standard open ureteral reimplantation (UR) have been developed. One such option, robot-assisted laparoscopic extravesical ureteral reimplantation (RALUR-EV), has experienced a recent increase in utilization [3]. RALUR-EV offers several advantages, having been shown to be associated with decreased narcotic pain requirement and shorter length of stay relative to the open approach [4,5].

However, these efforts to minimize patient morbidity cannot come at the cost of efficacy or safety. Reported RALUR-EV success rates have ranged from 77% to 99%, without identification of factors that may account for the variability [6–9]. Initial reports demonstrated few complications, but recent reviews of administrative datasets have raised questions regarding the increased complication rates of RALUR-EV compared with open UR [10,11].

To address these issues, our multi-institutional group formed in 2014 to collaboratively assess RALUR-EV. Our first study detailed surgical outcomes from 2005 to 2014, reporting a radiographic success rate of 87.9% with a Clavien grade 3 complication rate of 2.7%, but was limited by the inclusion of each surgeon's initial learning curve [12]. In the present study we prospectively collected data on patients undergoing RALUR-EV from 2015 to 2017, hypothesizing that clinical outcomes and complication rates would be improved with greater surgeon experience. We also aimed to assess technical nuances of the procedure, to provide guidance for new adopters.

Materials and methods

After IRB approval, data were prospectively collected on children undergoing RALUR-EV by pediatric urologists at eight academic medical centers in the United States from 2015 to 2017. Surgeons had a median experience of 30 RALUR-EV cases (IQR 30–82) prior to the study period. Data were managed using Research Electronic Data Capture (REDCap) electronic data capture tools [13]. We performed a retrospective analysis of these prospectively collected data.

The inclusion criterion was undergoing RALUR-EV for primary VUR. We excluded patients with VUR secondary to neurogenic bladder and those who underwent tapering of a megaureter. Radiographic failure was defined as persistent VUR on postoperative voiding cystourethrogram (VCUG) or radionuclide cystogram (RNC) on the affected side. Bladder-bowel dysfunction (BBD) was defined per AUA Guidelines [2]. Indications for surgery were site-specific, but included failure of conservative management or persistence of VUR beyond 5 years of age (as the authors feel that spontaneous resolution beyond this age is unlikely

[14], although we recognize that any age cutoff is arbitrary).

All surgeons used a transperitoneal approach, with slight variation in key steps summarized in Table 1. We focused on these technical factors based on prior literature demonstrating their impact on RALUR-EV outcomes [9]. Care was taken to preserve the ureteral vascularity by minimizing cautery use and limiting dissection around the UVJ to a Y-dissection. A urinary catheter was placed intraoperatively and removed on postoperative day (POD) 1 or 2 depending on institution protocol. Percutaneous abdominal drains were not routinely used except at one center. Operative time was measured from incision to closure, inclusive of any concurrent procedures.

All patients underwent postoperative renal ultrasound (RUS) at 1–3 months, and most underwent VCUG or RNC after 3 months. Radiographic failures were followed clinically and underwent reoperation if indicated at the individual surgeon's discretion. Postoperative complications were graded using the Clavien–Dindo scale [15].

Statistical analyses were performed using STATA 14.0 (Statacorp, College Station, TX, USA), with $p < 0.05$ representing significance. Two tailed t test was used for comparison of means. Radiographic success rates between surgeons were compared using Fisher's exact test. Univariable regression was performed to assess factors associated with complications and radiographic failure. Multivariable regression was not performed given the low number of events.

Results

A total of 144 patients underwent RALUR-EV during the study period, with demographics summarized in Table 2. One patient (0.7%) required conversion to open for intraoperative bleeding and poor visualization, and is therefore not included in the analysis of outcomes. The majority of ureters (73.4%) had grade III or higher VUR. The majority of ureters with grade 1 VUR (89.5%) were selected for RALUR rather than alternate treatments because of contralateral high grade VUR.

Mean operative time (OT) was 194 min (SD 62) overall, and shorter for unilateral cases than bilateral (174 ± 55 vs. 218 ± 61 , $p < 0.01$). Concurrent procedures were performed in 74 cases (52.1%), including cystoscopy (54, 38.0%), contralateral bulking agent injection (11, 7.7%), bladder diverticulectomy (2, 1.4%), heminephrectomy (2, 1.4%), circumcision (1, 0.7%), meatoplasty (1, 0.7%), nephrectomy (1, 0.7%), suprapubic catheter placement (1, 0.7%), and enterolysis (1, 0.7%). Among cases of RALUR-EV without concurrent procedures, overall mean OT was 177 min (SD 65) and OT was shorter for unilateral cases (159 ± 60 vs. 195 ± 67 , $p = 0.03$). Mean detrusor tunnel length, measured as described in Table 1, was 3.2 cm (SD 0.7).

Mean length of stay (LOS) was 1.5 days (SD 1.0), and was shorter following unilateral cases than bilateral (1.1 ± 0.6 vs. 1.9 ± 1.3 , $p < 0.01$). Radiographic success was achieved in 136 of 145 (93.8%) ureters studied with postoperative VCUG or RNC (Summary Table). This corresponded to a per patient radiographic success rate of 91.4%. Fifty-eight

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