Shortened operative time for pediatric robotic versus laparoscopic dismembered pyeloplasty

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Introduction: *Robotic-assisted laparoscopic pyeloplasty (RALP) is increasingly becoming the standard procedure for management of ureteropelvic junction obstruction (UPJO) in the pediatric population, but few studies have shown a clear advantage over the more technically demanding laparoscopic pyeloplasty (LP) in children. The objective was to study the patients treated with RALP or LP at our institution and the associated outcomes for each minimally invasive approach for the correction of UPJO.*

Materials and methods: *Our laparoscopic and robotic database was queried to identify all patients with a history of primary robotic-assisted or laparoscopic dismembered pyeloplasty for the correction of UPJO performed at our institution from January 2010 through November 2013 and were retrospectively reviewed. We analyzed age, surgical time, blood loss, hospital stay length, postoperative complications, and success rate.*

Results: *Seventy-three total patients were identified as having RALP or LP during this time period with five patients excluded from the analysis. We identified 55 patients with RALP and 13 patients with LP. No differences in success rate or postoperative complications were found for the two cohorts. The length of procedure was significantly shorter for the RALP group compared to the LP group.*

Key Words: pediatric population, robotic-assisted laparoscopic pyeloplasty

Introduction

Since the introduction of laparoscopic pyeloplasty (LP) in 1993, pediatric urologists continue to seek to understand the role of LP in the management of pediatric ureteropelvic junction obstruction (UPJ).[1] Due to the perceived increased difficulty of intracorporeal suturing during completion of LP in children, the availability and use of LP has been limited. Pediatric urologists have considered robotic-assisted laparoscopic pyeloplasty (RALP) as an alternative approach for minimally invasive pyeloplasty utilizing the da Vinci system (Intuitive Surgical Inc., Sunnyvale, CA, USA). The utilization of the da Vinci surgical system has assisted with the dissection, visualization and more efficient and precise suturing.[2]

Although multiple series in the pediatric population have demonstrated high success rates and low morbidity with RALP in children, few series have directly compared LP to RALP for correction of UPJO in children.[3,4]

Since January of 2010, both LP and RALP have been performed by a group of three attending pediatric urologists at our institution. In light of the disparate findings for outcomes of these two approaches in the literature, we sought to contribute to the increasing body of evidence for comparison of LP and RALP for correction of UPJO in children.

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Materials and methods

The laparoscopic and robotic databases at our institution were queried to identify all patients with a history of robotic-assisted or laparoscopic pyeloplasty performed from January 2010 through November 2013. All patients with primary robotic or laparoscopic dismembered pyeloplasty for the correction of UPJO were retrospectively reviewed. We analyzed age, surgical time, blood loss, hospital stay length, postoperative complications, and success rate. The surgical time extracted included the time required for, cystoscopy and retrograde pyelogram, patient positioning, robotic-docking and undocking. Postoperative complications were gathered from the operative notes and subsequent clinical visits and hospitalizations. Success was determined through resolution of hydronephrosis on ultrasounds and/or resolution of clinical symptoms. Failure was determined if there was recurrent or persistent signs of obstruction measured by worsening hydronephrosis; decreased drainage on renograms confirmed on subsequent imaging studies.

Indications for surgery

Indications for surgery included severe hydronephrosis with decreased renal function on diuretic renal scan < 40%, increasing hydronephrosis, or symptomatic renal colic with hydronephrosis.

Outcome measures

Primary outcomes were total operative time, and hospital stay. Secondary outcomes were improved hydronephrosis, resolution of clinical symptoms, and complications classified by the Clavien-Dindo grading system.[5]

Surgical technique

All patients underwent a cystoscopy with retrograde pyelogram in a standard fashion. Those patients who underwent a LP were performed in a similar fashion described by Peters.[6] Those patients who underwent a RP were performed in a similar fashion described by Peters.[2] Antegrade double J stent placement was placed after the completion of the posterior wall via an angiocatheter percutaneously through the anterior abdominal wall at the costal margin except in small infants in which retrograde ureteral stenting was performed in some occasions. All patients were managed with bladder drainage for 1 day. They were discharged from the hospital once tolerating a diet and their pain was controlled.

Statistical methods

Demographic variables and outcomes of interest were summarized for the two surgical groups. Continuous outcomes were summarized as median (Q1, Q3) while categorical variables were summarized as frequency and percent. Comparisons between groups were done using Fisher's exact test for categorical outcomes and Wilcoxon Rank Sum (WRS) test for continuous outcomes. Length of procedure and hospital stay were summarized and compared between groups in Table 1. Postop complications (yes/no), success (yes/no), and follow up pain (yes/no) were summarized and compared in Table 2.

TABLE 1. **Continuous outcome measures**

Outcome	LP (n = 13)	RALP (n = 55)	H-L estimate (95% CI)	p value
Length of procedure (hours)	4.33 (4.03, 4.85)	3.95 (3.32, 4.33)	0.55 (0.08, 1.02)	0.03
Hospital stay (hours)	40 (28, 43)	28 (26, 41)	3.5 (-2, 13.5)	0.2

LP = laparoscopic pyeloplasty; RALP = robotic-assisted laparoscopic pyeloplasty; H-L = Hodges-Lehman estimate of median; CI = confidence interval

TABLE 2. **Categorical outcome**

Variables	n	LP (n = 13)	n	RALP (n = 55)	OR (95% CI)	p value
Postop complications	13	0 (0%)	55	2 (3.6%)	NA*	1.00
Success	12	11 (91.7%)	52	52 (100%)	NA*	0.19
Follow up pain	12	1 (8.3%)	52	5 (9.6%)	1.17 (0.11, 60.30)	1.00

*odds ratios do not exist due to 0 cell counts.
LP = laparoscopic pyeloplasty; RALP = robotic-assisted laparoscopic pyeloplasty; OR = odds ratio; CI = confidence interval

We estimated effect sizes for continuous outcomes using the Hodges-Lehmann (H-L) estimator and 95% confidence intervals. Effect sizes for dichotomous outcomes were estimated using odds ratios (OR) and 95% confidence intervals. All statistical analyses were done using the statistical software R v3.0.2 (R Foundation for Statistical Computing, Vienna, Austria). All tests were two-sided assuming a significance level of 5%.

Results

Seventy-three total patients were identified as having RALP or LP during this time period with five patients excluded from the analysis. Four patients with ureteral polyps, robotic/laparoscopic vascular hitch pyeloplasty or reoperative laparoscopic/robotic pyeloplasty were excluded from the study. One patient undergoing a RALP was converted to open and was excluded from the analysis due to robotic failure. One patient underwent conversion from RALP to LP due to robot malfunction and was included in the LP group.

We identified 55 patients with RALP and 13 patients with LP treated from January 2010 to November 2013 by three pediatric urologists. There were no differences in the demographics of the two groups, Table 3. No differences in success rate (LP 91.67% versus RALP 100%, p = 0.19) or postoperative complications were found for the two cohorts. The length of procedure was significantly shorter for the RALP group compared to the LP group (RALP versus LP, median 3.95 hours versus 4.33 hours, H-L estimator 0.55, 95% CI 0.08 to 1.02, p = 0.03).

None of the patients in the LP group had postoperative complications. However, in the RALP group, two patients had postoperative complications, one grade I and one grade II. One patient (grade I) developed buttock blisters presumably due to following the procedure likely due to robotic positioning or possibly sterile preparation in combination with morbid obesity. Another patient (grade II) developed pseudomonas pyelonephritis, which resolved with antibiotic administration. A total of four patients (1 LP and 3 RALP patients) were excluded from the comparison of success rate due to the lack of follow up. One failure in the LP arm was identified within the study. The patient presented back to the emergency room 13 months following a left LP with persistent back pain. An ultrasound revealed increasing hydronephrosis, and the patient underwent a left repeat open pyeloplasty with missed crossing vessels who has resolution of symptoms and improved hydronephrosis.

Discussion

Open pyeloplasty has always been the standard for treating UPJO. After LP was first described, its integration in the armamentarium of treating UPJO was limited because of the technically demanding required laparoscopic skills. Subsequently, Peters first described pediatric robotic pyeloplasty, which garnered more interest and utilization.[2] The success of RALP has been compared to the standard open pyeloplasty previously. Lee et al compared RALP versus open pyeloplasty and concluded a benefit of decreased hospital stay and decrease pain, but longer surgical time.[7] In their study the surgical times for RALP approached that of the open cohort. Similarly RALP and LP have also been compared in both adults and children. A 2009 meta-analysis found eight studies comparing LPs and RALPs including both pediatric and adult populations. It estimated equivalency between the two procedures in regard to postoperative leaks, hospital readmissions and success rates.[8] In this meta-analysis, the operative time of the seven qualifying articles demonstrated a 10 minute reduction of operative time favoring RP, but this was not significantly different.

TABLE 3. **Demographic variables**

Variables	**LP (n = 13)**	**RALP (n = 55)**	**p value**
Age at surgery (yrs), median (Q1, Q3)	7.3 (1.8, 11.5)	7.3 (3.6, 12.5)	0.56
Gender, n (%)			1
Male	9 (69.2%)	36 (65.5%)	
Female	4 (30.8%)	19 (34.6%)	
Side of obstruction, n (%)			0.27
Left	8 (61.5%)	37 (67.3%)	
Right	4 (30.8%)	18 (32.7%)	
Bilateral	1 (7.7%)	0 (0%)	

LP = laparoscopic pyeloplasty; RALP = robotic-assisted laparoscopic pyeloplasty; Q1 = first quartile; Q3 = third quartile

Few smaller studies have focused their comparison of RALP to LP for correction of UPJO in children. In a study by Franco et al they evaluated the utilization of the da Vinci robot for the anastomosis compared to a straight LP and noted no difference in the surgical time.[4] Riachy et at found that RALP was significantly shorter than LP.[3] Cundy et al reported a meta-analysis focused exclusively on pediatric patients.[9] When comparing RP versus LP, there was a shorter operative time for the RP, though not statistically significant. Similarly, in our study we found that RP was statistically shorter than LP.

It is likely that the da Vinici system facilitates quicker suturing and knot tying compared to a straight LP. Furthermore in our study the surgical time included the docking and undocking of the robot, which has been an argument contributing to the length of the RALP, but was still significantly shorter than the LP. Although the surgical time was not broken down to indicate specific times for steps of the procedure (i.e. setup, anastomosis), we believe that the benefit gained was achieved through a shorter time to perform the intracorporeal anastomosis with the robot. This time benefit was even sufficient to overcome the extensive time that is required for robotic setup to prevent robotic collision and limitation of arm movement intraoperatively. This finding is not consistent with some of the past studies that demonstrated an increased or equal operative time secondary to setting up the robotic system around the child and careful positioning of the robotic arms.[10] Our LP experience may not be as large as others potentially contributing to longer surgical times. However, it is worth noting that the surgeons performing LP in our institution had experience with this procedure both in practice and at other institutions prior to joining Arkansas Children's Hospital.[11] Riachy did show a longer learning curve in the LP group compared to the RALP cohort.[3]

In regards to success, as deemed by resolution of the hydronephrosis and the lack of symptoms of obstruction, we did not notice a difference in the success between the RALP and LP groups. The reported success is similar to those mentioned in prior papers comparing these two modalities.[3,4] The equivalent success was also seen when comparing RP versus LP and RP versus open pyeloplasty by Cundy in their meta-analysis.[9] We did have one failure in the LP group due to a missed crossing vessel at the time of the surgery initial surgery performed with a transmesenteric approach, which was observed and corrected with the second open procedure. This observation adds to the growing evidence that RALP is safe and effective in treating UPJO.

There are several limitations of this study. It is a retrospective study, where the patients were not randomly assigned to LP and RALP, which could lead to potential biases. Another limitation of this study was the relatively small cohort of LPs preformed at our institution. With the access to a da Vinci surgical system on our campus, our LP numbers have drastically reduced. Small sample sizes in our study also limited our ability to adjust for other factors such as age, gender, etc., when comparing outcomes between the two groups. Other limitations include not age matching or comparing our cohorts based on age.

Conclusions

The findings in our series support prior observations that robotic-assisted and laparoscopic dismembered pyeloplasty provide comparable results for correction of UPJO with no difference in complications rates. Our comparison also adds further evidence to the growing body of research demonstrating reduction in operative time requirement for robotic-assisted pyeloplasty as compared to laparoscopic pyeloplasty. □

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