Predictive factors for early discharge (≤24 hours) and re-admission following robotic-assisted laparoscopic pyeloplasty in children

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Abstract

Introduction: Minimally invasive pyeloplasty (MIP) for correction of ureteropelvic junction (UPJ) obstruction in children has significantly improved the postoperative management of these patients. In this study, we sought to examine the factors associated with early discharge (≤24 hours) in children that underwent robotic-assisted laparoscopic pyeloplasty (RALP).
Methods: We performed a retrospective chart review of all children who underwent RALP from 2012 to 2018 in our center. Descriptive statistics and a non-adjusted risk analysis were performed to evaluate the factors associated with early discharge (≤24h), readmission, and complications within the first 30 days after the procedure.
Results: Eighty-nine patients out of 124 total pyeloplasties (72%) stayed ≤24 hours post-surgery. Of the variables analyzed, later cases were statistically associated with length of stay (LOS); the first 55 patients had a lower probability of being hospitalized for ≤24 hours (odds ratio [OR] 0.24, 95% confidence interval [CI] 0.09–0.64, p=0.004).
Conclusions: Robotic-assisted pyeloplasty for children is associated with a high rate of early recovery, short hospital stay, low re-admission, and complication rate. Although not statistically

significant, patients with shorter operative room time also had a shorter LOS. An increased LOS was observed in the initial patients of our series, and this is most likely explained because of the initial learning curve of all the team for the procedure itself and the more conservative postoperative management.

Introduction

Open dismembered pyeloplasty for repair of uteropelvic junction obstruction (UPJO) in children is the standard of care, however in recent years there has been a paradigm shift towards minimally invasive repair in the form of pure laparoscopic followed by robotic assisted laparoscopic pyeloplasty (RALP). Minimally invasive pyeloplasty (MIP) for correction of UPJ obstruction in children (laparoscopic or robotic assisted) has significantly improved the postoperative management of these patients. In general, the benefits of MIP include: faster recovery in the form of shorter hospital stay, decreased post-operative pain, and improved cosmesis. In the past 10 years, robotic surgery has arguably become adopted faster than pure laparoscopy given its flatter learning curve. Varda et al. found in their review of utilization trends that RALP has increased 29% annually.[1] In a single center experience by O'Brien and Shukla, they determined that a surgeon could reasonably make the transition from open to robotic assisted pyeloplasty without having formally trained or being experienced in a pure laparoscopic pyeloplasty.[2] Robotic assisted laparoscopic pyeloplasty has been applied to the pediatric population with UPJO, and RALP has been deemed a safe and viable option to the open approach.[3]

Previously published literature suggests that minimally invasive techniques allowed patients a faster recovery and an early discharge home. Nevertheless, not many studies have looked at the rates of early readmission and predictive factors for early rehospitalization following RALP. Furthermore, the factors associated with early discharge remain uncertain and many clinicians question whether early discharge of children that underwent RALP is safe.[4,5,6,7] Therefore, we sought to examine the factors associated with early discharge (≤24h) and early readmission in these patients.

Methods

Study design and data source

After approval from the Nicklaus Children's Hospital IRB, we performed a retrospective chart review of all children who underwent RALP from 2012 to 2018 at our center. UPJO diagnosis was based on serial renal ultrasounds and MAG3 renal scans. Indications for surgical interventions were SFU grade 3-4 UPJO associated with <40% of differential renal function

(DRF) on diuretic renography, and/or a decrease of 5–10% of RRF on follow-up. In other patients, hydronephrosis was associated with cyclic flank pain with or without vomiting and infrequently with recurrent UTI under antibiotic prophylaxis. Demographic, clinical perioperative data, intraoperative data, and outcomes were recorded. Operative room time was defined as the time that the surgeon spent on the robot console. At our institution, the first cases of RALP were performed with the DaVinci Si model, which was later replaced by the DaVinci Xi in 2016. For this study, we considered the diagnosis of additional renal anomaly in patients with horseshoe kidney, duplex system, ectopic pelvic kidney, or when the procedure was a redo pyeloplasty. There were three urologists who contributed to cases in this cohort [Surgeon A = 103/124 (83.1%), Surgeon B = 17/124 (13.7%), and Surgeon C = 4/124 (3.2%)].

Surgical procedure

All patients underwent a transperitoneal, Anderson-Hynes technique. In brief, the procedures were performed as follows. Cystoscopy with retrograde pyelogram and double-J stent placement was performed to visualize the obstruction. A foley catheter was inserted, and the patient was repositioned to a lateral decubitus position applicable to the proper side of interest. For the DaVinci Si, three robotic trocars were used (8.5mm for camera and two 8mm working ports); robotic ports were all placed in the midline – one at the umbilicus, one 5cm cranial, and the other 5cm caudal. In the first 35 cases performed on the Si, an additional 5mm port was used as an assistant port. All subsequent cases, on the Si and Xi, were done without an assistant port. For the Xi, the port placement was the same, however the camera trocar was 8mm. A 30-degree down lens was used for the entirety of the case. The transmesenteric approach was preferred for left-sided RALP, if the anatomy allowed. The ureteral-pelvic defect was identified and isolated with minimal devascularization. A hitch-stitch was used to aid in traction of the pelvis during transection and then reconstruction. The ureteral-pelvic defect was then transected sharply. The proximal ureter was spatulated, and the repair was then performed with a 5-0 Monocryl suture. Separate anterior and posterior wall closures were performed over the JJ stent in a running fashion. Sutures were passed via one of the robotic trocars. The umbilical port site fascia was closed with 2-0 Vicryl followed by 5-0 Monocryl for the skin. The foley catheter was discontinued on post-operative day 1 in the morning. Regarding post-operative pain management, in the first half of the series, our preference was Tylenol 10mg/kg every 6 hours and morphine 0.1 mg/kg every 4 hours when moderate/severe pain. In the later half, we significantly reduced the use of narcotics, giving preference to ketorolac 0.5 mg/kg instead, when the renal function of the patient was normal. The JJ stent was removed in the operating room approximately 2-4 weeks after surgery.

Statistical analysis
Statistical analysis was performed with the SPSS 24 software for Windows. After the determination of data distribution with normality test, medians and interquartile ranges [IQR: 25-75] were reported and a comparison of numerical variables between patients that were admitted >24 hours and ≤ 24 hours was performed using the Mann-Whitney U test. Categorical variables were presented as absolute values and frequencies and analyzed with a Chi-square or Fisher's exact test as required. Then, a univariable and multivariable-adjusted logistic regression analysis was performed to calculate the risk of >24 hours hospitalization. A p-value < 0.05 was considered statistically significant.

Results
A total of 124 children that underwent RALP were analyzed, 89 patients (71.8%) stayed ≤ 24 hours post-surgery in the hospital. With an average follow-up of 9 months [IQR: 4-20.8], 2 of 124 patients (1.6%) underwent re-do robotic pyeloplasty (p > 0.05). The first patient was Surgeon A's second robotic pyeloplasty in 2012. She developed flank pain 3 years after surgery and was found to have moderate hydronephrosis of the lower pole. Her intermittent pain and the hydronephrosis persisted, and eventually a re-do robotic pyeloplasty was performed in 2018. No renal function was lost. The second patient was from Surgeon B's cohort. She developed immediate obstruction, confirmed on retrograde pyelogram, after stent removal. A nephrostomy tube was placed, and she underwent re-do robotic pyeloplasty a month later. Both patients are presently doing well.

When comparing both groups, no difference was observed regarding age, gender, laterality, presence of renal anomalies or procedures such as pyeloscopy or stone removal (p > 0.05). We observed that patients underwent surgery with DaVinci Si model (from 2012 to 2016) had a longer length of stay than those in which the Xi model was used (2016 to 2018) (p = 0.009). Also, more patients with a crossing vessel were discharged within the first 24 hours (p = 0.010) (Table 1). Furthermore, no increased rates of readmission or complications were observed for the patients within the early discharge group when compared to the ones who had a longer length of stay. Eighteen complications were observed, all being minor (Clavien 3 or less) – such as constipation, UTI, or abdominal pain. Seven patients were readmitted; five of them due to a febrile UTI, while the other two presented symptoms of vomiting and abdominal pain. Additionally, patients with a crossing vessel had surgery when they were older (No crossing vessel = 6.8 [IQR: 2.7 - 10.8] years vs. crossing vessel = 11.4 [IQR: 8.7 - 15.6] years; p < 0.001).

On univariable analysis, an increase in operative room time was associated with an increased length of stay (LOS). In both univariable and multivariable-adjusted risk analysis, there was a significant association between crossing vessel and shorter length of hospitality stay (OR= 3.45, 95% CI: 1.09 - 10.89; p = 0.035). Additionally, the 55 children that had surgery with the DaVinci Si had a lower probability of being hospitalized for ≤24 hours (OR= 0.24, 95% CI:

0.09 - 0.64; p = 0.004) (Table 2). When comparing the 3 urologists that contributed to this cohort, the rate of early discharge was similar between surgeons (p = 0.566).

Discussion

The robotic-assisted approach for pyeloplasty has become popularized in the last decade. In 2015 in the United States, the robotic approach accounted for 40% of all procedures in children and 85% in the adolescent population.[1] In addition to the inherent benefits of a minimally invasive approach (e.g. less morbidity), the robot increases the dexterity of the surgeon making movements much more accurate and easier compared to the classical laparoscopic approach. This significantly reduces the learning curve, especially for reconstructive procedures like pyeloplasties, when compared with the classical laparoscopic approach.[8,9] More recently, experienced surgeons are observing fast and uneventful recovery by patients undergoing robotic surgery and are pushing to discharge patients earlier or even doing robotic surgery as an outpatient procedure.[10,11]

With that in mind, we sought to identify prognostic clinical features that would be associated with an early discharge (≤24h) after robotic pyeloplasty in children. This information would guide and reassure the pediatric urologist when deciding which subset of patients may be discharged with minimal risk.

In the first part of our retrospective series, the LOS was significantly longer compared to more recent cases. This was observed when comparing the type of DaVinci platform used (DaVinci Si vs Xi), since almost all of the first half of our series was performed using the DaVinci Si. We believe that this association was found due to the initial learning curve of all the operative team, the more conservative post-operative management, and the difference in port sizes and maneuverability between the Si and Xi models. For the first half of the series we used morphine as needed for moderate/severe pain. We virtually eliminated morphine in the second half of cases, using scheduled ketorolac at 30mg/kg. Also, early ambulation was encouraged more, later in the series.

This observation can also be found in the literature. Since the first description of robotic pyeloplasty in children in 2005, the LOS has systematically declined.[12] In 2006, two similar retrospective series of RALP have shown LOS of 2.3 and 2.4 days.[13,14] In a comparative series in 2013, Casella et al. showed a mean LOS of 1 day.[15] More recently, Fichtenbaum et al. showed a short series of 17 tubeless RALP in the outpatient setting.[11] In our study, a short-term assessment showed no complications, ER-visits, or readmissions 30 days after surgery. It is our belief that an experienced team and a well-established robotic program can safely perform an early discharge (≤24h) in the majority of patients.

Although not statistically significant, patients with short operative time also had a shorter LOS. This is an intuitive finding since more complex cases would take a prolonged operative time and thus have a longer hospitalization. Shorter procedures would mean less use of narcotics,

therefore faster recovery of bowel function. In a similar way, Freilich et al. showed that prolonged surgery (>2h) in pediatric urology procedures would be associated with a higher risk of complications.[16] As previously mentioned, reducing the surgery duration and consequently the time of hospitalization requires an experienced team and surgeon. Reducing the operative time with the increase of number of cases was already demonstrated by Murthy et al. in a comparative series with robotic and open pyeloplasty. In their study, they showed a significant trend in reducing the operative time with increasing experience in the robotic cases; after 40 cases the OP time would be similar to the open cases.[17]

No other differences in time of hospitalization was seen when analyzing age groups, gender or presence of associated kidney anomalies (e.g. duplex kidneys) (Table 1). Even when analyzing different age groups (i.e. infants), no differences were seen in the time of discharge. There is recent evidence showing similar results even for smaller and younger patients. Kawal et al. compared infants to older children and showed no difference in the outcomes with both groups, with a median length of stay of 1 day.[18] Kafka et al. prospectively compared patients weighing less than 10Kg that underwent RALP to a matched cohort of patients that had open pyeloplasty for UPJO.[19] In addition to similar outcomes in both groups, a reasonable short mean length of stay was observed for the RALP group (1 day).[19] For these reasons, we believe that patients in the infants and toddlers age groups may also be safely discharged home ≤24h after the procedure. Ultimately, we are unable to identify a clear reason behind the significant association between crossing vessels and shorter LOS at this time, and hope that further prospective studies will provide further insights into these findings.

Although our results are encouraging, this study is not without limitations: the retrospective methodology, lack of control group, moderate sample size, and absence of perioperative pain management evaluation. Despite these limitations, we believe our findings provide relevant and reliable information. We expect that further prospective studies validate our findings. Additionally, further research should analyze the economic impact of the overall decisions, with the intention that physicians can take effective measurements to decrease the economic burden of RALPs on the overall health system without affecting patient care.

Conclusions
Our findings demonstrate that pediatric RALP is associated with high rates of early recovery and short hospitalization and without increased rates of complications nor readmissions. Increased LOS was observed during the first half of the series (2012-2016), and those with shorter operative times had also a shorter LOS. Therefore, it is our belief that an experienced team and a well-established robotic program can safely perform an early discharge (≤24h) in the majority of patients, and that the findings of our study support the trend toward the treatment of robotic pyeloplasty as an outpatient procedure.

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Figures and Tables

Table 1. Clinical, demographic, and followup outcomes of the analyzed patients				
	Overall n=124 (100%)	**Hospital stay ≤24h** n=89 (71.8%)	**Hospital stay >24h** n=35 (28.2%)	**p**
Age at surgery (months)	103 (48.5–163)	104 (47–164)	90 (53–158)	0.689
Age group (months)				
Infants (0–12)	9 (7.3%)	7 (7.9%)	2 (5.7%)	
Toddlers (13–36)	16 (12.9%)	10 (11.2%)	6 (17.1%)	
Prepubertal (37–156)	63 (50.8%)	46 (51.7%)	17 (48.6%)	
Adolescents (157–216)	36 (29.0%)	26 (29.2%)	10 (28.6%)	0.828
Genders				
Males	84 (67.7%)	64 (71.9%)	20 (57.1%)	
Females	40 (32.3%)	25 (28.1%)	15 (42.9%)	0.137
Laterality				
Right	51 (41.1%)	37 (41.6%)	14 (40%)	
Left	73 (58.9%)	52 (58.4%)	21 (60%)	0.873
Pyeloscopy/stone removal	8 (6.5%)	5 (5.6%)	3 (8.6%)	0.686
Crossing vessel	39 (31.5%)	34 (38.2%)	5 (14.3%)	**0.010**
Renal anomaly	10 (8.1%)	5 (5.6%)	5 (14.3%)	0.143
DaVinci system				
Xi	69 (55.6%)	56 (62.9%)	13 (37.1%)	
Si	55 (44.4%)	33 (37.1%)	22 (62.9%)	**0.009**
Operative room time (minutes)	184 (161–228)	181 (159–218)	192 (174–244)	0.064
Postoperative complication 30 days	18 (14.5%)	10 (11.2%)	8 (22.9%)	0.098
Re-admission	7 (5.6%)	5 (5.6%)	2 (5.7%)	0.999
Length of followup (months)	9 (4–20.8)	9 (4–19.3)	14.5 (4–34.3)	0.331

Median (interquartile range 25–75).

Table 2. Univariable and multivariable-adjusted risk analysis to determine the association between the clinical and demographic characteristics and early discharge (≤24 hours)						
	Univariable			**Multivariable**		
	OR	**95% CI**	**p**	**OR**	**95% CI**	**p**
Age group (months)						
Infants (0–12)	1			1		
Toddlers (13–36)	0.48	0.07–3.09	0.437	0.71	0.09–5.86	0.752
Prepubertal (37–156)	0.77	0.15–4.10	0.762	1.03	0.15–7.12	0.973
Adolescents (157–216)	0.74	0.13–4.20	0.737	1.04	0.14–7.99	0.972
Gender						
Males	1			1		
Females	0.52	0.23–1.18	0.116	0.43	0.16–1.12	0.083
Laterality						
Right	1			1		
Left	0.94	0.42–2.08	0.873	1.24	0.46–3.31	0.671
Pyeloscopy/stone removal						
No	1			1		
Yes	0.64	0.14–2.81	0.550	0.85	0.14–5.17	0.863
Crossing vessel						
No crossing vessel	1			1		
Yes crossing vessel	3.71	1.31–10.48	**0.013**	3.45	1.09–10.89	**0.035**
Renal anatomy						
No renal anomaly	1			1		
Renal anomaly	0.36	0.10–1.32	0.123	0.28	0.06–1.35	0.112
DaVinci System						
Xi	1			1		
Si	0.35	0.16–0.78	**0.011**	0.24	0.09–0.64	**0.004**
Operative room time (10 minutes)	0.91	0.84–0.99	**0.034**	0.91	0.82–1.01	0.090

CI: confidence interval; OR: odds ratio.