Robotic-assisted laparoscopic pyeloplasty for ureteropelvic junction obstruction

A retrospective review of a high-volume Canadian center

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ABSTRACT

INTRODUCTION: At present, there is no literature on the outcomes of robotic-assisted laparoscopic pyeloplasty (RALPyelo) in a Canadian context. Our objective was to perform a retrospective review of RALPyelo cases at a high-volume Canadian center.

METHODS: We performed a retrospective review of patients who underwent RALPyelo at St. Michael's Hospital, between January 2012 and May 2019. Demographics, operative details, and pre- and postoperative imaging results (ultrasounds, computed tomography [CT] scans, and diuretic renal scan [DRS]) were recorded. Patients were excluded if at least one-year followup data was unavailable. Our primary outcome was clinical and radiologic improvement defined as 1) symptom improvement; 2) stable/improved split renal function on DRS; and 3) either improvement in the degree of hydronephrosis on ultrasound or CT, or improved drainage time on DRS. Secondary outcomes included postoperative complications, need for diagnostic intervention, and reintervention for recurrent UPJO.

RESULTS: A total of 156 patients underwent RALPyelo after exclusions. The median age was 42 and 66% were female. Mean followup was 2.5 years. For our primary outcome, 87% had clinical and radiologic improvement. Diagnostic investigation for possible recurrent/persistent obstruction, based on symptoms and/or imaging results, was required in 17% of cases, but only 3% required reintervention for recurrent UPJO. Accordingly, the overall treatment success was 97%. The most common postoperative complication was urinary tract infection (18%), and urine leak was seen in only 2% of patients.

CONCLUSIONS: The results of our study compare favorably with currently reported outcomes in the literature and demonstrate the safety and high level of success of RALPyelo at a high-volume Canadian center.

INTRODUCTION

Ureteropelvic junction obstruction (UPJO) is a relatively common urologic condition where either an extrinsic or intrinsic compression at the junction between the renal pelvis and proximal ureter impedes urine flow. UPJO is predominantly a congenital condition observed in the pediatric population and affects one in every 1000–2000 live births, with an equal male-to-female ratio.[1] Within the adult age group, UPJO has an overall incidence of one in 1500.[1]

The indications for treatment of UPJO include recurrent episodes of pain, the formation of renal calculi, recurrent urinary tract infections (UTIs), and complete or partial loss of ipsilateral renal function. Treatment options include conservative measures, such as chronic nephrostomy tube or ureteric stenting, that require routine exchanges, vs. surgical intervention with either retrograde or antegrade endopyelotomy and pyeloplasty. Pyeloplasty offers the highest chance for success as compared to endopyelotomy.[2,3]

Different approaches can be used to perform a pyeloplasty, including open, laparoscopic, and robotic-assisted laparoscopic.[3] Each approach comes with its benefits and drawbacks depending on various patient factors and surgeons' preferences and skill. Robotic-assisted laparoscopic pyeloplasty (RALPyelo) offers the advantages of minimally invasive surgery to the patient (less postoperative pain, faster recovery, and

KEY MESSAGES

- This is the first reported Canadian series of robotic-assisted laparoscopic pyeloplasty for UPJO from a high-volume center.
- The review demonstrates the safety and high success rate of robotic pyeloplasty for UPJO.

minimal scarring), as well as distinct technical advantages to the surgeon (better ergonomics, enhanced dexterity, greater precision). RALPyelo, using the da Vinci® system (Intuitive Surgical, U.S.) was first introduced by Sung and colleagues in an experimental setting in 1999,[4] and the clinical feasibility of the procedure was confirmed by Palese et al[5] in 2005 and Mufarrij et al[6] in 2007.

At present, there is no literature on the outcomes of RALPyelo in a Canadian context. Accordingly, the objective of our study was to report the first Canadian experience with RALPyelo based on data from a single high-volume Canadian center and highlight our unique modification for suturing the anastomosis that minimizes handling of the ureter at its most critical location near the apex.

METHODS

Study design

We performed a single-institution, retrospective cohort study of all patients undergoing a RALPyelo at St. Michael's Hospital. St. Michael's Hospital is a tertiary care hospital in Toronto, ON, Canada, servicing the greater Toronto area and surrounding communities with a population of over 7 million. St. Michael's Hospital was the only center in the region performing RALPyelo during the study time frame. We conducted this study according to a prespecified protocol that was approved by the Institutional Review Board at St. Michael's Hospital. Reporting of this study follows the STROBE guidelines set for observational studies.[7]

Study population

We identified all patients who had undergone an upper tract robotic-assisted laparoscopic reconstructive procedure at St. Michael's Hospital using a master log of all robotic cases. We included all patients who underwent a RALPyelo between January 2012 and May 2019. Patients were excluded if they underwent an upper ureteric reconstruction (i.e., ureteroureterostomy), if they did not have at least one year of followup post-pyeloplasty, or if their records were otherwise incomplete from the electronic medical record (EMR) at the hospital.

Using our EMR, a detailed chart review was performed to extract all demographic, preoperative and postoperative clinic details, and operative findings. Demographics included age, gender, height, weight, body mass index, and past medical and surgical history. Preoperative clinic details included symptom status and results from imaging studies (i.e., ultrasound, computed tomography [CT] scans, and diuretic renal scans [DRS]). Operative findings included side of surgery, presence of crossing vessel, concomitant removal of stones, duration of surgery, and estimated blood loss along, with other details. Postoperative details included symptom status, length of stay, results from imaging studies (i.e., ultrasound, CT scans, and DRS), and complications.

Importantly, the presence of symptoms pre- and postoperatively was determined based careful review of the clinical notes in the EMR and not using a validated pain questionnaire.

Surgical technique

All patients without a pre-existing stent in place either had a stent placed retrograde in advance of or at the start of the procedure under fluoroscopic guidance, or had a stent placed antegrade during the RALPyelo.

Once all ports were in place, the colon and its mesentery were adequately mobilized and medialized. The proximal ureter was then identified lateral to the gonadal vein. The ureter was encircled and traced up towards the UPJ. Care was taken to maintain a good amount of periureteral tissue to ensure vascularity. The UPJ was completely dissected out and the renal pelvis was cleared and mobilized to allow adequate exposure for a dismembered pyeloplasty. In cases with a crossing vessel, the vessels were preserved, encircled, and completely dissected free from the ureter/UPJ below. Small (5 mm) polymer locking clips were often placed to temporarily tack the perinephric tissues laterally to help improve exposure. These clips were removed at the end of the case.

Next, the renal pelvis was incised sharply on its medial surface superior to the UPJ. This provides a handle of renal pelvis on the transected ureter that can help to manipulate the ureter in a no-touch technique. The incision is carried laterally to the level of the UPJ. In cases with crossing vessels, the ureter is passed anterior to the vessels at this point. The ureter is then spatulated along its lateral surface for approximately 2 cm or until the area of narrowing has been completely incised.

The spatulated proximal ureter was then anastomosed to the cut edge of the renal pelvis in a running continuous fashion using two 4-0 PDS sutures. Our unique offset-from-the-apex technique was employed, placing the posterior wall suture first about 1–2 cm from the apex (Figure 1). This suture was tied down and run continuously away from the apex of the spatulation. Once the posterior wall was complete, the anterior wall suture was placed next to the posterior wall suture and situated closer to the apex (Figure 1). The suture was tied down and then the apical sutures, which are the most critical of the anastomosis, could be placed with the upmost precision and using a no-touch technique, as the ureter is held clearly in place by the completed offset posterior and anterior wall sutures. Minimizing handling near the apex and having precisely placed sutures at this location is critical to preventing recurrent stenosis.

In some cases, the ureteral handle of excess renal pelvis was excised prior to complete the anastomosis, but a standard reduction pyeloplasty technique was not employed for most cases. The anterior and posterior wall sutures were secured to one another, and the anastomosis was checked to be watertight.

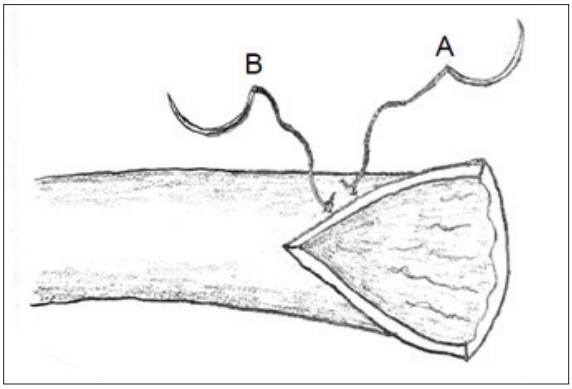

Figure 1. Spatulated proximal ureter with offset apex sutures: (A) posterior wall structure; and (B) anterior wall suture.

Followup

The ureteric stent was typically left in place for 4–6 weeks postoperatively and removed via cystoscopy under local anesthetic. All patients were followed postoperatively with renal ultrasound and DRS, and occasionally CT scans, as clinically indicated. The results of all postoperative DRS and ultrasounds completed at St. Michael's Hospital were recorded, including results at six weeks, six months, and one year post-pyeloplasty, as well as two-year and three-year post-pyeloplasty, if available.

Cystoscopy and retrograde pyelogram ± diagnostic ureteroscopy were used to evaluate patients with either abnormal postoperative imaging (i.e., reduced split function compared to preop DRS, no improvement or worsened T½ drainage time, worsened hydronephrosis), persistent symptoms, or both.

Outcomes

Our primary outcome was clinical and radiologic improvement defined as: 1) symptom improvement; 2) stable/improved ipsilateral split renal function on DRS; and 3) either improvement in the degree of hydronephrosis on ultrasound or CT, or improved T½ drainage time on DRS. The primary outcome was defined on the most recently completely imaging and clinical assessment of symptoms. The mean time and standard deviation (SD) to the last ultrasound and/or DRS scan, along with followup visit were reported.

Patients who were asymptomatic or their symptom status was undefined preoperatively were recorded as having symptom improvement if they remained asymptomatic postoperatively and had no signs of persistent/recurrent obstruction on postoperative ultrasound and DRS.

Secondary outcomes included: 1) postoperative complications (e.g., urine leak, bleeding requiring blood transfusion, wound infection, bowel injury, conversion to open, and UTI); 2) need for diagnostic intervention (retrograde pyelogram or diagnostic ureteroscopy) to evaluate patients with either abnormal postoperative imaging, persistent symptoms, or both; and 3) reintervention for recurrent UPJO with either endopyelotomy, repeat pyeloplasty, or nephrectomy.

Analysis

Categorical data is presented as frequencies and percentages. Continuous data is presented as median with interquartile range or as mean ± SD, depending on the distribution of data.

RESULTS

A total of 188 patients underwent RALPyelo over the study time frame, and after excluding patients with incomplete or missing one-year followup data, our study cohort consisted of 156 patients. The median age was 42 years and 66% were female (Table 1). Mean followup was 2.5 years (SD 1.7). Most patients were in good health, with 71% being an American Society of Anesthesiologists (ASA) 1 or 2. As might be expected, there was almost an even split between right- (54%) and left-sided (46%) surgery. A crossing vessel was

Table 1. Patient demographics and operative details	
Study sample	N=156
Median age at OR (IQR)	42 (28–58)
Gender (%) Male Female	 53 (34) 103 (66)
Mean BMI (SD)	25 (6)
ASA status (%) I II III IV	 27 (17) 84 (54) 40 (27) 3 (2)
Hypertension (%)	25 (16)
Type 2 diabetes (%)	8 (5)
Prior history of nephrolithiasis (%)	14 (9)
Prior endoscopic surgery (i.e., ureteroscopy or percutaneous nephrolithotomy) (%)	20 (13)
Prior endopyelotomy (%)	9 (6)
Prior pyeloplasty (%)	4 (3)
Preoperative stent or nephrostomy tube Stent Nephrostomy tube	 41(26) 5 (3)
Side of surgery (%) Left Right	 71 (46) 85 (54)
Mean OR duration, min (SD)	178 (47)
Concurrent stone removal stones (%)	14 (9)
Crossing (%)	46 (30)
Mean stent duration, days (SD)	35 (7)
Mean LOS, nights (SD)	2 (1)
Mean followup, years (SD)	2.5 (1.7)

ASA: American Society of Anesthesiologists; BMI: body mass index; IQR: interquartile range; LOS: length of stay; OR: operating room; SD: standard deviation.

encountered as the cause for obstruction in 30% of cases and concurrent stone removal was performed in 9% of cases. Nine patients (6%) had a prior endopyelotomy and four patients (3%) had a prior pyeloplasty at another center — three laparoscopic and one open.

Pre- and postoperative symptom status was defined in all cases reviewed except one that didn't document preoperative symptom status.

In terms of our primary outcome, 87% had clinical and radiologic improvement. The vast majority (76%) had symptom improvement, stable or improved ipsilateral split renal function on DRS, improved hydronephrosis on ultrasound or CT, and improved T½ drainage time on DRS. The breakdown of the number of patients satisfying each iteration of the composite primary outcome are listed in Table 2.

Of note, there were 21 patients who were asymptomatic preoperatively. All 21 of these patients, as well as the one patient with undefined preoperative symptom status, were asymptomatic postoperatively. Furthermore, none of these of 22 patients had worsened hydronephrosis or deterioration in their split function to indicate recurrent obstruction

Diagnostic investigation for possible recurrent/persistent obstruction, based on symptoms and/or abnormal imaging results, was required in 26 (17%) cases; however, only five of these patients (3%) required reintervention for recurrent UPJO. Accordingly, the overall treatment success was 97%, considering that diagnostic intervention showed no evidence of recurrent UPJ stricture in the remaining patients who required diagnostic investigation for abnormal imaging or symptoms. Of those requiring reintervention, four patients underwent endopyelotomy, with one of these failing endopyelotomy and requiring a redo-RALPyelo. The remaining patient requiring reintervention required a redo-RALPyelo, as the reconstructed UPJ was obliterated. Both patients who underwent a redo-RALPyelo had successful outcomes.

The most common postoperative complication was UTI (18%), and importantly, urine leak was seen in only 2% of patients. One patient had a small bowel injury repaired intraoperatively, with no subsequent sequelae.

Table 2. Primary and secondary outcomes	
Study sample	N=156
Primary outcome n (%)	135 (87)
Symptom improvement + stable/improved split renal function + improved hydro-nephrosis + improved drainage on DRS	119 (76)
Symptom improvement + stable/improved split renal function + improved hydro-nephrosis	12 (8)
Symptom improvement + stable/improved split renal function + improved drainage on DRS	4 (3)
Secondary outcomes, n (%)	
Diagnostic investigation for possible recur-rent/persistent obstruction	26 (17)
Repeat intervention for recurrent UPJO	5 (3)

DRS: diuretic renal scan; UPJO: ureteropelvic junction obstruction.

No patients had bleeding requiring blood transfusion and no patients required conversion to open.

DISCUSSION

Our single-center, retrospective cohort study demonstrates a high success rate of RALPyelo with low risk for significant complications. Eighty-seven percent of patients had clinical and radiologic improvement and only 3% of patients required repeat intervention for recurrent stenosis and obstruction, resulting in an overall success rate of 97%. This represents the first study reporting on a Canadian center's outcomes for RALPyelo. It also highlights the excellent outcomes associated with our modified suturing technique that involves placement of the anastomotic sutures offset from the apex of the spatulated ureter to facilitate precise placement of the critical apical sutures in a no-touch technique.

Results from our study compare favorably with those in the published literature. The most recently published series is from 2022 and reports the single-institution experience with RALPyelo by Whiting et al.[8] This was a 10-year retrospective review of prospectively collected data on 160 patients (mean age 45.3±17.4 years) that underwent retroperitoneal (95%) or transperitoneal (5%) RALPyelo in a tertiary care hospital in the U.K. They reported a success rate (i.e., symptom improvement and/or unobstructed renogram) of 94.5%. Mean operating time was 139.4±45.6 minutes. Median hospital stay was one night (range 1–27). Six major complications were reported (>grade 2 on Clavien-Dindo classification), including urine leak, pain after stent removal, migrating stent requiring ureteroscopy, perirenal hematoma requiring open evacuation, and stent reinsertion.

Similarly, a systematic review and meta-analysis by Autorino et al from 2014 showed a success rate of RALPyelo ranging from 81–100% across 10 case series included in their review, with each series having at least 50 patients.[9] The complication rate ranged from 1.8–17.9% and the mean length of hospital stay ranged from 1.1–4.6 days across the same 10 studies.

Results from our study also compare favorably to the only existing series in the literature from Canada that reports on minimally invasive pyeloplasty from McMaster University. They reported on their initial experience in 2004[10] and updated this in 2008.[11] The updated series reported on their experience in 77 patients undergoing laparoscopic pyeloplasty with a mean followup of only 13 months.[11] Our series demonstrated a shorter mean length of stay (two vs. three days) and shorter mean operative time (178 vs. 218 minutes). Success rates were similar at 90.4% in the McMaster series vs. 87% in the present study; however, the longer followup in the present study introduces the possibility that more cases of recurrent obstruction could have been identified over time.

Strength and limitations

Our study has several strengths, including that it represents the first reported data in a Canadian context, while also being one of the largest reported series on RALPyelo with one of the longer mean followup data. We had complete and comprehensive pre- and intraoperative data available for all of the patients that underwent RAPyelo at St. Michael's Hospital during the study period, accessible through their EMR. The vast majority (83%) of these patients had adequate postoperative followup data, including ultrasounds and DRS, allowing us to include them in our final cohort for assessing our primary and secondary outcomes. Our primary and secondary research outcomes were clearly articulated and clinically well-defined.

The results of our study must be viewed within the context of our study limitations. This is a single-center study and so the results may not be generalizable to other centers. This was a retrospective study and so it is theoretically at risk for selection bias, as those patients who were excluded because of lack of followup data could have had significantly different outcomes than the remainder of our cohort. However, as the only center performing RALPyelo in the Greater Toronto Area and a tertiary referral center seeing patients from Northern Ontario, the patients included in our study cohort did span the full range, from the simplest to the most complex cases. Finally, symptom status preoperatively and postoperatively was determined based on review of existing clinical notes and not using a formal, validated pain questionnaire, and as such, this could limit the validity of this metric of our primary outcome.

Moving forward, ongoing prospective collection of data on patients undergoing RALPyelo will provide

> “ Our results demonstrate the safety and high level of success of RALPyelo at a high-volume Canadian center. ”

more robust data on outcomes, allowing for potential further refinement in technique and patient selection.

CONCLUSIONS

The results of our retrospective review compare favorably with currently reported outcomes in the literature and demonstrate the safety and high level of success of RALPyelo at a high-volume Canadian center.

COMPETING INTERESTS: The authors do not report any competing personal or financial interests related to this work.

This paper has been peer-reviewed.

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