

# Treatment of ureteropelvic junction obstruction and urolithiasis in children with minimally invasive surgery

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## Abstract

**Background:** Ureteropelvic Junction Obstruction (UPJO) is the most common congenital ureteral anomaly. Nowadays, according to the increasing incidence of urolithiasis, 20% of children with UPJO presents urolithiasis. Open pyeloplasty was the standard treatment before the introduction of minimally invasive surgery (MIS). Nevertheless, only scattered experiences on MIS were previously described and universal agreement on the treatment of UPJO plus urolithiasis is still missing.

**Objective:** The study aim was to describe our experience with a series of pediatric patients affected by UPJO and urolithiasis treated with robot-assisted pyeloplasty (RAP) and endoscopic removal of stones using a flexible cystoscope and a stones basket in a singular tertiary referral center.

**Material and methods:** We retrospectively reviewed our data from pediatric patients affected by UPJO and urolithiasis undergoing RAP between April 2013 and December 2019. The analysis was conducted on seven patients. All procedures were performed by one expert robotic surgeon and one endoscopic surgeon skilled in the management of urolithiasis.

**Results:** The mean age was 7 years (IQR 4–16). The median stone area was 77.7 mm<sup>2</sup> (IQR 50.2–148.4). Most of them (71.4%) presented preoperative symptoms. The median operative time was 110 min (IQR 104–125) with a console time of 90 (IQR 90–105). The median length of stay was 5 days (IQR 4–5). Median follow-up was 16 months (IQR 10–25).

**Conclusion:** RAP with concomitant flexible ureteroscope is a safe and effective option for the simultaneous management of UPJO with urolithiasis with excellent outcomes in children.

## Keywords

Urology, pediatric, robotic, ureteropelvic junction obstruction, urolithiasis

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## Introduction

Ureteropelvic Junction Obstruction (UPJO) occurs in 1 per 20,000 newborns and is the most common ureteral congenital anomaly with a hospitalization rate of 2.4/100,000 in the pediatric population.<sup>1,2</sup> The etiology of UPJO includes congenital and acquired alterations causing urine flow obstruction involving the proximal upper ureter, this condition can lead to hydronephrosis and progressive loss of renal function due to backpressure increase on the kidney.<sup>3</sup> With the advent of fetal

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ultrasonography (US), most cases are usually detected prenatally and later presentations are therefore decreasing frequently related to accessory lower pole vessels (causing extrinsic compression).<sup>4</sup> Approximately one in five patients with UPJO also present urolithiasis due to calculus formation predisposition owing to urinary stasis and infection, indeed, in the pediatric population an increasing percentage of renal stones diagnosis has been recorded with not a shared standard of care.<sup>2,5,6</sup>

Regarding UPJO clinical and surgical management, over the past 20 years, it has consistently evolved, open Anderson Hynes pyeloplasty was the standard treatment before the introduction of minimally invasive surgery (MIS) with success rates above 90%.<sup>7</sup> Laparoscopic pyeloplasty (LP) or Robot-assisted pyeloplasty (RAP) nowadays represents valid alternatives to open approach with comparable postoperative outcomes with reduction in post-operative pain, early recovery, decreased length of hospital stay (LOS), and better cosmesis results.<sup>8,9</sup>

While several series describe MIS approach for UPJO and associated anomalies, universal agreement in case of concomitant UPJO and renal stones disease is still missing in the pediatric population.<sup>5,10</sup> Although nowadays open approach still represented the gold standard in this setting of patient, according to stone size and children's features, a combination of LP or RAP with rigid nephroscope or ureteroscope may successfully reach stones with the same benefit of MIS before mentioned.

Aim of this study is to describe our experience with a consecutive series of pediatric patients affected UPJO and concomitant renal stones treated with RAP and endoscopic removal of stones using a flexible cystoscope and a stones basket in a singular tertiary referral center.

## Materials and methods

### *Patients and dataset*

After the ethic committee board approval (ethic board approval number is CEAVC 11766), we retrospectively reviewed our prospectively collected clinical and surgical data from consecutive pediatric patients affected by UPJO and renal stones undergoing RAP between April 2013 and December 2019 at a single tertiary referral center. The final analysis was conducted on seven patients treated with flexible cystoscope and basket stones removal. All procedures were performed by one expert robotic surgeon and one endoscopic surgeon skilled in the management of urolithiasis thanks to the shared expertise of our interhospital department.<sup>11,12</sup>

Patients were selected for surgery according to obstruction evidence on diagnostic imaging evaluation with US, Renal Scintigraphy, and abdomen RX that were always performed. Magnetic resonance imaging was scheduled based on the patient's clinical features whereas

no computed tomography (CT) was performed owing to radiation exposure. Stones burden was reported in mm<sup>2</sup> and obtained by multiplying two dimensions of the stone as seen in the most accurate kind of preoperative imaging assessment performed. Clinical preoperative features were assessed using American Society of Anesthesiologists (ASA) classification system and Chronic Kidney Diseases status (CKD).<sup>13</sup> Categorical, continuous parametric, and non-parametric variables were reported as frequencies and proportions, mean and standard deviation, or as median and interquartile range (IQR), respectively.

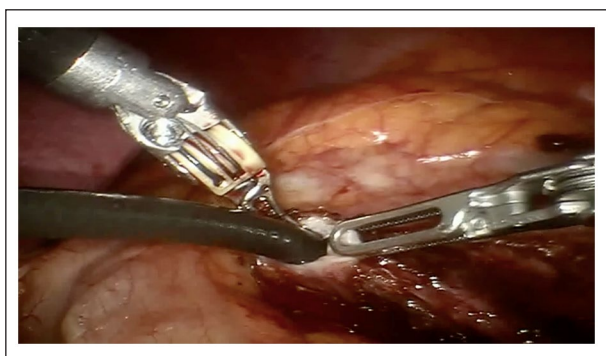
Intraoperative features assessed were crossing vessels, overall operative time, console time, and endoscopic time reported as the period between the use of flexible ureteroscope with visualization of the stone and its remotion outside the surgical field. Postoperative data as LOS, days of drainage, days of catheter, locations, and analysis of the extracted stones, were recorded. Complications burden was graded according to the modified Clavien classification system.<sup>14</sup> Intraoperative and postoperative complications were defined as medical and surgical events, altering normal postoperative course or delaying discharge, occurring until the 30th postoperative day. A scheduled follow-up protocol was applied at 1 month after stent removal and then at 6 and 12 months in case of asymptomatic patients. The success rate was defined as the reduction of hydronephrosis at US and no symptoms. All follow-up data were recorded and assessed in dedicated ambulatories at our tertiary referral center by medical doctors.

### *Surgical technique*

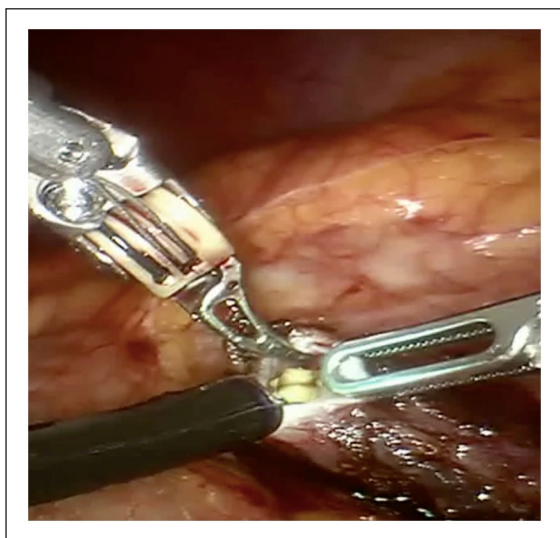
Robotic surgery was performed using the Xi or Si Da Vinci surgical system, (Intuitive Surgical, Sunnyvale, CA, USA), in a three-arm configuration with a 30° camera. All patients underwent general anesthesia with orotracheal intubation. Transabdominal lateral flank-approach with transperitoneal access was performed in all cases. Patients were positioned in lateral decubitus with the operative side on the top and twisted 45° axially. To increase flank exposure, the operating table was flexed slightly at the patient's waist. A Foley catheter was inserted in all patients. Four trocars were placed according to "Kyte-Like" configuration, previously described by our group.<sup>1</sup>

The da Vinci Xi or Si robot was then docked. Following an inspection of the peritoneal cavity, the colon was mobilized along the ipsilateral line of Toldt until the psoas muscle was visualized. The ureter was isolated and followed to the ureteropelvic junction with attempt to maintain the ureteral adventitia and periureteral vascular supply. The proximal ureter was dissected using round tip scissors, and excision of stenotic segment was performed; renal pelvis dissection was held by one robotic arm in order to maintain pelvis distention and obtain proper working space and visualization. Normally during this section, in case of

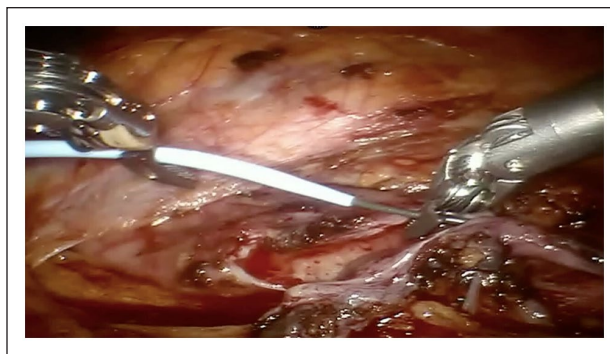
intraoperative visualization of stones, removal with robotic pliers was performed. Otherwise, flexible ureterorenoscopy was introduced into the 8 mm robotic trocar (5 mm trocar was used alternately according to the most suitable operating angle); exploration of renal pelvis and calices was operated by filling with physiological saline or exploiting pneumoperitoneum (Figures 1 & 2). The stone dislodgment was performed by introducing flexible basket in the ureterorenoscopy working channel. Extracorporeal stones removal occurred by the 5 mm laparoscopic trocar (8 mm robotic trocar was alternatively exploited according to the stone area). The ureter was then spatulated in the lateral portion and 6-0 thread anastomosis was performed from posterior plate to anterior one a double-J-stent (normally



**Figure 1.** Introduction of flexible ureterorenoscopy occurred through the 8 mm or the 5 mm robotic trocar (according to operating angle); exploration of renal pelvis and calices was then obtained by exploiting pneumoperitoneum or filling with physiological saline.



**Figure 2.** Flexible basket introduction was performed through the ureterorenoscopy working channel. Extracorporeal stones removal occurred by the 8 mm or the 5 mm laparoscopic trocar (according to stone area).



**Figure 3.** Double-J-stent introduction on hydrophilic guidewire and 6-0 thread anastomosis performed from posterior plate to anterior one.

removed after 4 weeks) (Figure 3). According to surgeon preference, abdominal drainage was placed at the end of the procedure.<sup>15,16</sup>

## Results

Overall, seven pediatric patients affected by UPJO syndrome with renal stones, treated with RAP, and stones removal with basket stones and flexible ureterorenoscopy were included in the analysis. Table 1 lists preoperative clinical and demographic characteristics of the pediatric patients included in the study. Overall study population median age was 7 years (IQR 4–16) with a median BMI of 19.6 kg/m<sup>2</sup> (IQR 17.0–20.0); the patient's gender was featured by four males and three females. Preoperative ASA score was assessed as one in all cases, no patients with ASA score equal to or greater than two were submitted to surgery. Anatomy variants such as pelvic ectopic kidney was recorded in one patient (14.3%) and the median stone area was 77.7 mm<sup>2</sup> (IQR 50.2–148.4). Preoperative symptoms like flank pain, urinary tract infection, and fever occurred in five (71.4%) cases, while only one patient (14.3%) presented a preoperatively placed pigtail due to flank pain and fever.

Intraoperative and postoperative features are summarized in Table 2. The median recorded operative time was 110 min (IQR 104–125) with a median console time of 90 min (IQR 90–105). The endoscopic time was 11 min (IQR 8–14); crossing vessels were found in three (42.9%) patients while drainage was placed in three (42.9%) cases. No intra or post-operative complications were recorded, each renal stone preoperatively observed was intraoperatively found. Median LOS was 5 (IQR 4–5) days and median days with catheter were three (IQR 3–4). Overall, six (88.8%) patients had calcium oxalate stones, while one (11.2%) child presented struvite stones (associated with preoperative urinary tract infection). After a median follow-up of 16 months (IQR 10–25) no relapses were assessed.

**Table 1.** Preoperative features pediatric patients with UPJO syndrome and renal stones treated with Robot-Assisted Pyeloplasty with endoscopic removal of stones using flexible stones basket.

Preoperative features	Overall population: seven patients
Gender, <i>n</i> (%)	
Male	4 (57.1%)
Female	3 (42.9%)
Age (years), median; IQR	7; 4–16
BMI (kg/m <sup>2</sup> ), median; IQR	19.6; 17.0–20.0
ASA score, <i>n</i> (%)	
I	7 (100%)
≥2	/
Anatomy variants, <i>n</i> (%)	
Ectopic kidney	1 (14.3%)
Symptoms, <i>n</i> (%)	
No	2 (28.6%)
Yes*	5 (71.4%)
Site of the stone, <i>n</i> %	
Pelvis	4 (57.1%)
Upper calyx	/
Medial calyx	2 (28.6%)
Lower calyx	1 (14.3%)
Stone area (mm <sup>2</sup> ), median; IQR	77.7; 50.2–148.4
Side, <i>n</i> (%)	
Right	2 (28.6%)
Left	5 (71.4%)
Patient with preop. Pigtail, <i>n</i> (%)	1 (14.3%)

BMI: body mass index; IQR: inter quartile range; ASA: score American society of anesthesiologists score.

\*Reported symptoms: Flank pain, urinary tract infection, fever.

## Discussion

The treatment of UPJO was performed for the first time by Anderson and Hynes in 1949, when they described open dismembered pyeloplasty.<sup>17</sup> This technique represented the best choice for the treatment of UPJO in the pediatric population for several decades; nowadays, laparoscopic and RAP have taken hold with superimposable functional results, faster recovery, and better cosmetic results compared to the open procedure.<sup>18</sup>

In particular, LP was performed for the first time in 1995 in children: comparing to the open strategy the advantages of LP are better postoperative pain control and decreased LOS, but this technique presented intrinsic disadvantages as limited maneuverability and high expertise required in intracorporeal suture with a long learning curve.<sup>19,20</sup> In contrast, the robot-assisted surgery has its enhanced dexterity and the magnified three-dimension vision ensures a simplified suture technique and better ergonomics compared to the laparoscopic approach, but this type of technology is not always available in the pediatric hospitals and present a higher cost and possible disadvantage in the youngest one, although feasible.<sup>8,21,22</sup>

Moreover, robotic experience has been recently proved safe and feasible even in complex cases such as horseshoe kidneys or associated anomalies.<sup>8,10</sup> Never less to say, calculi in children and stones in concomitant UPJO start to be more common due to the high grooving incidence of the urolithiasis condition.<sup>6</sup> Traditionally the standard technique was the open procedure but experiences of MIS and flexible nephroscope for UPJO and renal stones started to be reported in the adult setting, while the pediatric series

**Table 2.** Postoperative features of pediatric patients with UPJO and renal stones treated with Robot-Assisted Pyeloplasty with endoscopic removal of stones using stones basket.

Postoperative data	Overall population: seven patients
Total operative time (minutes), median; IQR	110; 104–125
Console time (minutes), median; IQR	90; 90–105
Endoscopic time (minutes), median; IQR	11; 8–14
Crossing vessels, <i>n</i> (%)	
No	4 (57.1%)
Yes	3 (42.9%)
Abdominal drainage, <i>n</i> (%)	
No	4 (57.1%)
Yes	3 (42.9%)
Intra or post-operative complications, <i>n</i> (%)	/
Length of stay (days), median; IQR	5; 4–5
Days with catheter, median; IQR	3; 3–4
Stone composition, <i>n</i> (%)	
Calcium oxalate	6 (88.8%)
Struvite	1 (11.2%)
Follow up (month), median; IQR	16; 10–25
Success rate <i>n</i> (%)	7 (100%)
Re-intervention, <i>n</i> (%)	/

IQR: inter quartile range.

\*Use of flexible ureteroscope with visualization of the stone and removal of it outside the surgical field.

are still few represented; regarding RAP and surgical intervention for stones the European Association of Urology (EAU) pediatric guidelines currently recommend that should be performed in separate procedures.<sup>23</sup>

Although EAU guidelines, one of the main advantages of the combine strategy is to avoid two procedures; in this light, Atug et al. described eight cases of adult patients who underwent RAP and concurrent removal of the stones with a flexible nephroscope. There were excellent results with a stone free-rate of 100% and no complications.<sup>24</sup> Indeed, Zheng et al. published their study, characterized by a cohort of nine patients with kidney stones treated with a rigid ureteroscope.<sup>23</sup> Moreover, Yang et al. presented their experience with 16 adult cases treated with RAP and stones removal with the aid of a flexible cystoscope.<sup>25</sup> Although not reported in our series, through the working channel is also may be possible to introduce a laser fiber in order to fragment the stone when the dislodgment is not possible due to the large dimension of the stone itself; moreover, according to the indication, this strategy is also useful for the dusting technique.

Indeed in the pediatric population, only one case has been described of concomitant RAP and pyelolithotomy on an adolescent and the patient was rendered stone-free with a single procedure.<sup>26</sup> After this study, Ballesteros et al. perform concomitant RAP and pyelolithotomy on 10 pediatric patients from 5 to 26 years of age. Nine of ten patients were rendered stone-free with robotic intervention. In two patients, no stone was found<sup>5</sup>; this is a possible condition related to the fact that pre-operative radiological exams such as CT in the children are not performed and ultrasounds US is the preferred imaging modality. US could results in less anatomical information for surgeons and a lack of stone characteristics at the moment of surgery.<sup>27</sup> Despite the small cohort, stones were found in all patients in our study.

RAP would seem to be with a lower complication rate and higher success rate with reductions in average operative times and reductions in LOS,<sup>20</sup> although the scarce literature does not permit to draft definitive conclusion. In our study, which represented the larger series in literature focusing only on pediatric cases, no intra or post-operative complications were recorded, the median of operative times was 110 min (range 104–125 min) and the LOS was 5 days (range 4–5 days). The LOS is slightly higher than the literature because our pediatric center represented the referral hub of a large part of Italy, so, commonly, the young patient moved from different regions; to avoid possible problems or stressful access to the emergency department in different hospitals to the children and the caregivers, it is might possible that in our clinical practice the LOS is higher.

Another topic debated in this period is the placement of the drainage. After RAP, a drain is routinely placed to detect any bleeding and/or possible anastomotic leakage.

Indeed, the urine loss in the abdomen may occur with urinary catheter in place or after its removal, when the vesicoureteral reflux caused by the presence of the ureteral stent may stress the anastomosis.<sup>28</sup> In these years, many studies are established that avoid placement of drainage after surgery does not change perioperative outcomes and postoperative success rate.<sup>14</sup> Our study confirms that drainage may be omitted with the same outcomes also in this setting patients.

Our study presents some limitations. Firstly, the main problem of this study is the limited number of patients and retrospective design of the study, therefore it will be necessary to develop further prospective studies with a larger sample of patients to confirm this combined approach as the gold standard. Another limitation is the single high experiences of the surgeons. It will need to evaluate a multicentric study to have a better experience related to multiple surgeons. Finally, it still must be defined if there is a stone size limit to this procedure. In our experience, the maximum stone size removed is 77.7 mm<sup>2</sup> (stone area, range 50.2–148.4 mm<sup>2</sup>) and after its' dislodgement into the pelvis, it was placed into a glove-finger to facilitate its' extraction.

In conclusion, our experience can confirm and assess in a specific pattern of patients the safety, feasibility, and efficacy of this intervention even in a pediatric population, with the advantage of employing more experienced professionals for such conditions that could plausibly be in constant increase in the coming years.

## Conclusion

Nowadays UPJO and stones start to be more frequent and they had a trend of grown incidence, shared decision, or uniform surgical approaches are debated. In this light, RAP with concomitant flexible ureteroscope seems to be a feasible option with excellent outcomes in children, although larger series are required to draft a definitive conclusion.

## Author contributions

Lorenzo Masieri and Simone Sforza contributed to conception and design of the study.

Simone Sforza, Alekseja Manera, Luca Lambertini contributed to generation, collection, assembly, analysis and/or interpretation of data. All authors contributed to drafting or revision of the manuscript; All authors approval the final version of the manuscript.

## Declaration of conflicting interests

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