

# Comparative Analysis of Robot Assisted Laparoscopy and Laparoscopic Pyeloplasty in the Treatment of Ureteropelvic Junction Obstruction

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**Abstract:** Through the comparison with laparoscopic pyeloplasty, this paper discusses the clinical value of robot assisted laparoscopic pyeloplasty in the treatment of ureteropelvic junction obstruction (UPJO). 82 patients with UPJO admitted to the First Affiliated Hospital of Medical College of Zhejiang University from January 2012 to December 2018 were retrospectively analyzed, including 43 patients who underwent robot assisted laparoscopic pyeloplasty (RALP group); Laparoscopic pyeloplasty was performed in 39 cases (LP group). The operation time, reconstruction suture time, intraoperative bleeding, postoperative drainage, postoperative intestinal recovery time, postoperative hospitalization time, hospitalization expenses, surgical complications and follow-up were compared and analyzed between the two groups. There was no significant difference between the two groups in operation time, renal pelvis reconstruction time, intraoperative bleeding, postoperative drainage tube stopping time, postoperative drainage volume and intestinal recovery time ( $P > 0.05$ ); and the postoperative indwelling time of urinary catheter and postoperative hospital stay in RALP group were shorter than those in LP group ( $P < 0.05$ ); The hospitalization cost in RALP group was significantly higher than that in LP group. Clavien Grade II complications occurred in 8 cases in LP group, Clavien Grade II complications occurred in 2 cases in RALP group, and there was 1 case of Grade III complications in both groups. The complication rate was 6.79% in RALP group and 23.07% in LP group. There was significant difference between the two groups ( $P < 0.05$ ). During the postoperative follow-up, hydronephrosis was aggravated in 1 patient in RALP group half a year after operation, and hydronephrosis was aggravated in 1 patient in LP group due to ureteral stone obstruction. Another patient in LP group was found to have more hydronephrosis than before. The success rate was 97.7% in RALP group and 94.8% in LP group. There was no significant difference between the two groups ( $P > 0.05$ ). Compared with laparoscopy, robot assisted laparoscopic pyeloplasty is a better surgical option. With the reduction of cost, it will gradually replace laparoscopic pyeloplasty.

**Keywords:** Robot-assisted Laparoscopy; Laparoscope; Ureteropelvic Junction Obstruction; Pyeloplasty

## 1. Introduction

Ureteropelvic junction obstruction (UPJO) is a common congenital malformation of urinary system. Patients with obvious obstruction often need surgical intervention in clinic. Since Anderson first described disconnected pyeloplasty in 1949, it has been used as the first-line operation for UPJO treatment because of its high cure rate. Although laparoscopy has accumulated a large number of cases in the treatment of UPJO, it cannot replace open surgery as the gold standard for the treatment of UPJO. Robot assisted laparoscopy has the advantages of high-definition field of vision, three-dimensional imaging and filtering jitter. It has technical advantages in intracavity suture reconstruction. In this study, we will compare the clinical efficacy of laparoscopy and robot assisted laparoscopy in the treatment of UPJO.

## 2. Materials and Methods

### 2.1 General Materials

This paper reviews and analyzes 82 patients with UPJO who were operated by two experienced laparoscopic doctors in the Department of Urology of the First Affiliated Hospital of Medical College of Zhejiang University from January 2012 to December 2018. There were 53 males and 29 females; there were 52 cases on the left and 30 cases on the right. There were 21 cases with renal calculi, 1 case with horseshoe kidney and 1 case with retrovena cava ureter. All patients underwent ultrasonography before operation to determine the degree of renal pelvic dilatation, and at least one UPJO diagnosis was made by intravenous pyelography (IVU), CT urography (CTU) or magnetic resonance urography (MRU). UPJO diagnosis clearly meets at least one of the following requirements: ① Low back pain, hematuria and other clinical symptoms; ② Accompanied by stones or secondary infection; ③ Progressive dilatation of renal pelvis and calyces; ④ Progressive renal impairment or renal insufficiency (renal function less than 40%). There were 43 cases of robotic assisted laparoscopic pyeloplasty (RALP), including 31 cases through abdominal approach and 12 cases through retroperitoneal approach; 39 cases underwent laparoscopic pyeloplasty (LP). There was no significant difference between RALP group and LP group in general data such as age, gender, side, body mass index, clinical symptoms and preoperative anterior and posterior diameter of renal pelvis (see Table 1).

Table 1 Comparison of General Data between RALP Group and LP Group

		RALP group	LP group	P
Number of examples (n)		43	39	
Age (years)		25 (5~40)	20(8~41)	0.064
Side (left / right)		23/20	29/10	0.05
Gender (male/ female)		29/14	24/15	0.577
Weight (kg/m <sup>2</sup> )		20.3(15.6~31.1)	20.4(12.8~26.3)	0.538
Clinical symptoms				
	Asymptomatic (n)	25	19	0.393
	Lumbago (n)	14	16	0.427
	Urinary tract infection (n)	2	3	0.910
	Hematuria (n)	2	1	0.615
Renal calculi (n)		11	10	0.904
Anteroposterior diameter of renal pelvis (n)				0.583
	10-30mm	27	22	
	30-50mm	6	9	
	50-70mm	8	5	
	70-90mm	2	3	

### 2.2 Surgical Methods

#### 2.2.1 Laparoscopic pyeloplasty adopts retroperitoneal approach

A 2.0 cm transverse incision is made on the iliac crest of the axillary midline to separate the retroperitoneal space and establish the retroperitoneal cavity. Three puncture cannulas were placed at the anterior axillary line, under the costal edge of the posterior axillary line and at the flat iliac crest of the anterior axillary line, and the lens was placed above the iliac crest. Remove extraperitoneal fat, open perirenal fascia, expose UPJ, and determine the location and cause of obstruction. ① Open the renal pelvis at the dilation above the obstruction, trim the renal pelvis, and make an oblique incision at the normal ureter below the obstruction. ② The lowest point of the renal pelvis and the lowest point of the corresponding ureteral wall were fixed and positioned, and the posterior wall and anterior wall were

sutured intermittently. ③After the double J tube was placed into the renal pelvis incision, the renal pelvis incision was closed by continuous suture. After checking that there was no active bleeding in the operation area, place a drainage tube around the kidney, close the incision and end the operation.

### **2.2.2 Robot assisted transabdominal laparoscopic pyeloplasty adopts the third generation Da Vinci robot Si surgical system.**

The patient took the contralateral oblique position. A 1.5cm incision was taken at the outer edge of rectus abdominis 3cm above the umbilical level as the lens hole. Under direct vision, the two fingers below the costal edge of the middle clavicular line and the two fingers above the iliac crest were punctured into the special puncture sleeve of the robot, and the puncture sleeve was placed next to the umbilical hole on the affected side as an auxiliary hole. Open the lateral peritoneum in the paracolic sulcus, free the colon to the inside, expose the kidney, open the perirenal fascia, free the UPJ and expose the obstructive segment. Laparoscopic pyeloplasty ① - ③ is referred to for the suture procedure of renal pelvis reconstruction.

### **2.2.3 Robot assisted retroperitoneal laparoscopic pyeloplasty patients were placed in the healthy lateral position.**

Take a 2.0cm transverse incision on the iliac crest of the axillary midline as the lens hole, and place the puncture sleeve under the rib edge of the axillary front line and the posterior axillary line respectively, and place the puncture sleeve horizontally at the axillary front line as the auxiliary hole. Open the perirenal fascia, find the UPJ obstruction and properly free the renal pelvis and proximal ureter. Refer to laparoscopic pyeloplasty ① - ③ for the steps of pyeloplasty and suture.

## **2.3 Postoperative Management and Follow-up**

Antibiotics were given routinely to prevent infection. The drainage tube was removed when the drainage was less than 10ml / D for 3 consecutive days. The double J tube was taken out under cystoscopy in the hospital from 1 to 3 months after operation. The anterior and posterior diameter of renal pelvis was understood by urinary color Doppler ultrasound 6 months after operation. After that, color Doppler ultrasound or CT of urinary system were rechecked every year. The imaging data and renal function results of postoperative follow-up were obtained by consulting outpatient data or telephone follow-up.

## **2.4 Observation Index**

The operation time, reconstruction suture time, intraoperative bleeding, postoperative drainage volume, time of stopping drainage tube, postoperative intestinal recovery time, postoperative hospital stay, hospitalization expenses, perioperative complications and follow-up were recorded.

## **2.5 Statistical Treatment**

SPSS 22.0 was used for statistical analysis. The measurement data are described by median (minimum maximum value), Mann Whitney U test of two independent samples is adopted, and the counting data are tested by chi square test.  $P < 0.05$  was regarded as statistically significant.

## **3. Results**

All patients in RALP group and LP group successfully completed the operation without conversion. See Table 2 for perioperative data. Among them, 21 patients found renal pelvis stones after incision of renal pelvis during operation, and underwent renal pelvis lithotomy (11 cases in RALP group and 10 cases in LP group). 11 patients found ectopic vessels during operation (6 cases in RALP group and 5 cases in LP group), which were cut off or placed on the opposite side of the ureteropelvic junction according to the blood supply. There was no significant difference between the two groups in operation time, renal pelvis reconstruction time, intraoperative bleeding, postoperative drainage tube stopping time, postoperative drainage volume and intestinal recovery time ( $P > 0.05$ ); The postoperative indwelling time of urinary catheter and postoperative hospital stay in RALP group were shorter than those in LP group ( $P < 0.05$ ); the hospitalization cost in RALP group was significantly higher than that in LP group.

### 3.1 Comparison of Surgical Complications

All patients had no intraoperative complications such as macrovascular and abdominal organ injury. The postoperative complications were divided into four levels according to Clavien classification system. In LP group, 8 cases had Clavien II complications, of which 3 cases had urinary tract infection leading to fever, which was relieved after replacing antibiotics to strengthen anti-inflammatory. One patient fell off the double J tube automatically 2 weeks after operation, and another 4 cases had anastomotic leakage, which stopped automatically 2 ~ 9 days after supportive treatment. In RALP group, Clavien grade II complications occurred in 2 cases, aspiration pneumonia occurred in 1 case, which improved after anti-inflammatory treatment, and anastomotic leakage occurred in 1 case, which stopped automatically after 5 days. There was one case of grade III complication in each group, which was perirenal effusion formed after operation, and healed after puncture and drainage under ultrasound-guided local anesthesia (Clavien IIIA). The complication rate was 6.79% in RALP group and 23.07% in LP group. There was significant difference between the two groups ( $P < 0.05$ ).

### 3.2 Postoperative Follow-up and Operation Success Rate

During the postoperative follow-up, the anterior posterior diameter of renal pelvis in the two groups was improved compared with that before operation. There was no significant difference between RALP group and LP group half a year after operation ( $P > 0.05$ ). One patient in RALP group had severe hydronephrosis half a year after operation, and the symptoms were not significantly relieved after balloon dilatation. The second open disconnection pyeloplasty was performed. The postoperative follow-up was 1 year, and the hydronephrosis and renal function were stable. One patient in LP group was aggravated by hydronephrosis due to ureteral stone obstruction. Another patient in LP group was found to have worse hydronephrosis (2.0cm before operation and 6.5cm after follow-up). Because the renal dynamic scan showed that the renal function was stable, no secondary operation was performed. During the follow-up from 6 to 48 months after operation, the clinical symptoms of other patients were improved, the hydronephrosis was reduced or not increased, and the renal function was improved or stable. It was considered that the operation was successful. The success rate of RALP group was 97.7%, and that of LP group was 94.8%. There was no significant difference between the two groups ( $P > 0.05$ ).

Table 2 Comparison of Perioperative Data between RALP Group and LP Group

	RALP group	LP group	P
Number of examples (n)	43	39	
Operation time (min)	126.5 (80~225)	122.5 (63~190)	0.798
Reconstruction suture time (min)	49 (38~75)	50 (39~68)	0.368
Intraoperative bleeding (ml)	20 (5~50)	20 (5~100)	0.923
Postoperative drainage (ml)	20 (0~260)	27.5 (0~235)	0.877
Time of stopping drainage tube (d)	5 (3~8)	6 (4~13)	0.411
Catheter stopping time (d)	6 (2~9)	7 (5~12)	0.011
Intestinal recovery time (d)	4 (1~6)	4 (2~7)	0.115
Postoperative hospital stay (d)	6(4~10)	7(5~13)	0
Hospitalization expenses (yuan)	64692(54257~72400)	18908(12489~37602)	0
Incidence of complications	6.97% (3/43)	23.07% (9/39)	0.044
Infection fever (n)	0	3	
Aspiration pneumonia (n)	1	0	
Double J tube falling off (n)	0	1	
Anastomotic leakage (n)	1	4	
Perirenal effusion (n)	1	1	
Anteroposterior diameter of renal pelvis half a year after operation (n)			0.775
0~20mm	27	21	
20~30mm	10	8	
30~40mm	2	5	
40~65mm	2	4	
Operation success rate	97.7% (42/43)	94.8(37/39)	0.931

#### 4. Conclusion

UPJO is the most common cause of congenital hydronephrosis. The purpose of surgery is to reconstruct the renal excretory system to reduce symptoms and protect renal function. The traditional undivided pyeloplasty does not remove the obstructive segment and abnormal muscle bundles and fibers. The incidence of postoperative restenosis is high, and it has little clinical value at present. In 1949, Anderson successfully implemented a new pyeloplasty, which can remove the diseased tissue, deal with the vagal vessels and fibrous bands, and restore the peristaltic conduction of the renal pelvis. The cure rate of the operation is as high as 90%, which is recognized as the gold standard for the treatment of UPJO. However, the disadvantages of open disconnection pyeloplasty are large trauma, postoperative incision pain, slow wound recovery and difficult treatment of secondary stenosis. In the 1980s, laparoscopy became popular all over the world and was gradually used in various urological operations. The operation steps of LP replicate the open Anderson Hynes disconnected pyeloplasty, retain its advantages and reduce complications. Scholars at home and abroad have followed suit and made technical improvements on this basis, so that its indications are basically equivalent to open surgery. Even in more complex cases, such as combined horseshoe kidney and retrovena cava ureter, LP has achieved good surgical results. However, its shortcomings were also found in the process of operation: firstly, there were unique complications of laparoscopy, such as hypercapnia and puncture side injury, and secondly, the operation of laparoscopic reconstruction was more complex. Surgeons must master various endoscopic operation skills, such as cutting and suturing techniques, which is very difficult for beginners and greatly limits the full popularization of LP. Since then, the Da Vinci robotic surgery system has been applied in clinic. With the help of three-dimensional high-resolution images and smart manipulator, the difficulty of laparoscopic surgery has been reduced, and surgeons with endoscopic experience can adapt quickly. Therefore, Da Vinci system has been rapidly promoted in North America and Europe, and the system has been introduced in China. The amount of RALP surgery is increasing year by year.

Different surgical paths are often determined by the personal habits and preferences of the operator. We use the retroperitoneal approach for LP surgery. The advantage of retroperitoneal approach is that it avoids the intestine, has little interference with the abdominal viscera, has a more direct exposure to the ureteropelvic junction, and is not easy to cause complications such as intestinal adhesion. However, the Da Vinci system equipment is large, and the mechanical installation and operation require a larger cavity space. The advantage of transabdominal approach is that the operation space is larger and the anatomical mark is clearer. Therefore, transabdominal approach is often the first choice for Da Vinci surgery. In order to understand the influence of different approaches of RALP on perioperative data, 12 patients in RALP group used retroperitoneal approach in this study. The results showed that there was no significant difference in perioperative data for RALP under different paths ( $P > 0.05$ ).

Operation time is an index to compare the advantages and disadvantages of different operation methods, and the conclusions drawn by different institutions are different. Light et al. Conducted a systematic review and meta-analysis of LP and RALP, and found that nearly half (8 / 15) of the institutions concluded that the operation time of RALP was significantly shorter than that of LP, while other institutions concluded that the operation time of RALP was similar or even opposite. Therefore, it has been controversial whether the operation time of RALP was dominant. In this study, the completion time of RALP and LP were 126.5 (80 ~ 225) min and 122 (63 ~ 190 min) respectively. There was no significant difference between them. Further analysis of the reconstruction suture time of the operation found that RALP group and LP group were almost similar. It can be seen that the advantage of Da Vinci robot was not in the operation time.

Riachy made statistics on the complications of pyeloplasty and found that the incidence rates of RALP group and LP group were 4.3% and 11.1% respectively. Then Silay analyzed a total of 575 patients (185 in RALP group and 390 in LP group). It was found that the incidence of complications in RALP group and LP group was 7% and 15%. They found that the most common complications of pyeloplasty were anastomotic leakage, double J tube displacement, urinary tract infection, etc., which were basically Clavien I-III, and the incidence of complications of RALP was lower than that of LP. This is basically consistent with our results. The most common complications in this study are anastomotic leakage (8 cases) and urinary tract infection (3 cases). The incidence of complications in RALP group is lower than that in LP group. Because with the help of Da Vinci system, while protecting the blood supply of more surrounding tissues, the alignment of mucosa is better and the suture is closer, so the anastomotic healing is better and the incidence of complications is reduced accordingly. The advantages of Da Vinci robot are also reflected in the postoperative recovery. On the one hand, because the operator is more confident in the suture quality under the robot, on the other hand, because the accurate anatomy brings less damage,

the postoperative recovery is faster. Therefore, the postoperative urinary catheter retention time and hospital stay in RALP group are shorter than those in LP group. However, the shorter hospital stay does not significantly reduce the cost. The cost of robotic surgery system is very high, and even the cost of system maintenance and instrument loss is often higher than that of the system itself, which affects the choice of surgical methods by doctors and patients. Reducing the cost of robotic surgery will be an important research topic.

In the process of use, we found that the advantages of the robot are not only that, but sitting surgery can significantly save physical energy compared with laparoscopy and open surgery. The operator can also adjust the operation perspective by himself, reduce the number of assistants, avoid the disharmony with assistants, and increase the efficiency of the operation. Three dimensional visual field and filtering jitter are more suitable for clinical teaching and surgical demonstration, and can significantly shorten the learning curve of beginners. However, the Da Vinci system also has some shortcomings: ①The purchase and maintenance of equipment are expensive; ②Young doctors rarely have access to the operation; ③ Manipulator lacks tactile feedback system, so operators often need to rely on vision and experience to make up for tactile loss; ④The “slender” manipulator cannot perform heavy operation and cannot pull and carry huge tissue structures.

There are also deficiencies in this study, lack of prospective comparative data, and the number of cases through retroperitoneal approach is small, which may affect the data analysis. However, it can still be proved that robot assisted laparoscopic pyeloplasty is a minimally invasive, safe and effective treatment. With the cost reduction and technical improvement, there will be a trend to replace laparoscopic pyeloplasty.

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