

# Robot-Assisted Laparoscopic Ureterolysis: Case Report and Literature Review of the Minimally Invasive Surgical Approach

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## ABSTRACT

**Objectives:** To evaluate our case of robot-assisted ureterolysis (RU), describe our surgical technique, and review the literature on minimally invasive ureterolysis.

**Methods:** One patient managed with robot-assisted ureterolysis for idiopathic retroperitoneal fibrosis was identified. The chart was analyzed for demographics, operative parameters, and immediate postoperative outcome. The surgical technique was assessed and modified. Lastly, a review of the published literature on ureterolysis managed with minimally invasive surgery was performed.

**Results:** One patient underwent robot-assisted ureterolysis at our institution in 2 separate settings. Operative time (OR) decreased from 279 minutes to 191 minutes. Estimated blood loss (EBL) was less than 50mL. The patient has been free of symptoms and both renal units are unobstructed. According to the published literature, 302 renal units underwent successful laparoscopic ureterolysis (LU), and 6 renal units underwent RU. There were 9 open conversions (all in LU). Mean OR in LU was 248 minutes for unilateral and 386 minutes for bilateral cases. In RU, mean OR was 220 minutes for unilateral and 390 minutes for bilateral cases. EBL averaged 200mL in LU and 30 mL in RU.

**Conclusions:** Our data reveal that robot-assisted ureterolysis is safe and feasible. Published data demonstrate the advantages of minimally invasive surgery.

**Key Words:** Ureterolysis, Laparoscopy, Retroperitoneal fibrosis, Robot-assisted.

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## INTRODUCTION

Ureteral obstruction secondary to extrinsic compression results from both benign and malignant processes. Retroperitoneal fibrosis (RPF) and ureteral endometriosis (UE) are 2 uncommon conditions that cause ureteral obstruction.<sup>1-25</sup>

First described in 1905 by Albarran and then by Ormond in 1948, RPF is a chronic inflammatory process characterized by deposition of dense fibrous tissue within the retroperitoneum.<sup>26-28</sup> Possible causes of RPF include medications, infections, malignancy, inflammatory conditions, trauma, prior surgeries, and radiation therapy. About two-thirds of cases are considered idiopathic.<sup>10,25</sup>

Endometriosis, defined by the ectopic presence of endometrium, is another entity that can cause ureteral obstruction. Ureteral endometriosis occurs in <1% of patients with endometriosis and is classified as extrinsic or intrinsic. Symptoms are often nonspecific and can be associated with silent loss of renal function.<sup>22</sup>

Treatment of both RPF and UE has classically been to relieve urinary tract obstruction, preserve renal function, and minimize the morbidity associated with surgery.<sup>17</sup> Open ureterolysis is effective in relieving ureteral obstruction, but can be associated with complications.<sup>28</sup> Minimally invasive surgery offers rapid convalescence, lowers the need for postoperative analgesic use, the need for blood transfusions, and is associated with quicker return of bowel function.<sup>10</sup> In 1992, Kavoussi performed the first laparoscopic ureterolysis (LU), and since then the minimally invasive approach has been an accepted surgical alternative.<sup>1</sup> Moreover, with the advent of robotics, and its advantages, surgeons are now leaning toward its use in ureterolysis.

We report on our first patient who underwent robot-assisted laparoscopic ureterolysis (RU), describe our technique, and review the published literature on ureterolysis via the minimally invasive approach.

## MATERIALS AND METHODS

### Case History

In February 2009, one male patient (2 renal units) underwent robot-assisted laparoscopic ureterolysis. He pre-

sented initially with complaints of bilateral flank pain and was found on an ultrasound, CT scan, and a MAG-3 renal scan to have bilateral ureteral obstruction secondary to presumed idiopathic retroperitoneal fibrosis. He subsequently failed conservative management including ureteral stent placement and steroid therapy. He was initially scheduled to undergo bilateral ureterolysis; however, secondary to a prolonged operative time, right ureterolysis was performed first, followed by left ureterolysis 3 months later. The right renal unit was operated on first because of the predominant function of 80% on renal scan. Both renal units were stented and percutaneously drained preoperatively. Demographic information, operative parameters and short-term outcome were assessed. Operative technique is briefly described below.

### **Literature Review**

A literature search of on-line databases including PubMed and Ovid MEDLINE (1950 through July 2009) for studies describing laparoscopic and robot-assisted laparoscopic ureterolysis was then conducted. Only articles published in English were included. Thirty studies were identified. We excluded 2 initial studies to prevent possible overlap of patients during the same time frame by the same authors. Two additional studies excluded were a case report complicated by a pneumothorax secondary to a congenital defect, and a case report complicated by multiple gynecologic procedures. Hence, 26 series of LU and RU published between 1992 and 2008 were reviewed, comprising 319 renal units (mean patient age, 44 years). These are summarized in **Table 1**.<sup>1-25</sup> We then tabulated operative parameters and outcome success.

### **Operative Technique for Robot-Assisted Laparoscopic Ureterolysis**

#### ***First Renal Unit (Right Side)***

The patient was placed in a high flank position after endotracheal and nasogastric intubation. A Foley catheter was placed, bony prominences were padded, and the table was then slightly flexed. Pneumoperitoneum was initiated with a Veress needle. A 12-mm trocar was placed in the midline just superior to the umbilicus. Two 8-mm robotic trocars were placed, 4 cm cephalad and caudad to the initial site, in the midclavicular line. A 5-mm trocar was placed 4cm cephalad to the initial site in the midline. The two 8-mm and the 5-mm ports were placed under direct visualization. The white line of Toldt was then incised, and the peritoneal structures reflected medially after the robot was docked. Gerota's fascia was identified and used

to localize normal ureter proximally. The ureter was then traced to the encased area and sharply dissected free with round tip scissors. The assistant provided retraction with a suction device. A biopsy of the fibrotic mass was sent for frozen section. The remainder of the fibrotic mass was sent for permanent evaluation. A portion of posterior peritoneum was mobilized and placed to "peritonealize" the ureter. A 10-mm Jackson-Pratt drain was placed and the trocar sites closed. The ureteral stent was left in place. The right percutaneous nephrostomy tube was clamped postoperatively.

#### ***Second Renal Unit (Left Side)***

The patient was positioned and prepped as previously described. However, after the pneumoperitoneum was established with the Veress needle, the 12-mm trocar was placed 2 cm below the costal margin in the anterior axillary line. The two 8-mm ports were placed in the same position described above. The 5-mm assistant trocar was placed superior to the umbilicus in the midline. The trocars again were placed under direct visualization. The white line of Toldt was incised and reflected medially. We decided to change the approach due to our past experience, and approach the distal ureter in the pelvis first. The ureter was mobilized superiorly to the encased portion down to the level of the fibrotic mass. The ureter was traced superior to the encased segment and mobilized down to the level of the fibrotic mass. A biopsy of the fibrotic mass was sent for frozen section. The ureter was then dissected free using round tip scissors. All of the remaining fibrotic mass was excised and sent for permanent evaluation. Indigo carmine was given intravenously, and no extravasation was visualized from the ureter. The ureter was "peritonealized" as previously stated. Trocar sites were closed, and the ureteral stent was removed cystoscopically prior to endotracheal extubation. The percutaneous nephrostomy tube was manually occluded at surgical completion.

## **RESULTS**

### **Case Report**

#### ***Clinical Presentation***

A single patient (2 renal units) age 68 years old at our institution underwent successful robot-assisted ureterolysis in 2 separate encounters. Both renal units were pre-stented and had preoperative nephrostomy tubes in place.

**Table 1.**  
Laparoscopic and Robotic Ureterolysis

Ref	Series	Date	Technique	No. of Pts	Etiology	Mean Age	Gender	No. of Renal Units	Side
1	Kavoussi	1992	Lap	1	IRF	15	F	1	R
2	Puppo	1994	Lap	1	RF	46	M	2	B
3	Matsuda	1994	Lap	2	IRF	60	1F/1M	2	~
4	Elashry	1996	Lap	6	2 IRF, 2 RF, 2 OVS	36	F	7	2L/3R/1 B
5	Nezhat	1996	Lap	10	Endometriosis	35	F	11	9 Uni /1 B
6	Boeckmann	1996	Lap	1	IRF	66	F	2	B
7	Mattalaer	1996	Lap	5	IRF	58.4	4F/1M	5	3R/2 B
8	Castilho	2000	Lap	2	IRF, Riedel's thyroiditis	54.5	F	4	B
9	DeMirici	2001	Lap	1	RF	41	M	1	R
10	Fugita	2002	Lap	13	9 IRF, 5 medication-induced RF	52	4F/9M	20	4L/2R/7B
11	Donnez	2002	Lap	16	Endometriosis	~	F	17	7R/8L/1 B
12	Watanabe	2004	Lap	1	Endometriosis	43	F	1	L
13	Castle	2005	Lap	1	Erdheim-Chester disease	60	M	2	B
14	Okumura	2005	Lap	3	IRF	71	M	5	1L/2 B
15	Fong	2006	Lap	3	IRF	52.7	1F/2M	4	1L/1R/1 B
16	Brown	2006	Lap	5	IRF	56.4	3F/2M	10	B
17	Ghezzi	2006	Lap	33	Endometriosis	~	F	37	29 uni/4 B
18	Antonelli	2006	Lap	6	Endometriosis	33.1	F	7	5 uni/1 B
19	Schneider	2006	Lap	2	Endometriosis	34.8	F	2	~
20	Frenna	2007	Lap	54	Endometriosis	31	F	46	25L/18R/11B
21	Sato	2008	Lap	1	OVS	41	F	1	R
22	Mereu	2008	Lap	35	Endometriosis	32.7	F	58	~
23	Simone	2008	Lap	6	IRF	47	M	10	2 uni/4 B
24	Srinivasan	2008	Lap	34	17 IRF, 17 malignancy-induced RF	52	16F/18M	49	~
25	Stifelman	2008	Lap	5	IRF	48.6	3F/2M	9	1 R/4 B
			Robot	5	IRF	53.2	5M	6	1R3L1B
<b>Totals</b>				<b>252</b>	<b>95 fibrosis, 157 endometriosis/OVS</b>			<b>319 renal units</b>	

Bilateral ureteral obstruction was secondary to idiopathic retroperitoneal fibrosis.

**Radiographic Evaluation**

The patient was diagnosed with hydronephrosis seen on renal ultrasound secondary to a rise in the creatinine level from baseline. Subsequently, a CT scan of the abdomen and pelvis demonstrated external compression of both ureters with medial deviation and bilateral hydronephrosis. A preoperative MAG 3 renal scan was performed that documented bilateral obstruction [T1/

2 = 23 minutes (right), >60 minutes (left)]. The patient was also noted to have differential function of 85% versus 15%, respectively.

**Operative Parameters**

Operative time was 279 minutes in the first surgery and decreased to 191 minutes in the second. EBL was 50 mL and 20 mL, respectively. There were no intraoperative complications. Average length of hospital stay was 1 day.

### **Clinical Outcomes**

Follow-up in our study was 6 months. Ureteral stents were removed one week postoperatively followed by nephrostomy tube removal the following week. Replacement was not required. Postoperatively, a renal scan demonstrated an unobstructive pattern (T 1/2 <10 minutes) on the right renal unit, and an improved T 1/2 time on the left. A postoperative renal ultrasound showed resolution of bilateral hydronephrosis. The patient has been free of symptoms, and both renal units remain unobstructed. Biopsy results of the retroperitoneum were benign, with evidence of dense fibrous tissue.

### **Literature Review**

In the laparoscopic/robotic review, 252 cases (319 renal units) of ureterolysis were initially identified. A total of 308 renal units underwent successful ureterolysis. There were 9 (3.5%) conversions (11 renal units) to open surgery, all within the LU group. Among the 308 renal units, 302 were pure LU and 6 were RU. All patients in the LU and RU groups were either prestented or had intraoperative ureteral stents placed prior to ureterolysis. In addition, several had nephrostomy tubes in place.

### **Clinical Presentation**

In the LU group, mean patient age was 44 years (range, 15 to 66), and in the RU group it was 53 years (range, 48 to 58). Ureteral obstruction was secondary to RPF in 95 patients, and secondary to endometriosis in 153 patients. Three patients were diagnosed with ovarian vein syndrome and one with Erdheim-Chester disease, a rare progressive, non-Langerhans cell histiocytosis. The left side was more commonly involved than the right side (54% vs. 46%). Unilateral disease was more prevalent, while bilateral disease was seen in 43 patients.

### **Operative Parameters**

**Table 2** summarizes intraoperative data including mean operative time, EBL, and operative technique for LU and RU. Mean OR in LU was 248 minutes for unilateral and 386 minutes for bilateral cases. In RU, mean OR was 220 minutes for unilateral and 390 minutes for bilateral cases. EBL averaged 200 mL in LU and 30 mL in RU. There were 12 intraoperative complications in the LU group, including various injuries to the ureter, renal pelvis, iliac vein requiring open conversion, and subcutaneous emphysema. No intraoperative complications occurred in the RU group. Average hospital stay was 4 days for LU and 3 days for RU.

### **Radiographic Evaluation**

In both MIS groups, pre- and postoperative radiographic evaluation was variable. Evaluation included one or a combination of these modalities: renal ultrasound (40%), IVP (30%), CT scan (20%), and diuretic renography (20%).

### **Clinical Outcomes**

Mean follow-up for LU was 21 months and 5 months for RU. Recurrence was demonstrated in 12% of patients (12% in RPF and 12% in UE). Those with recurrence were managed with indwelling ureteral stents, or balloon dilatation of the ureter in one patient.<sup>15,25</sup>

## **DISCUSSION**

RPF and UE are 2 conditions that can lead to ureteral obstruction.<sup>1-25</sup> In RPF, the fibrotic mass encases and compresses the ureters leading to hydronephrosis. Only 30% of cases have an identifiable cause, with the remaining 70% being idiopathic.<sup>10,25</sup> Management first entails decompression of the obstructed system, followed by discontinuation of offending agents if known and if not consideration for medical management with corticosteroid therapy. Ruling out potential malignancy is important in the evaluation.<sup>24,29</sup> Traditionally open ureterolysis with deep tissue biopsy, and repositioning the ureters laterally, "intraperitonealizing" them or performing an omental wrap has been the gold standard in surgical management.<sup>4,24</sup> A recent multi-institutional survey of laparoscopic surgeons by Duchene et al<sup>30</sup> demonstrated that there is no uniform treatment algorithm for RPF and that most institutions recommend an attempt at steroids followed by laparoscopic ureterolysis.

Ureteral endometriosis is another rare process, most commonly diagnosed in women of childbearing age, which can result in ureteral obstruction. It is usually unilateral and involves the lower one-third of the ureter.<sup>22</sup> As previously mentioned, there is an extrinsic and intrinsic type and they can coexist. Management of UE is controversial.<sup>11</sup> Treatment modalities have included medical therapy alone, such as with progestin or danazol, or in combination with ureteral stent placement, ureterolysis, segmental ureterectomy, and nephroureterectomy.<sup>11,22</sup>

With the advent and advantages offered by minimally invasive surgery, ureterolysis is now performed using laparoscopy with or without robot assistance. Frenna and associates<sup>20</sup> reported on the benefits of laparoscopy in patients with UE including the magnified image, superior

**Table 2.**  
Intraoperative Data

Ref	Series	OR Time (min)	EBL	Transfusion	Conversion	Intra-op Complications	LOS (days)
Laparoscopic Ureterolysis							
1	Kavoussi	330		0		0	6
2	Puppo	540					3
3	Matsuda	389				1 (ureteral injury)	
4	Elashry	255	140	2	0	0	2.8
5	Nezhat						1.8
6	Boeckmann					1 (subcut emphysema, re-operation)	7
7	Mattalaer	301 240 unil 300 B					
8	Castilho	216.7	“minimal”	0	0	1 (renal pelvis lac re-operation)	4.5
9	DeMirici	200			0		5
10	Fugita	294 192 unil 381 B	243 245 241	1	2	1 (Boari flap)	4
11	Donnez						
12	Watanabe						
13	Castle						hospice
14	Okumura	350			0		
15	Fong						
16	Brown	259	80	0	0	1	4.2
17	Ghezzi	230					
18	Antonelli						
19	Schneider						
20	Frenna					1 (ureteral injury)	
21	Sato						
22	Mereu	330	325			3 (ureteral injury)	
23	Simone	80 unil, 200 B	75 unil, 150B				3.33
24	Srinivasan	304.25	300	1	6 (iliac vein injury)	3	3.4 (IRF); 3
25	Stifelman	110 unil, 509 B	50 unil, 362.5 B		1 (B reimplant)		3.2
	<b>Totals / Avg</b>	<b>248 unil, 386 B</b>	<b>188 unil, 208 B</b>	<b>4</b>	<b>9</b>	<b>12</b>	<b>4</b>
Robotic Ureterolysis							
25	Stifelman	220.5 unil, 390 B	25 unil, 35 B		0		3
	Current Study	279 R, 191 L	35 unil	0	0	None	1

exposure, and greater ability to identify disease in the pelvis and retroperitoneal space as well as in the lower urinary tract. Operative times are reasonable despite often requiring additional procedures. Additional procedures

include hysterectomy, salpingo-oophorectomy, excision of endometrioma, bowel resection, nephrectomy, ureterectomy with ureteroureteroneostomy, ureteroneocystostomy, boari flap, ileal ureter, and others.

Since the first case report of laparoscopic ureterolysis by Kavoussi et al<sup>1</sup> in 1992, several reports have been published that demonstrate the efficacy and safety of the laparoscopic approach.<sup>1–25</sup> In 2008, Srinivasan and colleagues<sup>24</sup> published one of the largest series of ureterolysis, comparing open and laparoscopic techniques with respect to morbidity and treatment efficacy. In their study, the authors did not find any specific diagnosis or preoperative variable that influenced conversion to open surgery, or predicted poor postoperative outcomes following laparoscopic surgery. Complication rates were comparable in both groups at 8% and postoperative imaging demonstrated resolution of obstruction in both patient groups, 94% LU and 97% open.

In 2006 Mufarrij and Stifelman<sup>31</sup> performed the first robot-assisted laparoscopic ureterolysis with laparoscopic omental wrap. Two years later, they reported on their initial series of 5 patients. Their 2 most recent surgeries were performed entirely robotically. They reported on the advantages offered by robotics, including working in magnified 3-dimension and the better articulation of instruments in assisting with dissection and freeing the diseased ureter circumferentially.<sup>25,32</sup>

We are only the second institution to publish on robot-assisted laparoscopic ureterolysis. The primary surgeon (KG) has strong robotic pelvic surgical experience, having performed over 700 robot-assisted pelvic procedures including radical cystectomy and prostatectomy. Utilizing the robot outside the pelvis contributed to the initial prolonged operative time and demonstrated the typical learning experience. Modifications were made to our technique. This included an alteration in port placement as well as our operative approach. Dissecting the ureter first beginning in the pelvis, instead of in an antegrade fashion led us to a much easier and efficient second experience. Utilizing that foundation of robot-assisted surgery within the pelvis assisted the surgeon to operate from a more familiar region as expected for a pelvic surgeon to an area less encountered. Our experience, however, may be different than that of nonpelvic surgeons whose comfort level may be the opposite.

## CONCLUSIONS

Our data reveal that robot-assisted laparoscopic ureterolysis is feasible and can be performed safely. Published data demonstrate the clinical advantages of minimally invasive surgery. Close monitoring and long-term follow-up are essential given risk of recurrence.

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