



# Comparison of Retrograde Intrarenal Surgery and Laparoscopic Surgery in the Treatment of Proximal Ureteral and Renal Pelvic Stones Greater than 15 mm

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## Abstract

**Introduction:** There is insufficient data on which modality should be the first choice in the treatment of proximal ureteral and renal pelvic stones greater than 15 mm.

**Aim:** To compare retrograde intrarenal surgery (RIRS) and laparoscopic stone surgery for big upper ureteral and renal pelvic stones.

**Materials and methods:** We reviewed medical records of 163 adult patients who underwent RIRS or laparoscopic surgery for upper ureteral or renal pelvic stones  $\geq 15$  mm between January 2013 and February 2018. A total of 121 patients were included in the study. The patients were divided into two groups as RIRS (n=58) and laparoscopic surgery (n=63) and the groups were compared with regard to their demographic, stone, and operative characteristics and postoperative outcomes and complications.

**Results:** Both operation time and hospitalization time were significantly shorter in the RIRS group compared to the laparoscopic surgery group ( $p < 0.001$ ). Complete stone clearance was achieved in 44 (76%) patients in the RIRS group and in 57 (90%) patients in the laparoscopic surgery group ( $p = 0.031$ ). Both the VAS scores and postoperative analgesic requirement were lower in the RIRS group. Based on the modified Clavien-Dindo classification, the two groups were similar with regard to peri- and post-operative complication rates. However, the incidence of Grade 3b complications (e.g. ureteral rupture, conversion to open surgery) was significantly higher in the laparoscopic surgery group and the incidence of Grade 4b complication (urosepsis) was significantly higher in the RIRS group.

**Conclusions:** Laparoscopic surgery can provide higher stone clearance and lower auxiliary treatment rates compared to RIRS although it can be more disadvantageous in terms of operative time, hospitalization time, postoperative VAS scores, and analgesic usage (narcotic and non-narcotic).

## Keywords

laparoscopic pyelolithotomy, laparoscopic ureterolithotomy, retrograde intrarenal surgery

## INTRODUCTION

The primary treatment modalities for urinary system stone disease include extracorporeal shock wave lithotripsy (ESWL), rigid ureterorenoscopy (URS), retrograde intrarenal surgery (RIRS), percutaneous nephrolithotomy (PNL), open surgery, and laparoscopic surgery. Before the 1980s, the majority of the patients with urinary system stone disease had required open surgery for the removal of the stones.<sup>1</sup> However, since its introduction by Chaussy et al. in 1980, ESWL has become the most common treatment modality owing to its efficacy and safety.<sup>2,3</sup> After 1990s, on the other hand, PNL has become widespread all over the world and has been accepted as the standard method particularly for the treatment of large kidney stones. Over the last decades, rigid URS and RIRS have gained further popularity due to technological advancements. The development of smaller-caliber semi-rigid and flexible ureteroscopes and the introduction of improved instrumentation such as deflectable-tip endoscopes, ureteral access sheaths, superior optics, and stone-retrieval devices has led to an increased use of endoscopic systems for both renal and ureteral stones. Moreover, major technological advancements have been achieved in the realm of RIRS. Similarly, with the advancements in laparoscopic techniques and equipment, laparoscopic ureterolithotomy and pyelolithotomy have become viable options for large ureteral and renal pelvic stones. These developments, in turn, have led to the almost complete abandonment of open surgery in the treatment of urinary system stone disease.

The current European Association of Urology (EAU) guidelines recommend RIRS as one of the first-line treatment modalities for renal stones  $\leq 20$  mm.<sup>4</sup> However, there is compelling evidence suggesting that stones up to 30 mm in size can be treated by RIRS despite the fact that it has lower success rates and often requires staged procedures.<sup>5,6</sup> Open and laparoscopic surgical stone removal can not be offered as first-line therapy to most patients with stones. These techniques should be considered in rare cases in which ESWL, retrograde or antegrade URS and PNL fail, or are unlikely to be successful.<sup>4</sup> However, if expertise is available, laparoscopic ureterolithotomy and pyelolithotomy can be performed with high stone-free rates (SFRs) and lower auxiliary procedure rates for large proximal ureteral and renal pelvic stones. In this study, we aimed to compare RIRS and laparoscopic stone surgery to determine which one is the better choice for large upper ureteral and renal pelvic stones.

## MATERIALS AND METHODS

### Study design

We reviewed medical records of 163 patients who underwent RIRS or laparoscopic surgery (laparoscopic ureter-

olithotomy and laparoscopic pyelolithotomy) for  $\geq 15$  mm unilateral upper ureteral or renal pelvic stones between January 2013 and February 2018. Pediatric ( $<18$  years old) and morbidly obese patients and patients with solitary kidney, urinary system anomalies, skeletal malformations, a history of ureteral or urethral stricture, and patients with incomplete medical records were excluded from the study. As a result, a total of 121 patients were included in the study.

The patients were divided into two groups as RIRS (n=58) and laparoscopic surgery (n=63) and the groups were compared with regard to their demographic, stone, and operative characteristics and postoperative outcomes and complications. Surgical success was defined as complete stone clearance at the first month CT. The American Society of Anesthesiologists (ASA) score was calculated for each patient to assess the physical status of the patients before surgery and pre-existing comorbidities. The presence and severity of pain was measured on the first postoperative day using a 10-point Visual Analog Scale (VAS) from 0 to 10 (0, no pain; 10, intolerable pain). Complications were classified according to the modified Clavien-Dindo classification.<sup>7</sup> Sepsis was defined as the identification of two or more systemic inflammatory response syndrome (SIRS) criterias, in addition to known or suspected infection.

### Preoperative evaluation

An informed consent form was obtained from each patient prior to the procedure. Patient assessment included medical history, physical examination, complete blood count, coagulation tests, serum biochemical analysis, urinalysis, and urine culture. Each patient was evaluated preoperatively by non-contrast computed tomography (CT) and/or intravenous urography to assess the pelvicalyceal system, urinary tract malformations, and stone characteristics. Proximal ureter stones was defined as stones that located between the ureteropelvic junction and the iliac vessels. Stone size was determined by the measurement of the longest dimension. Each patient had sterile urine culture prior to surgery. Antibiotic prophylaxis was administered with second-generation cephalosporin.

### RIRS technique

The entire RIRS procedure was performed under general anesthesia with the patient in the lithotomy position. Prior to the RIRS procedure, rigid ureteroscopy using a 9.5 Fr semi-rigid ureteroscope was routinely performed for optical dilatation and for the placement of the guidewire. A 9.5/11.5 Fr ureteral access sheath (Cook Medical Bloomington, IL, USA) was routinely inserted under fluoroscopy guidance. When the access sheath could not be passed, a 4.8 Fr JJ stent was placed and the RIRS procedure was postponed for 14 days. All the procedures were performed using a 7.5 Fr Flex-X<sup>2</sup> ureterorenoscope (Karl Storz, Tuttlingen, Germany). The stones were fragmented using Hol-

mium:YAG laser device (Sphinx, Lisa Laser, Katlenburg, Germany) and 200  $\mu\text{m}$  laser fibers (energy level: 0.8-1.2 J and frequency: 12-15 Hz) until they were deemed small enough to be able to pass spontaneously. The larger fragments were extracted using a stone basket catheter (1.3F OptiFlex, Boston Scientific, Marlborough, USA). A 4.8 Fr JJ stent (Boston Scientific, Natick, USA) was routinely inserted at the end of the procedure and was removed two weeks later. All procedures were performed by two experienced surgeons.

### Laparoscopic surgery technique

The entire procedure was performed under general anesthesia with the patient in the lateral (flank) position. Insufflation was performed using the closed technique with a Veress needle. The first 10-mm camera trocar was inserted at the level of the umbilicus just lateral to the rectus muscle. A carbon dioxide pneumoperitoneum was created with the pressure maintained at 12 mmHg. The second and third trocars were used for the laparoscopic working instruments. A 10-mm trocar (at the right hand of the operator) and a 5-mm trocar (at the left hand of the operator) were placed 6 to 8 cm laterally from the first trocar along the anterior axillary line to form an isosceles triangle with the first trocar. *After mobilizing the colon along Toldt's line*, Gerota's fascia was opened at the line of its merge with the psoas sheath. Dissection was started

and extended medially till the exposure of the ureter. The ureter was then dissected cephalocaudally to avoid stone migration. The stone was identified as a bulge. To confirm stone localization, an endograsper was used to palpate the ureter till a gritty sensation was perceived. A longitudinal ureterotomy was performed using laparoscopic scissors and then the stone was removed by a grasper through the 10-mm port; however, large stones were placed in a sac before removal. For renal pelvic stones, the dissection was extended towards the pelvis and pyelotomy was performed using laparoscopic scissors. The stone was removed in a similar fashion to that of ureteral stone. After the insertion of a 4.8 Fr JJ stent (Boston Scientific, Natick, USA), the ureteral or pelvic incisions were closed with 4/0 vicryl interrupted sutures. The reflected colon was replaced and an 18 F soft abdominal tube drain was placed close to the suture line. The 10-mm port sites were closed at the end of the procedure. The JJ stents were removed 4 weeks after the operation. All procedures were performed by an experienced surgeon.

### Statistical analysis

All data were analyzed using SPSS for Windows version 22.0 (IBM SPSS, Armonk, NY, USA). Descriptives were expressed as mean  $\pm$  standard deviation (SD). The two groups were compared using Student's t test. A p value of  $<0.05$  was considered significant.

**Table 1.** Comparison of demographic data and stone characteristics

	RIRS (n=58)	Laparoscopic surgery (n=63)	p
Age, years (mean $\pm$ SD)	48.42 $\pm$ 14.33	46.4 $\pm$ 12.53	0.44
Sex, n (%)			
female	21 (36.2%)	16 (25.3%)	0.20
male	37 (63.7%)	47 (74.6%)	
BMI, kg/m <sup>2</sup> (mean $\pm$ SD)	25.7 $\pm$ 3.9	25.4 $\pm$ 3.8	0.62
ASA score, (mean $\pm$ SD)	1.9 $\pm$ 1.0	1.8 $\pm$ 1.1	0.71
Stone side, n (%)			
right	28 (48.2%)	22 (34.9%)	0.52
left	30 (51.7%)	41 (65%)	
Stone location, n (%)			
pelvis	34 (58.6%)	34 (53.9%)	0.41
proximal ureter	24 (41.3%)	29 (46%)	
Stone size (mm) (mean $\pm$ SD)	22.83 $\pm$ 5.53	21.68 $\pm$ 6.91	0.31

RIRS: retrograde intrarenal surgery; SD: standard deviation; BMI: body-mass index; ASA: American Society of Anesthesiology; HN: hydronephrosis

## RESULTS

**Table 1** presents the demographic and stone characteristics of the patients in both groups. Mean age was 48.42 $\pm$ 14.33 and 46.54 $\pm$ 12.53 years in the RIRS and laparoscopic surgery groups, respectively. No significant difference was found

between the two groups with regard to age, gender, body mass index (BMI), ASA score, and stone side (right or left), location, and size.

**Table 2** presents the operative characteristics and postoperative outcomes of the patients. Both operative time and the length of hospital stay were significantly shorter

**Table 2.** Operative data and post-operative outcomes

	RIRS (n=58)	Laparoscopic surgery (n=63)	P
Operation time, min (mean±SD)	62.27±12.35	154.39±73.89	<0.001
Hospitalization time, hours (mean±SD)	26.75±47.36	133.71±105.20	<0.001
VAS (24 hours) (mean±SD)	3.77±1.55	5.42±1.22	<0.001
Analgesic usage, n (%)			
Non-narcotic	36 (62%)	12 (19%)	<0.001
Narcotic	22 (37.9%)	51 (80.9%)	<0.001
Success, n (%)	44/58 (76%)	57/63 (90%)	0.031
Auxiliary treatment, n (%)			
SWL	11 (18.9%)	0	
RIRS	3 (5.1%)	3 (4.7%)	0.031
PNL	0	3 (4.7%)	

RIRS: retrograde intrarenal surgery; VAS: visual analogue scale; SWL: shockwave lithotripsy; PNL: percutaneous nephrolithotomy

in the RIRS group compared to the laparoscopic surgery group ( $p<0.001$ ). Complete stone clearance was achieved in 44 (76%) patients in the RIRS group and in 57 (90%) patients in the laparoscopic surgery group and a significant difference was found ( $p=0.031$ ). Of the 14 patients who had residual stone fragments in the RIRS group, 11 patients underwent SWL (6 weeks after the first procedure) and 3 patients underwent second-session RIRS (6 weeks after the first procedure). In the laparoscopic surgery group, 6 patients had residual stone fragments, of whom 3 patients underwent RIRS (3 months after the first procedure) and 3 patients underwent miniaturized percutaneous nephrolithotomy (3 months after the first procedure). Both the VAS scores and postoperative analgesic requirement were lower

in the RIRS group compared to the laparoscopic surgery group.

**Table 3** presents the postoperative complications detected in both groups. Based on the modified Clavien-Dindo classification, the two groups were similar with regard to peri- and post-operative complication rates ( $p=0.325$ ). However, the incidence of Grade 3b complications (e.g. ureteral rupture, conversion to open surgery) was significantly higher in the laparoscopic surgery group and the incidence of Grade 4b complications (e.g. urosepsis) was significantly higher in the RIRS group, whereas no Grade 5 complication (death) was observed in any patient in both groups.

An ureteral access sheath could not be introduced in 14 (24.1%) patients in the RIRS group and thus the surgical

**Table 3.** Comparison of perioperative and postoperative complications between the groups

	RIRS (n=58)	Laparoscopic surgery (n=63)	P
Overall complications, n (%)	8 (13.7%)	12 (19%)	0.325
Complications, n (%)			
fever (>38°C)	0	1 (1.5%)	
urosepsis	7 (12%)	1 (1.5%)	
blood transfusion	0	3 (4.7%)	
ureteral rupture	0	1 (1.5%)	
prolonged drainage	0	1 (1.5%)	
intra-abdominal abscess	0	1 (1.5%)	
conversion to open surgery	0	3 (4.7%)	
subcapsular hematoma	1 (1.7%)	0	
myocardial infarction	0	1 (1.5%)	
Modified Clavien-Dindo classification, n (%)			
grade 1	0	1 (1.5%)	0.33
grade 2	1 (1.7%)	3 (4.7%)	0.35
grade 3a	0	2 (4.7%)	NA
grade 3b	0	4 (6.3%)	0.05
grade 4a	0	1 (1.5%)	NA
grade 4b	7 (12%)	1 (1.5%)	0.02
grade 5	0	0	NA

procedure was delayed for 14 days. A total of 8 complications occurred in the RIRS group, including urosepsis in 7 and subcapsular hematoma in 1 patient. Sepsis developed one day after hospital discharge in 2 and on the first postoperative day in 5 patients. Empirical antibiotherapy (ceftriaxone 2 g/day) and palliative treatment were initiated for each patient. Treatment was adjusted to the clinical status of the patient and antimicrobial susceptibility testing and was continued for up to 14 days as needed. One patient with subcapsular hematoma was treated conservatively and was discharged on postoperative day 15. At the 3<sup>rd</sup> month follow-up, hematoma was completely absorbed.

In the laparoscopic surgery group, *conversion to open surgery* was required in 3 (4.8%) patients since the dissection plans could not be clearly identified. In these patients, complete stone clearance was achieved by open surgery and all the patients were discharged on postoperative day 4. One patient had prolonged urine leakage (more than 3 days) and was treated with percutaneous nephrostomy. Another patient had intra-abdominal abscess (3×3 cm) and was treated with percutaneous drainage catheter insertion followed by antibiotherapy. Still another patient had complete ureter rupture during ureterolithotomy and was treated with laparoscopic primary repair. Intraoperative blood transfusion was performed in only 3 (4.8%) patients.

## DISCUSSION

Proximal ureteral and renal pelvic stones can be managed by various treatment options including ESWL, RIRS, percutaneous approaches, laparoscopic surgery, and open surgery. Of these, open ureterolithotomy and pyelolithotomy have several drawback associated with their invasive nature. Compared to open surgery, laparoscopic approaches provide lower postoperative morbidity, less postoperative pain, shorter hospitalization times, shorter recovery times, and better cosmetic results.<sup>8</sup> The success rates of laparoscopic ureterolithotomy and pyelolithotomy for large ureteral and renal pelvic stones are almost 100%.<sup>9</sup> However, despite its high success rates and acceptable morbidity, laparoscopic stone surgery is rarely used in daily clinical practice mainly because most ureteral and renal stones can be treated using minimally invasive endourological techniques (RIRS and PNL) or SWL. Nevertheless, the increasing experience with laparoscopy in urology poses the question of whether laparoscopy may be a good option for urolithiasis, particularly in experienced centers.

Laparoscopic ureterolithotomy and pyelolithotomy can be performed via the transperitoneal or the retroperitoneal route. Both procedures have advantages and disadvantages in the management of upper ureteral and renal pelvic stones. The retroperitoneal approach is advantageous in that the ureter can be accessed more directly and intraperitoneal contamination or infection due to urine leakage is less likely. Another advantage of this approach is the absence of peritoneal irritation. However, retrope-

ritoneal laparoscopic surgery is difficult and complex to perform during the learning-curve period of a urologist due to the narrow retroperitoneal working space. The main benefits of the transperitoneal access to the kidney and ureter are a larger working space and a more familiar overview of the anatomic landmarks. In contrast, the most common disadvantages of this access include a higher rate of complications related to the bowel and the complications associated with urine extravasation into the peritoneal space.<sup>10</sup> In our study, all the patients were treated via the transperitoneal route since our clinic had relatively greater experience in the transperitoneal technique. Meaningfully, we consider that the intra-abdominal abscess detected in the laparoscopic ureterolithotomy group might have been prevented if the retroperitoneal route had been employed in that group.

Retrograde intrarenal surgery is one of the most popular natural orifice surgeries. With its relatively lower morbidity and use of natural orifices, RIRS is considered as a reasonable option both by patients and surgeons. Stones up to 3 cm can be treated by RIRS depending on the operator skills.<sup>5</sup> However, RIRS has several disadvantages in the management of large stones. First, its stone clearance rate is relatively low particularly in large stones and it often requires staged procedures to achieve better success rates. The second drawback is the high pelvic pressure during operation, which increases the likelihood of sepsis particularly in risky patients even if the culture is sterile before the operation. In our RIRS group, preoperative culture was sterile in all the patients who developed sepsis and there was no comorbidity that could cause immunodeficiency. Moreover, the presence of urosepsis in the RIRS group suggested that surgical factors rather than patient-related factors were effective in these patients.

In a recent meta-analysis of 14 studies (7 randomized controlled studies-RCTs and 7 non-RCTs), it was reported that laparoscopic ureterolithotomy and PNL have higher success rates compared to URS (rigid, semirigid URS or RIRS), and laparoscopic ureterolithotomy (LU) has a longer operative time and a higher complication rate with no differences in hospitalization time compared to URS. The authors also noted that URS should be considered as the standard therapy for the treatment of large proximal ureteral stones.<sup>11</sup> However, in most of the cases included in this meta-analysis, preoperative stenting was frequently used to allow passive ureteral dilatation. Accordingly, when repeated sessions are taken into consideration, it should be noted that the surgical procedure needs to be repeated 3 times, which may not be acceptable to patients.

To our knowledge, there has been no study in the literature comparing laparoscopic pyelolithotomy and RIRS in the treatment of renal pelvic stones. Ever since PNL was accepted as the standard treatment for large pelvic stones, comparative studies have been performed with PNL. A recent meta-analysis (RCTs; 4/9) reported that there was no difference between laparoscopic pyelolithotomy and PNL with regard to the length of hospital stay and blood

loss. However, laparoscopic pyelolithotomy was found to be more effective compared to PNL in the management of large renal stones although it was associated with longer operative times.<sup>12</sup>

Our study had several limitations. The most important limitation was its retrospective nature. Another potential limitation was the small number of patients. Larger studies with longer follow-up times are needed to clarify which treatment modality is more advantageous in the treatment of proximal ureteral and renal pelvic stones greater than 15 mm. Another limitation was that there was no percutaneous intervention arm in our study. Despite these limitations, the present study will contribute to the literature in terms of clarifying the role of laparoscopic stone surgery in the treatment of proximal and renal pelvic stones greater than 15 mm.

## CONCLUSIONS

Both RIRS and laparoscopic surgery are effective and safe procedures in the treatment of proximal ureteral and renal pelvic stones greater than 15 mm. Laparoscopic surgery can provide higher stone clearance rates and lower auxiliary treatment rates compared to RIRS, although it can be more disadvantageous in terms of operative time, hospitalization time, postoperative VAS scores, and analgesic usage (narcotic and non-narcotic). Due to its invasive nature that leads to these conditions, laparoscopic stone surgery is generally not considered as the first choice; however, it can be recommended for patients who demand a higher success and lower auxiliary treatment in a single session.

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# Сравнение ретроградной интратрениальной хирургии и лапароскопической хирургии при лечении проксимальных камней мочеточника и камней в чашечно-лоханочной системе размером более 15 мм

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## Резюме

**Введение:** На данный момент не установлено достаточного количества данных по вопросу о том, какой метод должен быть первым выбором при лечении верхних мочеточниковых камней и камней в чашечно-лоханочной системе размером более 15 мм.

**Цель:** Сравнить ретроградную интратрениальную хирургию (РИРХ) с лапароскопической операцией по удалению крупных верхних мочеточниковых камней и камней в чашечно-лоханочной системе.

**Материалы и методы:** Мы изучили медицинские карты 163 пациентов пожилого возраста, перенёвших РИРХ или лапароскопическую операцию по удалению крупных верхних мочеточниковых камней и камней в чашечно-лоханочной системе  $\geq 15$  мм в период с января 2013 года по февраль 2018 года. В исследование был включен 121 пациент. Пациенты были разделены на две группы: РИРХ (n=58) и лапароскопической хирургии (n=63), и группы были сопоставлены с точки зрения их демографии, камней и операционных характеристик, а также результатов и осложнений после операции.

**Результаты:** Как время операции, так и продолжительность госпитализации были значительно короче в группе РИРХ по сравнению с группой лапароскопической хирургии ( $p < 0.001$ ). Полное выведение камней было достигнуто у 44 (76%) пациентов в группе РИРХ и у 57 (90%) пациентов в группе лапароскопической хирургии ( $p = 0.031$ ). Как результаты ВАШ, так и послеоперационные анальгетические потребности были ниже в группе РИРХ. Основываясь на Классификации хирургических осложнений Clavien-Dindoq обе группы имели сходные результаты с точки зрения частоты пери- и послеоперационных осложнений. Однако частота осложнений класса 3b (например, разрыв мочеточника, переход к открытой хирургии) была значительно выше в группе лапароскопической хирургии, а частота осложнений класса 4b (уросепсис) была значительно выше в группе РИРХ.

**Заключение:** Лапароскопическая хирургия может обеспечить более высокий процент случаев с выведением камней и более низкую частоту дополнительного лечения по сравнению с РИРХ, хотя она может иметь больше преимуществ с точки зрения оперативного времени, продолжительности госпитализации, послеоперационного ВАШ, результатов и приёма анальгетиков (наркотических и ненаркотических).

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## Ключевые слова

лапароскопическая пиелолитотомия, лапароскопическая уретеролитотомия, ретроградная интратрениальная хирургия

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