

## Comparison of Flexible Ureterorenoscopy and Laparoscopic Ureterolithotomy Methods for Proximal Ureteric Stones Greater Than 10 mm

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**Purpose:** To examine the outcomes and compare the effectiveness of laparoscopic ureterolithotomy and flexible ureterorenoscopy (FURS) in patients with proximal ureteral stones larger than 10 mm in diameter.

**Materials and Methods:** In total, 150 patients who underwent laparoscopic ureterolithotomy and FURS because of ureteral stones in our urology clinic from January 2010 to June 2015 were retrospectively analyzed. The patients were divided into 2 groups: 70 patients who underwent laparoscopic ureterolithotomy (Group 1) and 80 patients who underwent FURS (Group 2). Success rates and complications were compared.

**Results:** The success rates were 95.7% and 90.0% in Groups 1 and 2, respectively; there was no statistically significant difference between the groups. No statistically or clinically significant complications occurred in either group.

**Conclusion:** Laparoscopic ureterolithotomy and FURS are both effective and reliable for the treatment of proximal ureteral stones. However, considering the shorter operation and hospitalization times and the management of situations that require secondary interventions, we suggest that FURS, as a minimally invasive method, may be the first choice in the treatment of proximal ureteral stones.

**Keywords:** ureteral calculi; surgery; laparoscopy; adverse effects; lithotripsy; postoperative complications; ureterolithiasis; treatment outcome; ureteroscopy; methods.

### INTRODUCTION

Ureteral stones are seen in approximately 15% of the population and are responsible for 20% of cases of urolithiasis.<sup>(1)</sup> The aim of treatment of ureteral stones is to achieve complete stone removal with minimal morbidity. Standard treatment methods for upper ureteral stones include extracorporeal shock wave lithotripsy (SWL), ureterorenoscopy (URS), ureterolithotomy, and antegrade percutaneous nephrolithotomy. Although the rates of laparoscopic treatment for large and impacted ureteral stones seem to have decreased with the development of flexible URS (FURS) and fine-tipped laser lithotripsy, laparoscopy still has high success rates in the treatment of ureteral stones that cannot be treated by SWL and endoscopic methods.<sup>(2)</sup> In this study, we examined the outcomes and compared the effectiveness of laparoscopic ureterolithotomy and FURS in patients with proximal ureteral stones larger than 10 mm in diameter.

### MATERIALS AND METHODS

After obtaining approval from the local ethics committee at our hospital, the medical files of 150 patients who underwent laparoscopic ureterolithotomy and FURS because of ureteral stones in our urology clinic from January 2010 to June 2015 were retrospectively analyzed. The patients were divided into 2 groups: 70 patients who underwent laparoscopic ureterolithotomy (Group 1) and 80 patients who underwent FURS (Group 2). Patients with proximal ureteral stones larger than 1 cm in diameter were included in the study. Patients with a solitary kidney, ureteropelvic junction obstruction, pelvic kidney abnormalities, non-opaque and multiple stones, and a history of open or percutaneous surgery or SWL were excluded.

Preoperatively, all patients underwent a complete blood count, serum urea and creatinine measurement, bleeding and coagulation profile analysis, urinalysis and urine culture, intravenous urography, and computed to-

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**Table 1.** Demographic and clinical characteristics of study participants.

Parameters	Group 1 (n = 70)	Group 2 (n = 80)	P Value
Median age, years (range)	49 (20-70)	46 (16-76)	.459
Gender, n (%)			.781
Male	32 (45.71)	44 (55)	
Female	38 (54.28)	36 (45)	
Side, n (%)			.624
Right	33 (47.14)	31 (38.75)	
Left	37 (52.85)	49 (61.25)	
Median BMI, kg/m <sup>2</sup> (range)	25.77 (23.63-30.42)	25.87 (23.18-29.15)	.894

**Abbreviation:** BMI, Body Mass Index.

mography without contrast, if needed.

The success rates and complications in Groups 1 and 2 were compared. Residual stones and stone-free rates were evaluated by urinary tract radiography and ultrasonography 4 to 6 weeks after surgery. Cases involving detection of small fragments (< 4 mm) and the absence of stones were considered successful. Cases involving symptomatic and/or residual fragments greater than 4 mm or stone clearance achieved with an auxiliary procedure were deemed technique failures. Double J (DJ) ureteral stents in the stone-free patients were removed 2 weeks after FURS. We first compared the success rates of the procedures and then compare the hospitalization and operation times and complication rates.

Three trocars (10–12 mm) were used for laparoscopic ureterolithotomy. The initial port was placed by the open method at the junction of the 12th rib and posterior axillary line. In the open method, a 1.5 cm incision was made in the fascia of the external oblique muscle. The retroperitoneal space was accessed by puncturing the fascia of the transversus abdominis muscle with a blunt clamp. First, an 800-mL space was created with a finger and then with a balloon dissector while the peritoneum was shifted medially at the same time. The second port was placed 1 cm anterior to the 11th rib. The third port was placed at the anterior axillary line, 2 cm superior and 2 cm medial to the spina iliaca anterior superior. After expansion of the retroperitoneum and opening of

Gerota's fascia, the ureter was identified over the psoas muscle. Protuberance of the stone was noted, and the stone was grasped with a Babcock clamp. After stabilization of the stone, the ureter was incised vertically with a wedge-tipped endoscopic scalpel. The stone was extracted with right-angle forceps. It was placed in an endobag, and a 26 cm antegrade DJ ureteral catheter was inserted. The ureteral incision was closed using 4/0 Vicryl suture. A Hemovac drainage catheter was placed in the periureteric area near the second port site. The DJ catheter was left in place for 7 days.<sup>(3)</sup>

In the FURS procedure, a 9.5- to 11.5 French (F) access sheath (Elit Flex, Ankara, Turkey) was placed in all patients in the lithotomy position. Standard retrograde FURS was applied with a 7.5 F flexible ureteroscope (Flex X2; Karl Storz GmbH, Tuttlingen, Germany). Stone fragmentation was achieved using a 4- to 30 W holmium laser (Medilas H20; Dornier Med-Tech GmbH, Wessling, Germany) with 200- or 365 µm laser fibers at 5 to 10 Hz and 0.2- to 3.0 joule (J) intervals. The fragments were collected in a 1.9 F basket (Zero Tip; Boston Scientific, Marlborough, MA, USA) and sent for stone analysis. Residual stones were checked on postoperative day 1 with X-rays and ultrasonography, and the stone-free status was confirmed on X-ray, ultrasonography, and non-contrast computed tomography 2 weeks after surgery.<sup>(4)</sup>

**Table 2.** Operation parameters.

Variables	Group 1 (n = 70)	Group 2 (n = 80)	P Value
Median stone diameter, mm (range)	17 (14-30)	15.5 (10-20)	.074
Median hospitalization time, days (range)	3 (2 - 13)	1 (0.5 - 3)	< .001
Median operational time, min (range)	80 (40-150)	45 (35-85)	.001
Stone-free rate, n (%)	67 (95.7)	75 (93.75)	.081

### Statistical Analysis

The Statistical Package for the Social Science (SPSS Inc, Chicago, Illinois, USA) version 15.0 was used for statistical analysis of the data. Numerical variables are expressed as mean  $\pm$  standard deviation. Because there were two groups, the significance of differences in medians was tested with the Mann–Whitney *U* test. Nominal variables were tested with Pearson's  $\chi^2$  test or Fisher's exact test. *P* values of  $< .05$  were considered to indicate statistical significance.

### RESULTS

Demographic characteristics of the patients (**Table 1**) and stone sizes (**Table 2**) were similar in both groups. The mean operation time in Groups 1 and 2 was  $80.71 \pm 2.90$  and  $49.18 \pm 1.39$  min, respectively, and the mean hospitalization time in Groups 1 and 2 was  $3.08 \pm 0.17$  and  $1.19 \pm 0.06$  days, respectively. The operation time and hospitalization time were shorter in Group 2, and the differences were statistically significant (**Table 2**). The grade of hydronephrosis was similar between the two groups (**Table 3**).

In Group 1, the surgical procedure was ended laparoscopically in 67 of 70 (95.7%) patients. We returned to open surgery after incision of the ureter laparoscopically in three patients. We could not perform percutaneous nephrolithotomy or FURS because of gonadal vein injury in one patient and the possibility of extravasation and failure to provide clear vision in two. Although the patients were stone-free after the open procedure, these cases were considered unsuccessful.

In Group 2, 75 of 80 patients (93.75%) became stone-free, and the fluoroscopy time was  $22.09 \pm 4.21$  s. Stone fragments migrated into the lower calices in five patients, and because FURS was not able to reach the lower calix, these patients needed SWL postoperatively to obtain complete stone clearance. These five cases were considered FURS failures. In three patients, we could not reach the proximal ureter using a flexible ureterorenoscope because of stricture of the distal ureter; thus, we placed a DJ catheter. Two weeks later, these patients were treated with FURS. FURS after place-

ment of DJ was described as a part of the procedure, so these three cases were considered FURS successes. There was no significant difference in success rates between the groups (**Table 2**).

No statistically significant differences were observed in the total number of complications or grade of complications by the Clavien classification (**Table 4**). We observed no renal failure or increased creatinine levels in any patient in the preoperative or postoperative period. We placed a percutaneous nephrostomy tube on postoperative day 7 in one patient in Group 1 because of prolonged urine extravasation, although a DJ stent was placed intraoperatively. The patient was discharged on postoperative day 13 after the leakage stopped, and no clinical pathology was observed. A postoperative fever was detected in three patients in Group 2, but the fever resolved with conservative treatment. These three patients were discharged successfully. No preoperative stone analysis was performed in these patients. We did perform postoperative stone analyses of 17 patients in Group 1 and found calcium oxalate in 9 patients, calcium phosphate in 6, and struvite in 2. Postoperative stone analysis of 13 patients in Group 2 revealed calcium oxalate in 8 patients and calcium phosphate in 5. We recommended specific suggestions for patients with stone analyses and general suggestions for the patients without analyses.

### DISCUSSION

While some ureteral stones may pass readily through the urinary tract, some require surgical procedures to provide a stone-free status. The location and size of the stone, presence of hydronephrosis, and initial renal function play important roles in determining the type of surgery. When these factors are taken into consideration, treatment options include medical treatment, SWL, URS, antegrade URS, and laparoscopic and open ureterolithotomy.

Success of SWL for proximal ureteral stones ranges from 57% to 96%.<sup>(5-7)</sup> It is generally considered a first-line therapy because it has no need for anesthesia or surgical intervention and is a noninvasive outpatient

**Table 3.** Grade of hydronephrosis in patients.\*

Hydronephrosis	Group 1 (n = 70)	Group 2 (n = 80)	<i>P</i> Value
Grade 0	1 (1.42)	6 (7.5)	
Grade 1	29 (41.42)	36 (45)	.550
Grade 2	31 (44.28)	32 (40)	
Grade 3	9 (12.85)	6 (7.5)	

\* Data are presented as n (%).

**Table 4.** Complication rates according to Clavien classification.

Clavien Complication Grade	Group 1 (n = 70), no	Group 2 (n = 80), no	P Value
1	0	3 (fever)	
2	0	0	.491
3a	1 (percutaneous nephrostomy)	5 (SWL)	
3b	3 (open operation)	0	
Total, n (%)	4 (5.71)	8 (10)	.334

**Abbreviation:** SWL, extracorporeal shock wave lithotripsy.

procedure. However, SWL may be insufficient for large stones and hard stones, such as cystine and calcium oxalate, and it has a risk of renal parenchymal damage. Thus, alternative treatment methods are needed for some patients.<sup>(8)</sup> For these reasons, minimally invasive methods, such as laparoscopic approaches and FURS, are taking the place of SWL.

Recently, based on developments in URS and lithotripsy, FURS with holmium-YAG laser lithotripsy is becoming preferred to a semi-rigid URS with lithotripsy in the endoscopic treatment of ureteral stones. FURS can reach migrated stones because of its high mobility. However, it may not be possible to perform FURS or place a ureteral access sheath because of stricturing of the ureteral orifice. Thus, secondary procedures may still be needed.<sup>(9,10)</sup> In the present study, eight patients required additional interventions.

The stone-free rate for URS in proximal ureteral stones larger than 1 cm ranges from 77% to 85%.<sup>(11,12)</sup> In their series of 58 patients with this type of stone, Potis and colleagues<sup>(13)</sup> reported a stone-free rate of 84%. Chen and colleagues<sup>(14)</sup> reported a stone-free rate of 84% for proximal ureteral stones of > 2 cm. In our study, the success rate of FURS was 90%, consistent with the current literature.

Prabhakar and colleagues<sup>(15)</sup> performed FURS in their series of 30 patients. They reported a mean stone diameter of 25 mm, a mean hospitalization time of 1 day, and a mean operational time of 92 min. In their series of 100 patients, Hatipoğlu and colleagues<sup>(16)</sup> reported a mean stone diameter of 15.26 mm, a mean hospitalization time of 1.3 days, and a mean operational time of 52.72 min. In the present study of 80 patients, we found a mean stone diameter of 15.8 mm, a mean hospitalization time of 1.19 days, and a mean operational time of 49.1 min, consistent with the current literature.

FURS has some minor complications, such as hematuria, fever, and ureteral laceration, with rates ranging from 0% to 35%.<sup>(17,18)</sup> The most common postoperative complication is fever at a rate of 1.8%.<sup>(19)</sup> In the present study, postoperative fever occurred in three patients, and the complication rate was 3.75%. FURS is performed under direct vision, and the device has a thin, flexible nature; thus, major complications are rare. Serious complications include ureteral stricture and ureteral avulsion. No major complications occurred in this study.

The first application of laparoscopic surgery in stone disease is ureterolithotomy. European urology guidelines state that laparoscopic ureterolithotomy has higher success rates than SWL or URS if performed with correct indications, such as the presence of large and impacted ureteral stones that cannot be treated by endoscopic methods or SWL.<sup>(2)</sup> Laparoscopic ureterolithotomy may be performed via transperitoneal or retroperitoneal techniques. In both, the subsequent procedure is similar once the ureter is reached. The most important difference is that to reach the transperitoneal space, mobilization of the colon is required, which can lead to significant injuries and morbidity. The most important advantages of retroperitoneal laparoscopic ureterolithotomy are the direct access to retroperitoneal organs, less frequent abdominal contamination and infection due to urinary leakage, and the absence of peritoneal irritation.<sup>(20)</sup> Thus, we prefer a retroperitoneal approach in all of our cases.

The success rate for laparoscopic ureterolithotomy is > 90%.<sup>(21,22)</sup> The largest series of laparoscopic ureterolithotomies (123 cases) reported a stone-free rate of 96.7%.<sup>(23)</sup> Only one patient in this series required open surgery due to migration of the stone. The stone-free rate was 96% among 24 patients in the series by Bayar

and colleagues<sup>(24)</sup> In the present study, the success rate was 95.7%.

In their series of eight patients, Demirkesen and colleagues<sup>(25)</sup> reported a mean stone diameter of 17 mm, a mean hospitalization time of 3.25 days, and a mean operational time of 150 min. In their series of 24 patients, Bayer and colleagues<sup>(24)</sup> reported a mean stone diameter of 15 to 20 mm and a mean hospitalization time of 3.4 days. In their series of 101 patients, Gaur and colleagues<sup>(26)</sup> reported a mean stone diameter of 16 mm, a mean hospitalization time of 3.5 days, and a mean operational time of 79 min. The present study showed similar results.

The complication rate of laparoscopic ureterolithotomy is low; even in the study with the highest reported rate of 17.6%, the most common cause was ureteral urinary leakage.<sup>(27)</sup> In the present study, the urinary leakage rate was 1.4%, and the leakage was treated by percutaneous nephrostomy. To prevent the development of ureteral stenosis, another complication, it is important to protect the blood supply of the incised portion of the ureter during the operation. Nourira and colleagues<sup>(28)</sup> reviewed the literature and reported a ureteral stenosis rate of 2.5%. In the present study, we found no complications that could be attributed to ureteral stenosis.

Overall, we found that the FURS and laparoscopic ureterolithotomy had similar success rates for the treatment of proximal ureteral stones. Open surgery seems to be the only way to manage complications when endoscopic procedures are not sufficient for laparoscopic ureterolithotomy. However, the management of complications in FURS can be less invasive than laparoscopy.

## CONCLUSIONS

Laparoscopic ureterolithotomy and FURS are both effective and reliable in the treatment of proximal ureteral stones. However, when considering the short operational and hospitalization times and the management of situations that require secondary interventions, we suggest that FURS, as a minimally invasive method, may be the first choice in the treatment of proximal ureteral stones.

## CONFLICT OF INTEREST

None declared.

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