

Effect of ureteral calculus in outpatients receiving semirigid ureteroscope laser lithotripsy

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Abstract

The surgical outcomes of patients with single ureteral stones who had undergone ureteroscopic Holmium laser lithotripsy as outpatients and compare them with those of patients who had received the same procedure as inpatients. Records were obtained from January 2012 to December 2016 for selected patients who had undergone the above mentioned procedure at our institution. Patients were excluded if their ECOG performance status was ≥ 2 , presented with multiple stones or concomitant renal stones, had histories of cancer or congenital urinary system abnormalities, or had undergone urinary system reconstruction surgery. Patients could decide whether to receive the procedure as an outpatient or inpatient. All surgeries were performed by a single surgeon. Patients preoperative, operative, and postoperative data were recorded. The clinical results, such as urinary tract infection, analgesic requirement, rate of returning to the emergency room, stone clearance, surgical complications, and medical expenditure for the treatment courses were analyzed and compared between the 2 cohorts. In total, 303 patients met the inclusion criteria. Among them, 119 patients decided to receive ureteroscopic laser lithotripsy as outpatients, whereas 184 decided to be inpatients. The outpatient cohort was younger ($P < .001$), had smaller stone diameters ($P < .001$), and fewer comorbidity factors ($P = .038$). Patients with a history of stone manipulation favored receiving the procedure under admission ($P < .001$). After 1:1 propensity score matching, no significant differences were discovered between the cohorts with regard to operative time, rate of lithotripsy failure, and operative complications. Furthermore, rates of stone clearance, post-op urinary tract infection, analgesic requirement, and returning to the emergency room were comparable between the 2 groups. However, the medical expenditure was significantly lower in the outpatient cohort ($P < .001$). Our data revealed that outpatient ureteroscopic lithotripsy with a Holmium laser was more economical compared with the inpatient group and achieved favorable outcomes for patients with a single ureteral stone.

Abbreviations: ESWL = extracorporeal shock wave lithotripsy, Ho:YAG = holium:yttrium-aluminum-garnet, URSL = ureteroscopic lithotripsy.

Keywords: injury, laser, outcome, risk, ureteroscopy, urolithiasis

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In compliance with national guidelines the regional ethics review board of the study approved by the Institutional Review Board of Chang-Gung Memorial Hospital, Taiwan, approved the study (approval 1060323).

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1. Introduction

Urolithiasis is a common disease with incidence ranging from 11% to 13% in men and 5.6% to 7.0% in women by the age of 70 years.^[1,2] Risk factors for developing urolithiasis include genetic predisposition, socioeconomic conditions, certain metabolic disorders, and environmental factors.^[3] Common symptoms of urolithiasis include hematuria, dysuria, renal colic, nausea, vomiting, and fever. In our daily practice, extracorporeal shock wave lithotripsy (ESWL) and ureteroscopic lithotripsy (URSL) are the 2 most common therapeutic strategies if conservative or medical treatment fails.^[4] Although ESWL is a noninvasive, safe, and anesthesia-free procedure that can be performed in an outpatient fashion, the initial success rate of ESWL is inferior to that of URSL.^[5] When performing URSL, a lithotripsy-capable device is passed through the ureteroscope inserted into the affected ureter to disintegrate the stone.^[2] In the past 20 years, URSL with electrohydraulic, pneumatic, ultrasonic, or laser probes has developed steadily, resulting in improved surgical outcomes and decreased morbidity.^[6,7,8] Among these modalities, laser lithotripsy decomposes stones using a photo-thermal mechanism, causes less oscillation of targeted stones, and as a result, the pushing forces on the stone decrease and lead to a decreased likelihood of stone upward migration.^[9] Endoscopic laser lithotripsy can be conducted in an outpatient

department.^[10] It is a general concept that there are many advantages of outpatient surgery over traditional inpatient surgery, including more convenient, lower cost, reduced stress, and more predictable scheduling. Complications of laser URSL, such as postoperative bleeding, urinary infection, and ureteral stricture or perforation may occur and they are not rare.^[2] In Asian-Pacific countries including Taiwan, urologists prefer to conduct URSL in a hospitalization basis for safety reason. However, whether hospitalization for URSL can prevent these complications remains questionable. To the best of our knowledge, no head-to-head studies exist with regard to comparisons of the surgical outcomes of URSL between inpatient and outpatient groups. Therefore, the purpose of this study was to evaluate the surgical outcomes of stone patients who had undergone outpatient URSL and compare them with those of inpatients who had undergone the same procedure. In addition, patients' preferences for these 2 treatment modalities and the medical expenditure were evaluated.

2. Methods

2.1. Study population

Records were obtained from January 2012 to December 2016 for selected patients who had undergone ureteroscopic lithotripsy by holmium:yttrium-aluminum-garnet (Ho:YAG) laser in our institution. Before they were included, all the patients were evaluated and screened to be suitable for outpatient surgery by the surgeon responsible for the project. This study was approved by the Institutional Review Board of Chang-Gung Memorial Hospital, Taiwan. All patients fully understood the process, advantages and disadvantages, risks of treatment options, and signed a consent form before receiving treatment. The inclusion criteria were adult patients, unilateral single ureteral stone, duration of symptoms ≥ 2 weeks, and suitable for outpatient surgery. All the selected patients had only received medical treatment without any invasive procedure including ureteric stenting or nephrostomy before they were included. The exclusion criteria were an Eastern Cooperative Oncology Group (ECOG) performance^[11] status of ≥ 2 , active urinary tract infection (UTI), multiple stones or concomitant renal stones, presented for symptom relieve, and history of cancer or congenital urinary system abnormalities. Furthermore, those who had undergone urinary system reconstruction surgery were excluded. To maintain objectivity, all selected patients were interviewed and the surgical procedures were performed by a single surgeon. After patients had received a detailed explanation of the surgical process, they were able to select whether to undergo outpatient or inpatient surgery according to their free will. The stone sizes, defined as the longest diameter of the stone, were evaluated by computed tomography (CT), intravenous pyelography (IVP), or plain radiography of the kidney, ureter, and bladder (KUB). The degree of hydronephrosis was assessed by either CT scans or the ultrasonography.

During the operation, all patients in the outpatient group received general anesthesia, whereas all patients in the inpatient group received either general or spinal anesthesia according to the decision of the anesthesiologists. We used an 8 Fr. Karl Storz semi-rigid ureteroscope with a 400- μ m laser fiber connected to a 60-W holmium laser generator (LUMENIS Company) to disintegrate the stones (energy: 1.2–1.6 J; frequency: 8–12 Hz.). In the outpatient group, the operation was performed on an outpatient or ambulatory basis. After the end of the procedure,

the patients were observed for an hour in the recovery room, and then leave the hospital with oral antibiotics and analgesics. In the inpatient group, on the contrary, the patients were admitted to the ward for post-op care after the procedure.

The standard antibiotic usage was a single dose of prophylactic intravenous cefazolin followed by oral-form cefadroxil (500 mg) twice a day for 3 days. The standard analgesic regimen for both procedures was 7 days of acetaminophen. Follow-up KUB or CT scans were performed at 1 week and 1 month postoperatively. "Stone-free" was defined as no residual stones being visible in the imaging studies, whereas "stone upward migration" was defined as stone fragments measuring >3 mm pushed back into the kidney. After 1:1 propensity score matching, the clinical results, such as those of UTIs, analgesic requirements, rate of returning to the emergency room, stone clearance, surgical complications, and medical expenditure for the treatment courses, were analyzed and compared between the 2 cohorts. "Medical expenditure" represented claims to the Taiwan National Health Insurance Bureau, including those for admission, primary procedures, salvage treatment, and all follow-up examinations within 2 months of the operation.

2.2. Statistical analysis

MedCalc version 16.2.1 for Windows (MedCalcSoftwarebvba, Ostend, Belgium) was used for statistical analysis. Chi-Squared tests were used for qualitative variables, whereas the Student t test was used for quantitative variables; $P < .05$ was considered statistically significant.

3. Results

3.1. Study population

Figure 1 presents a flow chart illustrating the patient inclusion criteria. A total of 303 patients met these criteria, and among them, 119 patients decided to receive outpatient URSL, where as 184 decided to receive it as inpatients. As shown in Table 1, the outpatient cohort was younger (49.9 vs 54.6 years, $P < .001$), had smaller average stone diameters (8.4 mm vs 10.7 mm, $P < .001$), and had lower rates of comorbidity factors, including diabetes mellitus, hypertension, coronary arterial disease, stroke, and renal insufficiency ($P = .038$). Moreover, 75.6% of the outpatient group had no previous history of stone intervention; 58.6% of the inpatient group was stone intervention naïve ($P = .006$). The difference in severity of preoperative hydronephrosis was no significant between the 2 groups ($P = .665$). Patients with a history of stone manipulation favored choosing to receive the procedure under admission ($P < .001$), as shown in Table 2. After 1:1 propensity score matching, no significant differences were found to exist between the cohorts with regard to operative time, rates of double-J catheter indwelling, lithotripsy failure, or intraoperative complications, as shown in Table 3. Five patients had complications in the outpatient group, where as 6 patients had complications in the inpatient group.

3.2. Complication between inpatient and outpatient

All complications were minor and classified as either Clavien-Dindo grade I or II.^[12] The postoperative results are demonstrated in Table 4. Both groups had equally low UTI rates within 1 month of the operation (8.1% vs 7.3%, HR 1.28; 95% confidence

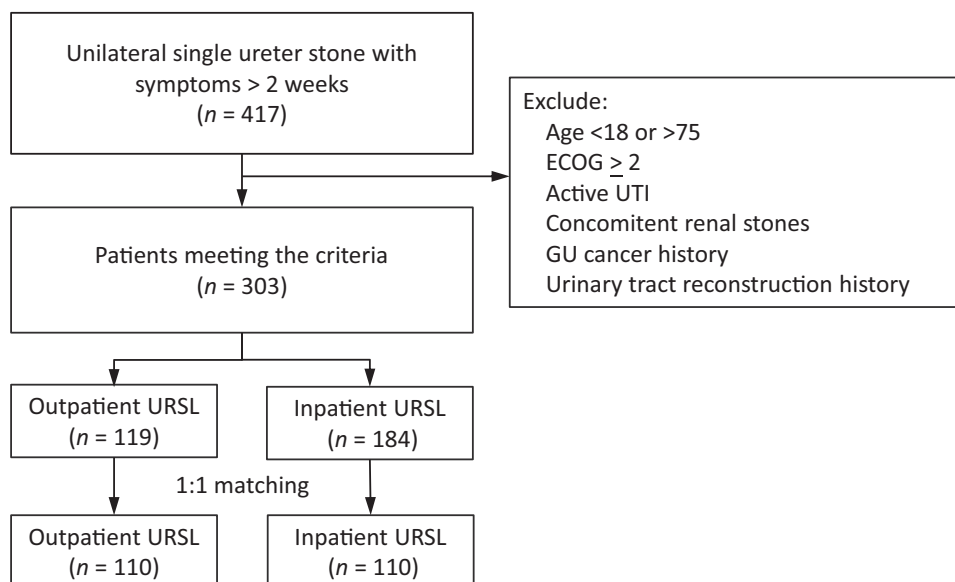


Figure 1. Flowchart illustrating the patient screening process.

interval [CI], 0.58–1.68, $P = .967$). Furthermore, the rate of stone clearances, analgesic requirements, and risk of returning to the emergency room within post-op were comparable between the groups. As for medical expenditure, the mean expenditure of the outpatient group was NT\$ 21,400 (20,100–92,100, SD = 7,400), whereas the mean expenditure of the inpatient group was NT\$ 31,000 (21,000–89,400, SD = 12,800). Overall, the data revealed that outpatient URSL was more economical compared with inpatient URSL ($P < .001$), as shown in Figure 2.

4. Discussion

Urolithiasis is a common disease, with an incidence peaking during the third and fourth decades of life.^[13] Most patients in

this age group are of the working population. Therefore, it is highly inconvenient and uneconomical for patients if they have to take leave due to being hospitalized for stone management. The Ureteral Stone Clinical Guidelines Panel of the American Urological Association indicated that ESWL, PCNL, and URSL are all recommended choices for first-line ureteral stone therapy.^[14] Among them, ESWL is an easy, safe, and effective treatment that can be performed in an outpatient fashion. Moreover, a study regarding patient decision-making for stone treatment revealed that ESWL is the most accepted modality for patients.^[15] ESWL is unable to immediately decompress the obstructed urinary system; furthermore, it depends on the spontaneous passage of stone fragments, which is less predictable. Further URSL is often required for ESWL treatment failure.

Table 1

Pre-operative data of the patients (n=303).

	Outpatient group	Inpatient group	P value
Patient number	119	184	
Age (range, SD)	49.9 (18–66,11.5)	54.6 (27–74,12.3)	<.001
Male/Female	89/30	126/58	.247
Stone diameter(mm) (range, SD)	8.4 (5–20, 3.0)	10.7 (5–30, 4.85)	<.001
ASA score ≥ III, n(%)	15 (12.6%)	53 (28.8%)	.002
Anesthesia	General	General: 56 Spinal: 128	
Stone level	Low: 45 (37.8%) Mid: 15 (12.6%) Upper: 59 (49.6%)	Low: 43 (23.4%) Mid: 22 (11.9%) Upper: 119 (64.7%)	.081
Stone intervention naïve	90 (75.6%)	108 (58.6%)	.006
Comorbidity factors	DM: 13 (10.9%) HTN: 27 (22.7%) CAD: 1 (0.8%) Stroke: 1 (0.8%) Cr > 1.3 ng/dL: 13 (10.9%)	DM:44 (23.9%) HTN: 84 (45.7%) CAD: 16 (8.7%) Stroke: 7 (3.8%) Cr > 1.3 ng/dL: 54 (29.3%)	.038
Hydronephrosis	No: 20 (16.8%) Mild: 53 (44.5%) Moderate-severe:46 (38.7%)	No: 31 (16.8%) Mild: 73 (39.7%) Moderate-severe: 80 (43.5%)	.665

ASA = American society of anesthesia, ESWL = extracorporeal shockwave lithotripsy, PCNL = percutaneous lithotripsy, SD = standard deviation, URS = ureterorenal scopy.

Table 2
Previous stone management history and present treatment choice.

	Number	Outpatient n (%)	Inpatient n (%)	P value
Intervention naive	198	90 (45.5%)	108 (54.5%)	.076
ESWL	66	20 (30.3%)	46 (69.7%)	<.001
URSL	30	9 (30.0%)	21 (70.0%)	<.001
Open or PCNL	9 (PCNL:3, Ureterolithotomy: 6)	0	9 (100%)	<.001

ESWL = extracorporeal shockwave lithotripsy, PCNL = percutaneous lithotripsy, URS = ureterorenal scopy.

It has been demonstrated that the time of relief is the most important factor in predicting long-term renal function deterioration, and the EGF/MCP-1 ratio, urinary NGAL and urinary KIM-1 are useful early biomarkers of progressive renal damage and could potentially play a role in predicting long-term renal outcomes.^[17] Nephron loss in long-term unrelieved obstruction remains a major concern.^[18] In addition, the bother score with regard to dysuria, hematuria, and flank pain were significantly higher in an ESWL group.^[19] Regarding medical expenditure, a systematic review and meta-analysis revealed that URS was significantly more cost-effective than ESWL for ureteral stones.^[20] For the abovementioned reasons, URSL plays a critical role in the treatment of stones.

With advances in technology, minimally invasive interventions are replacing open ureterolithotomy for treating impacted ureteral stones. Over the past 20 years, URSL, which can be performed in an outpatient department, has resulted in positive surgical outcomes and decreased morbidity.^[20] In our institution, holmium laser is used for lithotripsy because it is an ideal lithotripter for impacted ureteral stones. Among the various lithotripsy modalities, holmium laser yields smaller stone

Table 3
perioperative data after propensity score 1:1 matching.

	Outpatient n = 110 n (%)	Inpatient n = 110 n (%)	Outpatient vs inpatient	
			OR (95% CI)	P value
OP time (minutes) (range, SD)	50.8 (25–86,13.5)	50.9 (18–99,16.6)		.964
Admission days (range, SD)	0	3.2 (2–10,1.8)		
D-J catheter Indwelling	43 (39.1%)	77 (41.8%)	0.93 (0.69–1.67)	.774
Fail to lithotripsy	3 (2.7%)	2 (1.8%)	1.30 (0.38–14.3)	.620
Complications	5 (4.5%)	6 (5.5%)	0.93 (0.39–4.36)	.910
	Bleeding:2 False lumen:1 Upward migration:2	Bleeding:1 False lumen:1 Arrhythmia:1 Upward migration:3		

OP: operation; SD: standard deviation; D-J: double J catheter; OR: odds ratio; CI: confidence interval.

Table 4
Postoperative data after propensity score 1:1 matching.

	Outpatient n = 110 n (%)	Inpatient N = 110 n (%)	Outpatient vs Inpatient	
			OR (95% CI)	P value
UTI (<1 month)	9 (8.1%)	8 (7.3%)	1.28 (0.58–1.68)	.967
Anodyne require (>1 week)	11 (10.0%)	16 (14.5%)	0.59 (0.28–1.25)	.224
Came back ER (<1 month)	6 (5.4%)	2 (1.8%)	3.20 (0.78–13.07)	.172
Stone free (post-op 1 week)	89 (80.9%)	83 (75.5%)	1.18 (0.58–1.66)	.967
Stone free (post-op 1 month)	103 (93.6%)	91 (82.7%)	1.41 (0.73–2.69)	.381

CI = confidence interval, OP = operation, OR = odds ratio, UTI = urinary tract infection.

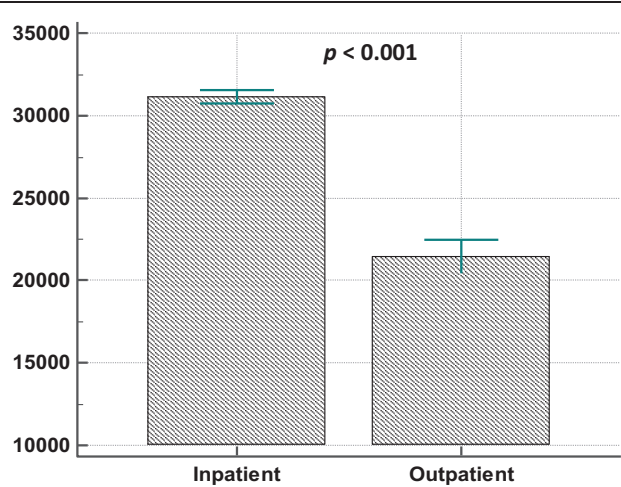


Figure 2. Medical expenses in the inpatient and outpatient groups.

fragments.^[21] However, no current research investigates whether outpatient or inpatient surgery has higher patient preference. Therefore, the first aim of our study was to evaluate patients' preference for these 2 modalities. Our study revealed that only 39% of the study population decided to receive outpatient URSL treatment after receiving a detailed explanation of the surgical indication, treatment process, and possible complications. The patients in this cohort were younger, possessed smaller stone diameters, and fewer comorbidity factors. By contrast, the stone level and degree of hydronephrosis did not affect patients' treatment decisions. In our study, the stones in the 2 groups were different in size, and the outpatient cohort possessed smaller average stone diameters.

The possible explanation is that in the patient's cognition, the size of the urinary stone is positively correlated with the severity of the disease and the probability of complications, which is not always correct in an urologist's point of view. Our research also confirmed that the treatment effect of the 2 cohorts were quite the same although their average stone sizes were different. Another notable finding was that previous stone treatment experience significantly affected the treatment choice of patients. Patients were more willing to accept the treatments that they have received before. When the patients had previously been treated with ESWL or URSL, the proportion who decide to undergo outpatient URSL is quite low (approximately 30%); by contrast, for patients who have never received any stone intervention (treatment naïve), the proportion who choose outpatient treatment increased to approximately 45%.

Another aim of our study was to evaluate the risk of complications in the 2 cohorts. The reason why outpatient URSL was not highly accepted by patients was probably that they were worried about potential complications that cannot be processed immediately after they leave the hospital. A randomized prospective study conducted by Verzere et al revealed that although the first URSL intervention's stone-free rate achieved 92.24%, 96% (130 out of 136) of patients had inpatient URSL.^[22] In that study, Verzere et al reported early postoperative complications, including fever in 15 cases and hemorrhage in 7 cases.^[22] Although the incidence of severe URSL complications (primarily ureteric injuries) has declined over time, the risk of such complications stays 2% to 4%.^[23,24]

Before comparing the surgical outcomes of our 2 cohorts, we performed 1:1 propensity score matching to ensure that the characteristics of the 2 groups were similar. A propensity score is the probability of a unit being assigned to a particular treatment given a set of observed covariates.^[25] This statistic technique is used to reduce selection bias by equating groups based on the covariates. Because the 2 groups in our study were different in age and comorbidities, which might influence the treatment result and the bias might occur. We use a propensity score to match age and comorbidities to minimize this potential influence. Furthermore, the 2 groups of patients received the same antibiotics protocols. The main difference between the 2 groups was that the inpatient group patients could receive large volume of intravenous fluid hydration after the procedure as well as closer monitoring from caregivers, whereas the outpatient group patients were only encouraged to hydrate orally at home. In addition, if the patient in the hospitalized group had an adverse effect (AE) after surgery, the physician can immediately handle it. On the contrary, the patient in the outpatient surgery group must return to the emergency room if AE occurs. Our data revealed that the intraoperative complications rates were low in both groups and were not significantly different (4.5% vs 5.5%, $P=.910$). All complications were minor and classified as Clavien–Dindo grade I or II. Both groups had equally low UTI rates within 1 month of the operation (8.1% vs. 7.3%, $P=.967$). Furthermore, the status of analgesic requirement and risk of returning to the emergency room within 1 month were comparable. Our results demonstrated that outpatient URSL for unilateral ureteral calculi is as effective as hospitalization and does not increase the risk of complications. Another aim of our study was to evaluate the medical expenditure between the 2 cohorts. We assumed that considerable medical expenses can be saved if the patients go home after surgery on the same day rather than being hospitalized for treatment. Our findings confirmed

this hypothesis. In our study, “medical expenditure” represented claims to the Taiwan National Health Insurance Bureau, including those for admission, primary procedures, salvage treatment, outpatient tracking fees, and all follow-up examinations within 2 months of the operation. Most outpatients were able to take care of themselves without returning to the emergency room. Very few expensive examinations or additional treatments were required in the series of follow-ups; therefore, the average medical expenses of outpatients were lower than those of the inpatients.

This study had some limitations. First, the groupings were based on the patients' wishes rather than randomization. Therefore, the characteristics of the 2 groups, such as ages and comorbidities, were different and resulted in bias in the analysis. Thus, we used propensity scores to correct our data in anticipation of reducing bias. Second, only the medical service performed in our hospitals within 2 months after the operation were counted in the medical expenditure analysis. In fact, some patients went to their local clinic or hospital for treatment if they had postoperative problems and we were unable to include these costs in the calculation. Third, we did not include patients who had undergone flexible ureteroscopy, which is an increasingly crucial and accepted surgical technique.^[26–27] However, we still believe this research study to be innovative and possess considerable clinical value. Overall, we confirmed that outpatient ureteroscopic lithotripsy with holmium laser is an effective, safe, and economical treatment strategy.

5. Conclusions

Our data revealed that ureteroscopic lithotripsy with holmium laser was more economical for outpatients than for inpatients and achieved favorable outcomes and decrease renal injury for patients with single ureteral stones. However, the patients were free to choose the treatment method, and their acceptance of outpatient URSL was not as high as expected. The acceptance was even lower for older patients, those who had been hospitalized for treatment in the past, or those with more comorbidities. Therefore, it is crucial for the physician to communicate thoroughly with the patient before the procedures.

Author contributions

Conceptualization: ke-hung Tsui.

Data curation: ke-hung Tsui.

Formal analysis: ke-hung Tsui.

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