

Semirigid Ureteroscopic Lithotripsy and Extracorporeal Shock Wave Lithotripsy for Proximal Ureteric Stones: A Comparative Appraisal of Efficacy and Safety

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Abstract

Background: Urolithiasis is a common disease worldwide; many options are now available for its management, but evaluation of patient- and stone-related factors helps to select the treatment modality. **Aim of Study:** The objective of the study was to compare the efficiency and integrity of semi-rigid ureteroscopy (URS) versus extracorporeal shock wave lithotripsy (ESWL) regarding stone-free rate and potential complications for patients with upper ureteric stone. **Patients and Methods:** A prospective study was performed, comprising 100 patients with upper ureteric stone sized < 10 mm. They were assigned into two equal groups: one group underwent ureteroscopic pneumatic lithotripsy and the other group underwent ESWL sessions. Patients' follow-up done at 1 month and 3 months for stone clearance and eventual complications, many factors related to the patient and stone were evaluated. **Results:** The mean age of all patients was 42.54 ± 14.07 years; 69% of patients were males. The initial stone-free rate (SFR) was statistically significant between the two groups (80% for URS and 62% for ESWL), SFR for ESWL group increased to 76% and 82% after the 2nd and 3rd sessions, respectively; however, it remained higher in the URS group after 3 months of treatment. Complications were minor in the two groups. Analysis of stone- and patient-related factors revealed no significant impact of patient's age, gender, height, and body mass index in both groups, whereas stone size, stone density, and ureteral wall thickness had a significant effect on SFR, the significance of proximal ureteric diameter (PUD) and renal pelvis anterior–posterior diameter was noticed in ESWL group only. **Conclusion:** Both ESWL and URS were safe and effective means for treating upper ureteric stones smaller than 10 mm, but evaluation of several factors related to patient and stone may help improve stone outcome.

Keywords: Extracorporeal shock wave lithotripsy, upper ureteric stone, ureteroscopy

INTRODUCTION

Urinary stone formation is a popular disease with a rising incidence and prevalence all around the world that appears even more evident in industrialized countries.^[1]

With the emergence of progressing endourological instruments and mechanisms, minimally invasive surgical procedures have increasingly superseded open surgery for dealing with proximal ureteric stones.^[2] The introduction of extracorporeal shock wave lithotripsy (ESWL) caused a major change in the management of urinary calculus.^[3] This technology is easy to apply, noninvasive, and efficacious, with a short time for recovery in contrast to other options.^[4] All shock waves, whatever their energy basis, are able to fragment calculi when correctly focused. ESWL is the most acceptable management for proximal ureteric stone,

owing to good efficacy and relatively low morbidity.^[5] The emergence of small caliber semi-rigid ureteroscopy (URS), in addition to the advancement of intracorporeal lithotripsy facility has significantly consolidated the ureterorenoscopic manipulated stone-free rate with a considerable reduction of complication rates.^[5] Incorporation of ureterorenoscopy with intracorporeal lithotripsy has proved to be a feasible option alternative to ESWL.^[6]

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The aim of this study was to compare the efficacy and safety of semi-rigid URS versus ESWL in terms of stone-free rate and possible complications for patients with upper ureteric stone.

PATIENTS AND METHODS

This study was conducted between October 2019 and September 2020 in Al-Yarmouk Teaching Hospital, Baghdad/Iraq, where 100 patients with an age range (17–72 years) presented with a single upper ureteric radiopaque stone <1 cm were eligible for study criteria and planned for either ESWL or URS. Patients with a stone size equal to or more than 1 cm, radiolucent stones, active urinary tract infection, age <17 years, body mass index (BMI) ≥ 30 , pregnancy, serum creatinine level >1.5 mg/dL, single kidney, congenital anomalies, and coexisting ureteral pathology including tumor/stricture, were excluded from the study.

Patients enrolled in this study were assigned into two equal groups (Groups A and B). Group A patients were treated by URS, whereas Group B was managed by ESWL. Initial evaluation involved a detailed history, clinical examination, and investigations including complete blood count, renal function test, urinalysis and urine culture, ultrasonography, kidney, ureter, and bladder (KUB), and noncontrast computed tomography with three-dimensional reconstruction to detect the precise location, size and density of the stone, degree of hydronephrosis, and ureteral wall thickness (UWT) (measured at the point of greatest soft-tissue thickness around the circumference of a stone).

Parameters of the study included patient's age, gender, height and BMI, stone size and density, degree of hydronephrosis, UWT, duration of symptoms, stone-free rate, and possible complications in both groups.

In the URS group (Group A), the procedure was done utilizing a 6/7.5 Fr semi-rigid ureteroscope (Karl Storz, Germany) with pneumatic Lithoclast for intracorporeal lithotripsy using a 2–3 Fr probe in single or multiple modes, the number of shocks was regulated to prevent stone migration. Preoperative antibiotic was administered, and general anesthesia was used in all patients, cystoscopy was performed, and then floppy tip (Polytetrafluoroethylene [PTFE]) guidewire sized 0.035"

was inserted to bypass the stone; in cases of difficulty passing the guide wire, it was introduced through the ureteroscope, A Nitinol Tipless Dormia basket was used to avoid stone retropulsion when expected, a double J stent 4.7 Fr was sited at the end of the procedure in all except six patients and left for 3–4 weeks based on the degree of stone impaction and manipulations performed.

In the SWL group (Group B), SWL was carried out using (SIEMENS Lithostar Multiline). All patients were treated in a supine position by the same lithotripter. Treatment is initiated by a voltage of 11–12 kV, with a gradual rise until attainment to the extreme that could be tolerated by the patients. Five–ten gram of topical lidocaine gel was layed on about 30 cm² skin area interrelated to the entry site of the shock waves, 30 min before the procedure. Intramuscular diclofenac sodium injection (75 mg) was given. Calculi were localized using fluoroscopy. The shock waves were delivered at a rate of 60–100 impulses per minute. A maximum of 3000 shock waves were given in each session. After each session, the patient was observed for 2 h, and ultrasonography with KUB radiography was used for follow-up at 2 weeks to check for disintegration and clearance. Re-treatment SWL was assumed for incomplete clearance. A maximum of three sessions of SWL were given.

In both groups, patients who ended 3 months of follow-up were monitored by KUB films and ultrasonography where the outcome variable was the stone-free status (defined as radiologic absence of stone, asymptomatic patients with stone fragment <3 mm).

The study was approved by the ethical committee of the institute and informed consent were obtained from all patients before enrolling in this study.

The data were recorded into Microsoft Excel spreadsheet 2016 and analyzed by SPSS (Statistical Package for the Social Sciences) version 26. Data were presented as mean \pm standard deviation, and unpaired *t*-test was used to compare means between the two groups. Pearson correlation was done among different parameters and presented as *r* (correlation coefficient) and *P* value (level of significance). *P* < 0.05 was considered significant.

Table 1: Comparison of baseline stone's and patient's characteristics and outcome between the two groups

Study variables	Group A (URS) (n=50)	Group B (ESWL) (n=50)	P
Mean age (years)	42.21 \pm 9.01	45.3 \pm 12.23	0.1535
Male gender (%)	32/50 (64)	37/50 (74)	0.1902
Mean stone size (mm)	5.60 \pm 2.25	4.75 \pm 4.11	0.193
Mean stone density (HU)	853 \pm 95.21	825 \pm 82.1	0.119
Duration of symptoms (days)	24.71 \pm 5.21	22.54 \pm 9.30	0.154
Ureteral wall thickness (mm)	2.28 \pm 0.95	1.9 \pm 1.1	0.680
Diameter of proximal ureter (mm)	6.28 \pm 2.95	6.9 \pm 3.1	0.895
Weight (kg)	65.4 \pm 11.5	61.1 \pm 13.1	0.084
Height (cm)	156.3 \pm 77.1	158.7 \pm 85.3	0.883
BMI (kg/m ²)	27.1 \pm 7.8	24.1 \pm 8.53	0.070
Stone-free rate (%) after initial intervention	40/50 (80)	31/50 (62)	0.0477
Stone-free rate (%) at 3 months	42/50 (84)	41/50 (82)	0.787

BMI: Body mass index, URS: Ureteroscopy, ESWL: Extracorporeal shock wave lithotripsy, HU: Hounsfield units

RESULTS

The mean age of all patients was 42.54 ± 14.07 years. There were 69 (69%) males and 31 (31%) females.

The mean patient’s age, height, weight, BMI, stone size, stone density, UWT, duration of symptoms, complications, and stone-free rate are summarized in Table 1. No significant difference was found in regard to patient characters and stone parameters between the two groups.

The initial stone-free rate (SFR) for URS was 80% (40/50 patients). DJ stent was placed in 27 cases. There were 10 failures (6 males and 4 females), 4 patients caused by proximal migration of the stone to the kidney, 3 cases as a result of severe stone impaction, and the remaining 3 cases were due to ureteral tortuosity. In contrast, the initial SFR for SWL was 62% (31/50 patients); for the remaining 19 cases, 7 cases were managed by successful second session SWL (retreatment procedure), three patients needed a third session, and 9 cases failed to be stone free after 3 sessions of ESWL and were managed by URS, so there was a statistically significant difference in initial stone-free rate between the two groups ($P = 0.0477$).

The stone-free rate after 3 months of treatment was still higher in the URS group than the ESWL group but with a statistically insignificant difference (84% vs. 82%, respectively).

In all patients, all complications were minor without significant differences between the two groups (20.7% for URS vs. 17.6% for ESWL). The most common complications were stent-related symptoms and flank pain (for Group A and B, respectively) [Figure 1].

When we analyzed the effect of stone- and patient-related factors on stone clearance after URS and SWL, it was demonstrated that patient’s age, gender, height, and BMI values did not have a significant impact on this aspect in both groups [Tables 2 and 3].

Other parameters, namely stone size, stone density as Hounsfield units (HU), diameter of the ureter proximal to the stone (PUD), renal pelvis anterior–posterior diameter (PAPD), and UWT had a significant correlation in an individual parameter-based manner, the significance of hydroureteronephrosis degree was identified in ESWL group rather than URS group [Tables 4 and 5].

Strong correlation was detected between UWT and symptoms duration in patients with failed ESWL and URS [Figures 2 and 3].

DISCUSSION

With the advancement of endourological equipment and techniques, minimally invasive surgical procedures have to an increasing degree replaced open surgery for treating upper ureteric stones.^[2] The initial stone-free rate in our study was 80% for the URS group and 62% for the ESWL group; thus, there was a significant difference between the two groups,

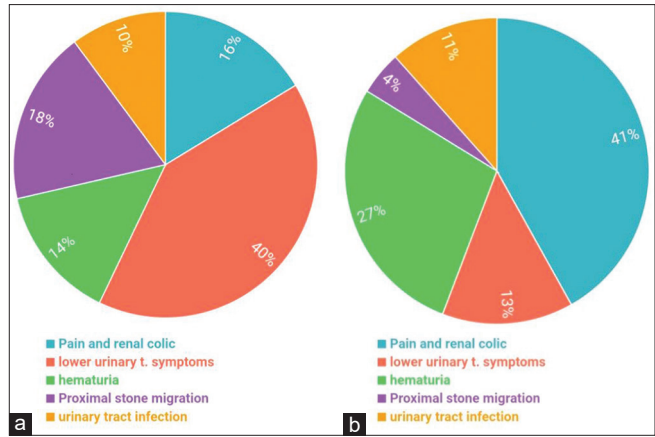


Figure 1: Complications percentages of both groups. (a) Ureteroscopy group, (b) extracorporeal shock wave lithotripsy group. URS: Ureteroscopy; ESWL: Extracorporeal shock wave lithotripsy

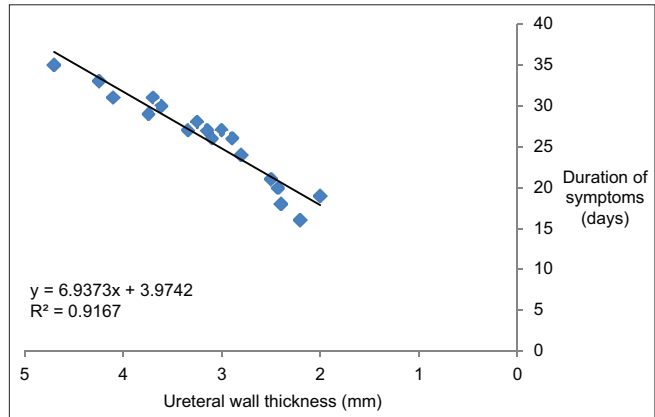


Figure 2: Correlation between ureteral wall thickness and duration of symptoms in patients with failed extracorporeal shock wave lithotripsy

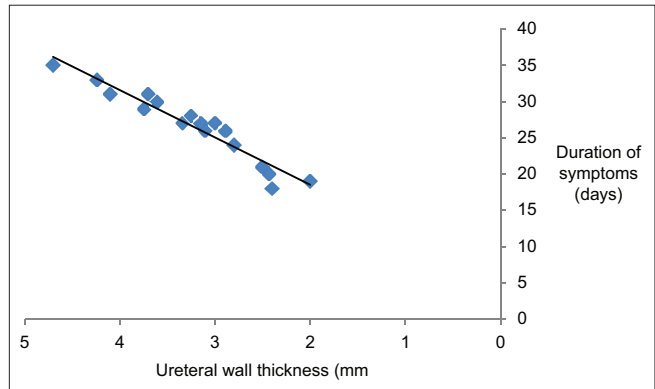


Figure 3: Correlation between ureteral wall thickness and duration of symptoms in patients with failed ureteroscopy

whereas the outcome after 3 months was comparable (84% vs. 82%, respectively). These results were in consistency with results of previous studies.^[7-10] However, opposite to the result of a study,^[11] in which it was concluded that URS has a higher stone-free rate, this might be due to difference in mean stone size and sample size. The key observation of this study was

that short-term stone-free rate was better with URS compared with SWL due to direct stone visualization by URS, allowing for accurate stone fragmentation and the ability to actively retrieve stones and/or fragments using baskets and forceps after stone fragmentation.

Overall complication rates were comparable between ESWL and URS with no statistical significance difference between the two groups (20.7% for URS vs. 17.6% for ESWL, $P = 0.401$), this finding was similar to the results of a study^[12] which concluded that both ESWL and semi rigid ureteroscopy were safe and highly efficacious for upper ureteric stone treatment and without significant difference.

Studying the effect of patient's and stone's factors on stone clearance in our study, we found that stone size, stone density as HU and UWT had a significant statistical effect in both groups

whilst proximal ureteric diameter (PUD) and renal PAPD had significant effect in ESWL group only.

A large proportion of patients in the present study was male gender (69%) with a mean age of 42.2 years for URS group and 45.3 years for ESWL group, this might be expected since stone disease is widespread in middle aged males, neither age nor gender found to be correlated to stone clearance outcome in both groups, this finding was in agreement with previous studies results^[13,14] which reported similar results of ESWL in both genders, Gökçe *et al.*^[15] stated that ESWL results were not affected by age, Prattley *et al.*^[16] also recorded stone-free rate equal to (88%–97%) for URS even in elderly patients.

BMI in our study was not found to have statistically significant correlation with stone-free rate ($P = 0.117$ for URS, $P = 0.625$ for ESWL), this was in accordance with other studies^[17,18] but opposing to results of a study^[19] which concluded that BMI is independent predictor of stone-free rate after ESWL (this difference might be due to exclusion of obese patient from our study).

In this study, stone size (<10 mm) found to have statistically significant correlation with the outcome in both groups, this finding was similar to other results reported by Shinde *et al.*,^[20] but in contrast to results of study by Yazici *et al.*,^[21] who concluded that only BMI and skin to stone distance were significant predictable factors of ESWL outcome in proximal ureteric stones.

Statistical evaluation of the effect of Stone density (measured by HU) on stone clearance revealed significant correlation in both groups, this finding was consistent with several studies,^[22-24] a rise in stone density may increase stone hardness rendering it difficult for breaking up by various lithotripters.

UWT may express the degree of stone impaction, our study results showed significant impact of UWT on stone clearance in both groups which could help to predict the procedure outcome, this finding was in agreement with results of two

Table 2: Effect of patient-related factors on stone-free rate after ureteroscopy

	Age	Gender (male/total) (%)	Height (cm)	BMI
Negative outcome	39.5±3.21	62.5	152.5±30.8	25.5±3.2
Positive outcome	41.2±2.74	59.52	155.1±22.4	23.7±1.9
<i>P</i>	0.1238	0.157	0.821	0.117

BMI: Body mass index

Table 3: Effect of patient-related factors on stone-free rate after extracorporeal shock wave lithotripsy sessions

	Age	Gender (male/total) (%)	Height (cm)	BMI
Negative outcome	38.6±2.85	55.55	156.8±76.1	24.7±2.4
Positive outcome	37.2±2.74	60.97	159.2±33.4	24.3±1.5
<i>P</i>	0.185	0.764	0.929	0.625

BMI: Body mass index

Table 4: Effect of stone-related factors, ureteric and renal pelvic measures on stone-free rate after ureteroscopy

	Stone size (mm)	Stone density (HU)	Proximal ureteric diameter (mm)	A-P pelvic diameter (mm)	Ureteral wall thickness (mm)
Negative outcome	6.7±1.79	897±83	7.50±2.76	32.68±2.35	3.56±1.77
Positive outcome	4.38±2.08	753±64	6.93±1.22	30.65±8.15	2.26±1.34
<i>P</i>	0.0124	<0.0001	0.1848	0.096	0.0368

HU: Hounsfield units

Table 5: Effect of stone-related factors, ureter and renal pelvis measures on stone-free rate after extracorporeal shock wave lithotripsy sessions

	Stone size (mm)	Stone density (HU)	Proximal ureteric diameter (mm)	A-P pelvic diameter (mm)	Ureteral wall thickness (mm)
Negative outcome	6.3±1.23	767±110	6.9±1.31	36.25±5.25	2.77±1.07
Positive outcome	4.6±2.35	681±83	4.87±0.79	28.35±9.12	2.15±1.81
<i>P</i>	0.0414	0.0108	<0.0001	<0.0001	0.0002

HU: Hounsfield units

papers^[25,26] but opposing to results of a study^[8] in which it was found that both URS and ESWL are safe and effective for impacted ureteric stone. This difference could be due to their use of different lithotripter (holmium: YAG laser).

Urinary obstruction is a critical issue as it can produce progressive impairment of renal function and serious complications, this led some researchers^[27] to advocate double J-stent insertion pre-ESWL or active stone removal in cases with stones producing a considerable degree of hydronephrosis. In our study, hydronephrosis degree, measured as proximal ureteric and A-P pelvic diameters, was significantly linked with negative ESWL outcome; this was in agreement with other studies by Chang *et al.*,^[28] who reported poor ESWL outcome in patients with high-grade hydronephrosis .

In contrast, A study^[10] which described better ESWL outcome in case of hydronephrosis.,this difference could be explained by the larger sample size included and technical differences.

CONCLUSION

Both ESWL and URS were safe and effective means for treating upper ureteric stones smaller than 10 mm.

Although many patients prefer ESWL over URS as ESWL is less invasive and free of anesthetic complications, small caliber URS yields a higher initial stone-free rate with a comparable complication rate and prompt relief of obstruction.

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Conflicts of interest

There are no conflicts of interest.

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