A comparative study between laser ureteroscopy versus extracorporeal shock wave lithotripsy for treatment of upper ureteric stones

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Objective
The purpose of this study was to compare the efficacy of extracorporeal shock wave lithotripsy (ESWL) versus laser ureteroscopy (URS) in the treatment of upper ureteral stones less than or equal to 1 cm.
Patients and methods
In our Ain Shams University Hospitals, we treated 90 patients aged 18–80 years with upper ureteric stones measuring from 6 mm up to 1 cm by computed tomography urinary tract. Patients were randomly divided into two groups: group A (45 patients) underwent laser URS, which was divided into two subgroups (A1: 22 patients had flexible URS and A2: 23 patients had rigid URS), and group B (45 patients), which underwent ESWL.
Results
The stone-free rate (SFR) was 38/45 (84.4%) in group A and 25/45 (55.6%) in group B (P=0.006) after the first session of ESWL, was 33/45 (73.3%) (P=0.303) after the second session, and was 35/45 (77.8%) (P=0.596) after the third session. A total of seven auxiliary procedures in group A and 10 in group B were needed to reach a 100% SFR (P=0.014). Group A had significantly longer operative time, hospital stay, and need for Double J (DJ) application than group B (P=0.028, 0.001, and 0.046, respectively). There were no significant differences between the two groups for the number of complicated cases, patient characteristics, or stone characteristics (P=0.65, 0.23, 0.77, and 0.62, respectively).
Conclusion
Both ESWL and Holmium laser lithotripsy (flexible and rigid URS) for upper ureteric stones had a high SFR and a low incidence of complications.
Holmium laser lithotripsy had higher initial stone rate than ESWL, which becomes comparable with repeated sessions of ESWL, but with longer hospital stay time, higher cost, and higher need for anesthesia. However, ESWL is still accepted as a practical and noninvasive first-line treatment method in the majority of cases because of its high success rates with advantage of outpatient procedure with no need of anesthesia.

Keywords:
DJ, extracorporeal shock wave lithotripsy, flexible ureteroscopy, laser, lithotripsy, retreatment rate, rigid ureteroscopy, stone-free rate, stone, ureter

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Introduction

Urinary stone disease is a common problem [1–3], which has a high recurrence rate owing to many factors, including metabolic disorders and congenital anatomical abnormalities in the urinary tract [4–6]. For many years, several factors should be considered when choosing the best treatment approach for ureteral stones, which include the number of stones and their size, composition, location, and the presence of hydronephrosis, and other anatomic factors such as morbid obesity, the presence of a solitary kidney, strictures, and ureteral anomalies [7–10]. Extracorporeal shock wave therapy was deemed effective, safe, and the first choice for treating 1-cm proximal ureteric stones [5,6,11,12]. However, ureteroscopy (URS) for upper urinary tract urolithiasis has a higher success rate and a lower retreatment rate when compared with extracorporeal shock wave lithotripsy (ESWL), especially after the development of flexible and smaller-caliber semi-rigid ureteroscopes and the introduction of lasers [13–16]. With the advancement in endoscopic technology, a new dimension has been opened in the treatment of stone disease. The entire urinary

collecting system either unilaterally or bilaterally can be reached using a flexible ureteroscope; stones can be actively fragmented via holmium laser and removed by some special basket catheters [17–19]. The indication of flexible ureteroscopy (F-URS) has been expanding, including intrarenal stones, ESWL failure, morbid obesity, musculoskeletal deformities, bleeding diathesis, and occupations that require complete stone clearance (i.e. pilots) [2,11,13,18].

Patients and methods

From 2020 to 2022, 90 patients aged from 18 to 80 years, with upper ureteric stones ranging from 6 to 10 mm, were treated in our Ain Shams University Hospitals. Patients with radiolucent, impacted stones, distal obstruction, children under the age of 18 years, bilateral or multiple stones, congenital renal or ureteric strictures or anomalies, or spinal deformities, as well as those who were morbidly obese (BMI >40 kg/m^2) or had bleeding disorders, were excluded from our study.

Patients were randomly allocated into two groups: group A (45 patients) underwent laser URS, which was divided into two subgroups, that is, A1: 22 patients underwent F-URS and A2: 23 patients underwent rigid ureteroscopy (R-URS), and group B (45 patients) underwent ESWL. Our institute's local committee provided ethical approval. A kidney, ureter, and bladder (KUB) radiograph made the stone diagnosis; to ensure radio-opacity of the stone in all cases, renal ultrasonography (to detect the stones, the degree of hydronephrosis, and the condition of the parenchyma) and computed tomography urinary tract (to determine stone densities and stone sizes) were done.

The laser settings were low energy as 0.5 J as a starting point up to 1.5 J, high frequency (10–20 Hz), and 7.5–10 W total power. In both flexible and rigid ureteroscopies, fibers with diameters of 365 and 550 m were used. A DJ stent of 6 or 7 F may be placed at the end of the procedure if necessary, whereas American and European guidelines require the use of a ureteral stent after placing a ureteral access sheath owing to ureteral dilation up to 15 F to reduce the risk of ureteral stricture formation. The OTU-100SR flexible ureteroscope was used in group A1. A Richard Wolf 8/9.8-Fr 430-mm working length semirigid ureteroscope was used in group A2.

In group B, ESWL (nonstented) was done in all patients in a supine position using Siemens or Dornier lithotripters under analgesia, and fluoroscopic guidance, voltage ramping was used with maximum shockwaves number of 3000 per session.

In both the groups, clinical assessment for pain and fever was done. KUB was repeated at 2 weeks postoperatively. The initial stone-free rate (SFR) after 2 weeks (no stone residual ≥0.3 cm) was calculated. Patients having nonsurgical fragments were evaluated monthly for 3 months. In cases with stone residual of 0.3–1 cm, medical expulsive therapy was used first, and they were re-evaluated at 1 month postoperatively. Patients with complications (obstruction, sepsis, persistent pain or oliguria) or failed medical therapy were managed accordingly either with ESWL, URS, or DJ stenting.

Follow-up visits were scheduled at 1, 3, and 6 months postoperatively. At each visit, clinical assessment, urine analysis, urine culture, KUB, and computed tomography urinary tract were done if needed.

Statistical analysis

The Statistical Package for the Social Sciences, version 23.0 (SPSS Inc., Chicago, Illinois, USA), was used to analyze the collected data.

Ethical considerations

A written signed consent form was obtained from all patients after a full explanation of the benefits of the procedure. The privacy of participants and confidentiality of data were guaranteed during the various phases of the study. The approval of the research ethical committee was obtained on October 4, 2020 with the number M D 225/2020.

Results

Between October 2020 and June 2022, 90 patients presented to our outpatient clinics with upper ureteric stones of less than or equal to 1 cm. All of them met our inclusion criteria. Patient characteristics, stone characteristics, and results are summarized and compared in Tables 1–4.

In group A, the mean±SD (range) operative time and hospital stay were 37.78 ± 4.92 min (27–45 min) and 12.53 ± 3.41 h (6–22 h), respectively. Ureteric dilatation was needed, and ureteric access sheath was used (10–12 F) while using F-URS, and there was failure to reach the stones in seven cases; seven auxiliary procedures were needed in these patients to become stone free. A total of 15 (33.3%) patients in group A needed DJ application.

UTI and fever were observed in five (11.1%) patients. Urine analysis, culture, and sensitivity were done. Proper antibiotic and analgesics were prescribed with marked improvement of the symptoms. Renal colic was observed in 6/45 (13.3%) patients, which were

Table 1 Comparison between three groups regarding patient and stone characteristics

Baseline characteristics	Group A1 (*N*=22)	Group A2 (*N*=23)	Group B (*N*=45)	Test value	*P* value
Age (years)					
Mean±SD	46.82±10.70	44.61±9.45	40.78±12.55	*F*=2.300	0.106
Range	30–75	35–64	19–60		
Sex [*n* (%)]					
Female	15 (68.2)	11 (47.8)	20 (44.4)	χ^2=3.465	0.177
Male	7 (31.8)	12 (52.2)	25 (55.6)		
Site [*n* (%)]					
Left	12 (54.5)	11 (47.8)	30 (66.7)	χ^2=2.459	0.293
Right	10 (45.5)	12 (52.2)	15 (33.3)		
Stone size (mm)					
Mean±SD	7.80±1.01	7.86±0.87	7.70±1.19	*F*=0.177	0.838
Range	6–9.5	6.5–9.7	6–10		
HU					
Mean±SD	830.27±125.59	841.00±140.89	886.20±149.12	*F*=1.458	0.238
Range	633–1053	600–1100	634–1177		

Using: *F* one-way analysis of variance; χ, χ test. *P* value more than 0.05 (NS).

Table 2 Comparison among three groups according to hospital stay

Hospital stay (h)	Group A1 (*N*=22)	Group A2 (*N*=23)	Group B (*N*=45)	*F*test	*P* value
Mean±SD	11.55±3.13^{II}	14.48±3.46^{I}	3.99±1.29^{III}	142.291	<0.001**
Range	6–19	8–22	2–6		

Using: *F*-One Way Analysis of Variance. Values in each row which have different Latin are significantly different at (*P*<0.05) using Tukey's test. **p*-value <0.001 (HS).

Table 3 Comparison among three groups according to operation time

Operation time (min)	Group A1 (*N*=22)	Group A2 (*N*=23)	Group B (*N*=45)	*F* test	*P* value
Mean±SD	39.45±3.49^{I}	37.17±5.60^{I+II}	35.78±3.42^{II}	3.153	0.021*
Range	32–45	27–45	29–41		

Using: *F*-One Way Analysis of Variance. Values in each row which have different Latin are significantly different at (*P*<0.05) using Tukey's test. **p*-value <0.05 significant.

Table 4 Comparison between three groups according to stone-free rate

	Group A1 (*N*=22)	Group A2 (*N*=23)	Group B (*N*=45)	*F* test	*P* value
Stone-free rate [*n* (%)]	19 (86.4)^{I}	19 (82.6)^{I}	25 (55.6)^{II}	9.017	0.011*

Using: χ^2: Chi-square test. Values in each row which have different Latin are significantly different at (*P*<0.05). **p*-value <0.05 (S).

managed successfully by strong analgesics. Stone migration was seen in three (6.7%) patients, and false passage during guide wire insertion was seen in two (4.4%) patients. Regarding hematuria, 8/45 (17.8%) patients developed mild hematuria and were treated by good hydration and intravenous fluids.

In group B, all patients were discharged on the same day, that is, an outpatient procedure, and the mean±SD (range) of hospital stay and operative time were 3.99±1.29 h (2–6 h) and 35.78±3.42 min (29–41 min), respectively. The number of shockwaves given ranged from 2500 to 3000 in the session. The SFR in group B was 35/45 (77.8%) [25/45 (55.6%) patients needed one session, 33/45 (73.3%) patients needed two sessions, and 35/45 (77.8%) patients needed three sessions). Ten auxiliary procedures (four ESWL and six URS) were needed for 10 patients to become stone free. Ten (22.4%) patients were complicated with mild hematuria, one (2%) patient developed fever, and 10 (22.4%) patients developed renal colic and were treated by strong analgesics, e.g. NSAIDs. NSAIDs and steinstrasse were seen in three (6%) patients and were treated by URS and DJ stenting.

Complications are summarized and compared in Table 5, and more than one complication occurred in the same patient.

There were significant statistical differences between the two groups regarding hospital stay (12.53±3.41 h in group A and 3.99±1.29 h in group B ; *P*=0.001); the operation time (37.78±4.92 h in group A and 35.78±3.42 h in group B; *P*=0.028); and in SFR [38/45 (84.4%) patients in group A and 25/45 (55.6%) patients in group B after the first session of ESWL, *P*=0.006], which became less significant after repeated sessions of ESWL (*P*=0.006), whereas there were no significant statistical differences between the two groups regarding patient characteristics, stone characteristics, retreatment rate (Tables 6 and 7), and number of complicated cases or complications (Table 5).

Discussion

A number of clinical studies performed over the last 20 years have attempted to define the best therapeutic approach for upper ureteric stones. Several factors

Table 5 Comparison between three groups according to complications

Complications	Group A1 (*N*=22) [*n* (%)]	Group A2 (*N*=23) [*n* (%)]	Group B (*N*=45) [*n* (%)]	χ^2	*P* value
UTI and fever					
No	20 (90.9)	20 (87.0)	44 (97.8)	3.139	0.208
Yes	2 (9.1)	3 (13.0)	1 (2.2)		
Renal colic					
No	20 (90.9)	19 (82.6)	35 (77.8)	1.746	0.418
Yes	2 (9.1)	4 (17.4)	10 (22.2)		
Stone migration					
No	21 (95.5)	21 (91.3)	–	3.705	0.157
Yes	1 (4.5)	2 (8.7)	–		
Hematuria					
No	19 (86.4)	18 (78.3)	35 (77.8)	0.739	0.691
Yes	3 (13.6)	5 (21.7)	10 (22.2)		
False passage and extravasation					
No	22 (100.0)	21 (91.3)	–	5.958	0.051
Yes	0	2 (8.7)	–		

Using: χ^2, χ^2 test. *P* value more than 0.05 (NS).

Table 6 Comparison between three groups according to retreatment rate

Retreatment	Group A1 (*N*=22) [*n* (%)]	Group A2 (*N*=23) [*n* (%)]	Group B (*N*=45) [*n* (%)]	χ^2	*P* value
No-retreatment	19 (86.4)	19 (82.6)	35 (77.8)	0.756	0.685
Retreatment	3 (13.6)	4 (17.4)	10 (22.2)		
ESWL (4th session)	–	1 (4.3)	4 (8.9)		
DJ and ESWL	–	2 (8.7)	–		
F-URS	–	–	2 (4.4)		
Preoperative for Dilatation	2 (9.1)	2 (8.7)	–		
R-URS	–	–	4 (8.9)		
Ureterolithotomy	1 (4.5)	–	–		

ESWL, extracorporeal shock wave lithotripsy; F-URS, flexible ureteroscopy; R-URS, rigid ureteroscopy.

Table 7 Comparison between three groups according to need for DJ application

Need for DJ	Group A1 (*N*=22) [*n* (%)]	Group A2 (*N*=23) [*n* (%)]	Group B (*N*=45) [*n* (%)]	χ^2	*P* value
No-need for DJ	16 (72.7)	14 (60.9)	39 (86.7)	5.915	0.050*
Need for DJ	6 (27.3)$^{I+II}$	9 (39.1)^{I}	6 (13.3)^{II}		
DJ due to extravasation	–	2 (8.7)	–		
DJ for ESWL	–	2 (8.7)	–		
DJ post-uretrolithotomy	1 (4.5)	–	–		
Postoperative(narrow lumen, edema, excessive manipulation and residual stones)	3 (13.6)	3 (13.0)	6 (13.3)		
Preoperative for dilatation	2 (9.1)	2 (8.7)	–		

ESWL, extracorporeal shock wave lithotripsy. Using: χ^2: Chi-square test. Values in each row which have different Latin are significantly different at (P<0.05). *p-value <0.05 (S).

should be considered when choosing the best treatment approach to manage ureteral stones, which include the number of stones and their size, composition, location, and the presence of hydronephrosis, and other anatomic factors such as morbid obesity, presence of a solitary kidney, strictures, and ureteral anomalies [2,19,20].

Although ESWL and URS remain the most common modalities for the treatment of proximal ureteral stones, there is still an ongoing debate among urologists regarding the best treatment modality [5,8].

ESWL is the most common intervention for upper ureteral stones [2,9,21].

However, it should be noted that ESWL is the least invasive method and the most performed despite the potential need for repeated treatments and greater failure rate compared with URS. Owing to its lesser invasiveness, ESWL was performed in the outpatient setting as a day-care procedure with the patient under analgesia [7,22,23].

Ureteroscopic stone extraction was first used for lower ureteric stones. However, recent technological advances, especially in the field of optics, have enabled endoscopes to become smaller in diameter, more flexible, and easier to introduce. Thus, performing URS along the whole course of the urinary tract has

become easier, more common, and with higher SFR than ESWL [10,17,22,24].

The introduction of the holmium : YAG laser has improved the URS SFR, with minimal risks of complications, and has been used for lithotripsy by many groups with optimizing results. The holmium : YAG laser can fragment all types of calculi, including hard calcium oxalate monohydrate and cystine stones [18,22].

In this prospective randomized controlled trial, the primary objective was to compare between laser lithotripsy of upper ureteric stones (using both flexible and rigid ureteroscopes) and ESWL (nonstented) for the management of upper ureteric stones (up to 1 cm) with normal or mild backpressure changes of the upper urinary tract. The study was conducted on 90 patients with upper ureteric stones, and they were divided randomly into two groups.

In our study, the initial SFR for group A (F-URS and R-URS) 84.4% (86.4% for F-URS and 78% for R-URS) and for group B was 55.6% (after the first session), and there was a significant difference in the SFR between the two studied groups (P=0.006), which became less significant with repeated sessions of ESWL.

In accordance with our findings, Alkan *et al.* [25] reported that the initial SFR for laser URS was 82% (87.5% for F-URS, 76.5% for R-URS) when applied to stones up to 1 cm, whereas Cui *et al.* [26] reported that SFR was 97.5% for laser URS and 77.5, 87.5, and 92.5% for ESWL (first, second, and third session, respectively) groups. There were significant differences between the first, second, and third sessions, but multiple sessions of ESWL resulted in similar outcomes to URS.

Yencilek *et al.* [27] reported that SFR was 92.89, 96.4, and 75.9% for ESWL, F-URS, and R-URS, respectively, whereas 77 (92.8%) of 83 patients in the ESWL group were stone free after three sessions; 41 (75.9%) patients and 27 (96.4%) patients were stone free after the single-step procedure in semirigid and flexible groups, respectively. The SFR was 67.4% after the first session of ESWL, 81.9% after the second, and 92.8% after the third session. Reasons for failure in the ESWL group were impacted stone in the edematous ureteral wall in four patients and steinstrasse formation in two patients. These patients were eventually managed by endoscopy.

The retreatment rate in our study was 15.6% in group A (13.6% for A1 and 17.4% for A2) and 22.2% in group B, with no significant difference between the two studied groups (P=0.596).

Kartal *et al.* [24], discovered that the retreatment rate was 5.3% (4 and 6.7%) and 46.3% for laser URS (F-URS and R-URS) and ESWL groups, respectively (P=0.001), with SFR 78.2% (89.6 and 67.2%) and 41.4% after 15 days from the procedure, which improved after 3 months to 95.5% (97 and 94.1%) and 79.5% (P=0.001) after usage of auxiliary procedures, for example, DJ application for dilatation prior URS or switching from one method to other like converting from R-URS to F-URS, which shows significant difference between two groups regarding retreatment rate and SFR, which may be due to a larger stone size (>10 mm).

In terms of DJ application need, our study found that group A (15/45; 33%) had significantly higher DJ application need than group B (6/45; 13.3%), with P value of 0.046. In contrast to our findings, Aboutaleb *et al.* [21] reported that 27.3% (18/66 patients) in the ESWL group required DJ application due to persistent renal colic not responding to NSAIDs and 27.2% (22/81) patients in the laser URS group required DJ application, but none required it preoperatively, with no significant difference seen between both groups (P=0.96).

According to Joshi *et al.* [28], all patients in the laser URS group had DJ stenting except for one patient whose ureteric ostium could not be visualized (44/45; 97.7%) and five patients in the ESWL group had DJ application (5/45; 11.1%), with significant differences between the two groups as in our study.

In terms of hospital stay, the mean time for hospital stay in our study was 12.53 ± 3.41 (11.55 ± 3.13, 14.48 ± 3.46) and 3.99 ± 1.29 h, in groups A (A1, A2) and B, respectively, which had a significant difference between the two groups (P<0.001).

In accordance with our findings, Kartal *et al.* [24], reported that the mean time for hospital stay was 1.3 ± 1.1, 1.5 ± 1.5 and 0.3 ± 1.1 days postoperative for F-URS, R-URS, and ESWL groups which also had significant differences between the two groups (P<0.001).

Regarding age, our study demonstrated that the mean age of the patients in groups A (A1 and A2) and B was 45.69 ± 10.02 (46.82 ± 10.70 and 44.61 ± 9.45) and 40.78 ± 12.55 years, respectively, and that there was no significant difference in the age between the two studied groups (P=0.427).

According to Jalbani *et al.* [29], the mean age for the ESWL and laser URS groups was 34.57 ± 13.30 and 36.04 ± 13.75 years, respectively, and it was statistically insignificant (*P*=0.60), as in our study.

In our study, the stone size was selected to be equal to or less than 1 cm with a mean size of 7.83 ± 0.93 (7.80 ± 1.01 and 7.86 ± 0.87) and 7.70 ± 1.19 mm for groups A (A1 and A2) and B, respectively, and there was no statistically significant difference found between the two studied groups regarding stone size, with *P* value of 0.569.

Cui *et al*. [26] reported that stone size in study ranged from 8 to 15 mm, with a mean stone size of 9.8 ± 3.5 and 10.2 ± 4.3 mm for ESWL and laser URS groups, which was slightly larger, with no significant difference between two groups, similar to our study (*P*=0.428).

In terms of operation time, Abdullateef *et al.* [23] reported that mean operation time was 34, 29, and 39 min for F-URS, R-URS, and ESWL, respectively, with a significantly longer operation time for ESWL (*P*=0.001), which is in contrast with our study, which shows a significantly longer operation time for group A (A1 and A2) than for group B [37.78 ± 4.92 (39.45 ± 3.49 and 37.17 ± 5.60) and 35.783.42 min, respectively (*P*=0.358)].

In agreement with our findings, Kartal *et al.* [24] reported that operation time was 50.2 ± 10.9, 41.6 ± 13.7, and 30.9 ± 3.9 min for F-URS, R-URS, and ESWL, respectively, with significantly longer operation time for the laser URS group than the ESWL group (*P*=0.001).

Concerning complications, Cui *et al.* [26] and Kartal *et al.* [29] reported that no major complications (e.g. perinephric hematoma and avulsion of ureter) occurred in their studies, as in ours.

In our study, both groups A (F-URS or R-URS) and B had a low rate of complications. UTI and fever were observed in 11.1% (5/45) patients in group A (2/22:9% patients in A1 and 3/23:13% patients in A2) and 2.2% (1/45 patients) in group B, and renal colic was observed in 13.3% (6/45 patients) in group A (2 in F-URS and 4 in R-URS) and 22.2% (10/45) patients in group B, which were managed by strong analgesics, with no significant difference between the two groups (*P*=0.091 and 0.408).

In disagreement with our study, Kartal *et al.* [29] reported that the rate of emergency department visits for renal colic or other reasons was significantly higher after ESWL than after the URS procedures (*P*=0.001).

Regarding hematuria in our study, mild hematuria was observed in 17.8% (8/45 patients) in group A (3/32% in A1 and 5/23% in A2) and 22.20% (10/45 patients) in group B, which was treated by good hydration with marked improvement of symptoms, with no statistically significant difference found between the two studied groups regarding hematuria and renal colic (*P*=0.598).

In disagreement with our study, as shown by Aboutaleb *et al.* [21], the ESWL group had a higher rate of gross hematuria at 54% (36/66 patients) and 32% (26/81) patients in laser URS, which had a mild significant difference between both groups (*P*=0.013).Our study showed that steinstrasse was seen in 3/45 (6%) patients in group B and failed to pass the stone after three sessions of ESWL, necessitating retreatment in the form of R-URS in two cases and F-URS in one case with DJ application.

According to Aboutaleb *et al.* [21], steinstrasse occurred in three (3.7%) patients in the laser URS group and 23 (23.6%) patients in the ESWL group, who were treated by alpha-blockers (Tamsulosin, 0.4 mg). This treatment was successful in 14 cases and failed in the remaining nine cases, which were shifted to laser lithotripsy, with a significant difference between both groups as in our study (*P*>0.05).

Our study showed that false passage and extravasation during guide wire insertion were seen in 2/23/23 (8.7%) patients in group A2, which were managed by DJ application, with no significant difference between the two groups (*P*=0.153.)

In disagreement with our study, Aboutaleb *et al.* [21] reported that ureteric injury and extravasation occurred in 6/81 (7.4%) patients in the laser URS group, which had a significant difference between both groups (*P*=0.03).

In agreement with our study, Khalil [20] reported that ureteric injury occurred in 3/45 (6.7%) patients in the laser URS group, which had no significant difference between both groups (*P*>0.05).

Our study showed that stone migration was seen in 3/45 (6%) of patients in group A [1/22 (4%) patient in A1 was managed by advancing F-URS into the kidney and dusting the stones, and 2/23 (8%) patients in A2 were managed by DJ application and ESWL) (*P*= 0.453).

In contrast to our findings, Aboutaleb *et al*. [21] reported no cases of stone migration during URS, which could be attributed to the use of the N-Trap basket.

Tiloklurs *et al*. [14] reported that stone migration was higher in the laser lithotripsy group (7/75 cases, 9.3%) than in the ESWL group 2/75 (2.7%) cases, which may be due to the use of a semirigid ureteroscope, with no significant statistical difference between both groups (P=0.052).

Conclusion

(1) Both ESWL and Holmium laser lithotripsy (F-URS and R-URS) for upper ureteric stones had high SFR and low incidence of complications.
(2) Each treatment method had advantages and disadvantages, as well as several factors to consider when selecting a treatment option.
(3) Holmium laser lithotripsy had a higher initial SFR than ESWL, which became comparable with repeated ESWL sessions, but at a higher cost, a longer hospital stay, and need for anesthesia.
(4) ESWL is still accepted as a practical and noninvasive first-line treatment method in the majority of cases because of its high success rates, which is comparable to laser lithotripsy after repeated sessions, with advantage of outpatient procedure, with no need of anesthesia but with higher rate of renal colic and hematuria postoperative due to passage of fragmented calculi.

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Conflicts of interest
There are no conflicts of interest.

References

1 Cui X, Ji F, Yan H, Ou TW, Jia CS, He XZ, *et al.* Comparison between extracorporeal shock wave lithotripsy and ureteroscopic lithotripsy for treating large proximal ureteral stones: a meta-analysis. Urology 2015; 85:748–756.
2 Ordon M, Andonian S, Blew B, Schuler T, Chew B, Pace KT. CUA Guideline: Management of ureteral calculi. Can Urol Assoc J 2015; 9:E837.
3 Hubert KC, Palmer JS. Passive dilation by ureteral stenting before ureteroscopy: eliminating the need for active dilation. J Urol 2005; 174:1079–1080.
4 Kumar A, Nanda B, Kumar N, Kumar R, Vasudeva P, Mohanty NK. A prospective randomized comparison between shockwave lithotripsy and semirigid ureteroscopy for upper ureteral stones< 2 cm: a single center experience. J Endourol 2015; 29:47–51.
5 Rabani SM, Moosavizadeh A. Management of large proximal ureteral stones: a comparative clinical trial between transureteral lithotripsy (TUL) and shock wave lithotripsy (SWL). Nephrourol Mon 2012; 4:556–559.
6 Johnson DB, Pearle MS. Complications of ureteroscopy. Urol Clin North Am 2004; 31:157–171.
7 Breda A, Ogunyemi O, Leppert JT, Lam JS, Schulam PG. Flexible ureteroscopy and laser lithotripsy for single intrarenal stones 2 cm or greater—is this the new frontier?. J Urol 2008; 179:981–984.
8 Dasgupta R, Cameron S, Aucott L, MacLennan G, Thomas RE, Kilonzo MM, *et al.* Shockwave lithotripsy versus ureteroscopic treatment as therapeutic interventions for stones of the ureter (TISU): a multicentre randomised controlled non-inferiority trial. Eur Urol 2021; 80:46–54.
9 Cone EB, Pareek G, Ursiny M, Eisner B. Cost-effectiveness comparison of ureteral calculi treated with ureteroscopic laser lithotripsy versus shockwave lithotripsy. World J Urol, 2017; 35:161–166.
10 Haleblian G, Kijvikai K, de la Rosette J, Preminger G. Ureteral stenting and urinary stone management: a systematic review. J Urol 2008; 179:424–430.
11 Drake T, Grivas N, Dabestani S, Knoll T, Lamm TB, Maclennan S, Sarica K. What are the benefits and harms of ureteroscopy (URS) compared with shock-wave lithotripsy (SWL) in the treatment of upper ureteral stones: a systematic review. Eur Urol Suppl 2017; 3:e746–e747.
12 Wen CC, Nakada SY. Treatment selection and outcomes: renal calculi. Urol Clin N Am 2007; 34:409–419.
13 Wong MY. Flexible ureteroscopy is the ideal choice to manage a 1.5 cm diameter lower-pole stone. J Endourol 2008; 22:1845–1848.
14 Tiloklurs C, Taweemonkongsap T, Amornvesukit T, Phinthusophon K, Nualyong C, Chotikawanich E. Comparison of successful treatment between ureteroscopic lithotripsy and extracorporeal shock wave lithotripsy for proximal ureteric calculi. J Med Assoc Thailand 2017; 100:S150–S154.
15 Bierkens AF, Hendrikx AJ, De La Rosette F JJ, Stultiens GN, Beerlage HP, Arends AJ, Debruyne FM. Treatment of mid- and lower ureteric calculi: extracorporeal shock-wave lithotripsy vs laser ureteroscopy. A comparison of costs, morbidity and effectiveness. Br J Urol 1998; 81:31–35.
16 Niwa N, Matsumoto K, Miyahara M, Omura M, Kobayashi H, Kikuchi E, *et al.* Simple and practical nomograms for predicting the stone-free rate after shock wave lithotripsy in patients with a solitary upper ureteral stone. World J Urol 2017; 35:1455–1461.
17 Schuster TG, Hollenbeck BK, Faerber GJ, Wolf JSJr. Complications of ureteroscopy: analysis of predictive factors. J Urol 2001; 166:538–540.
18 Grasso M. Ureteropyeloscopic treatment of ureteral and intrarenal calculi. Urol Clin North Am 2000; 27:623–631.
19 Rubenstein RA, Zhao LC, Loeb S, Shore DM, Nadler RB. Prestenting improves ureteroscopic stone-free rates. J Endourol 2007; 21:1277–1280.
20 Khalil M. Management of impacted proximal ureteral stone: extracorporeal shock wave lithotripsy versus ureteroscopy with holmium: YAG laser lithotripsy. Urol Ann 2013; 5:88–92.
21 Aboutaleb H, Omar M, Salem S, Elshazly M. Management of upper ureteral stones exceeding 15 mm in diameter: shock wave lithotripsy versus semirigid ureteroscopy with holmium: yttrium-aluminum-garnet laser lithotripsy. SAGE Open Med 2016; 4:2050312116685180.
22 Knoll T, Schubert AB, Fahlenkamp D, Leusmann DB, Wendt-Nordahl G, Schubert G. Urolithiasis through the ages: data on more than 200,000 urinary stone analyses. J Urol 2011; 185:1304–1311.
23 Abdullateef M, Shoma A, Sheir K, El-Nahas A, Mansour A, Elshal A, Ibrahiem EH. 1132 a randomized controlled trial comparing flexible ureteroscopy, semirigid ureteroscopy (URS) and extracorporeal shockwaves lithotripsy (SWL) for treatment of 0.5-1cm proximal ureteric stones. Eur Urol Suppl 2016; 3:e1132–e1132a.
24 Kartal I, Baylan B, Çakıcı MÇ, Sarı S, Selmi V, Ozdemir H, Yalçınkaya F. Comparison of semirigid ureteroscopy, flexible ureteroscopy, and shock wave lithotripsy for initial treatment of 11-20 mm proximal ureteral stones. Arch Ital Urol Androl 2020; 92:39–44.
25 Alkan E, Sarıbacak A, Ozkanli AO, Basar MM, Acar O, Balbay MD. Flexible ureteroscopy can be more efficacious in the treatment of proximal ureteral stones in select patients. Adv Urol 2015; 2015:416031.
26 Cui Y, Cao W, Shen H, Xie J, Adams TS, Zhang Y, Shao Q. Comparison of ESWL and ureteroscopic holmium laser lithotripsy in management of ureteral stones. PLoS ONE 2014; 9:e87634.
27 Yencilek F, Sarica K, Gürpinar T, Göktas C, Cangüven Ö, Albayrak S. A comparison of shock wave lithotripsy, semirigid and flexible ureteroscopy in the management of proximal ureteral calculi. Turk J Urol 2009; 35:101.
28 Joshi HN, Shrestha B, Karmacharya RM, Makaju S, Koju R, Gyawali D. Management of proximal ureteric stones: extracorporeal shock wave lithotripsy (ESWL) versus ureterorenoscopic lithotripsy (URSL). Kathmandu Univ Med J (KUMJ) 2017; 15:343–346.
29 Jalbani MH, Patujo YH, Shaikh AA. Comparison of efficacy of extracorporeal shockwave lithotripsy versus ureterorenoscopic Holmium Laser lithotripsy in proximal ureteric Stone management. Rawal Med J 2019; 44:67–70.