# *Comparison of Extracorporeal Shock Wave Lithotripsy Versus Ureteroscopic Stone Extraction in the Treatment of Ureteral Stones*

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**ABSTRACT**

***Aim:*** *There are some controversies on the effectiveness of extracorporeal shock wave lithotripsy (ESWL) and ureteroscopic stone extraction (URS) in ureteral stones. Because, previous studies on this topic mostly included lower ureteral stones, we aimed to compare effectiveness of these two methods in both lower and upper ureteral stones.*

***Method:*** *After diagnosis of urolithiasis, ESWL or URS was performed to patients. Stone-free ratio, complications and necessity of an additional intervention for both procedures were recorded. The decision about the selection of method was made based on the patients' choice. Upper and lower ureteral stones were included, while middle ureteral stones were excluded from the study.*

***Result:*** *Total number of patients undergone URS was 90 and ESWL was 96. There was no difference in male/female ratio, age and stone diameters between two groups (P>0.05). Upper ureteral stones were found to be more frequent in ESWL group than those in URS group (55.2% vs. 33.3%, respectively, P=0.004). Total stone-free ratio was 97.8% for URS and 68.8% for ESWL (P<0.001). Ratios of treatment failures and complications were found to be lower in URS group compared with ESWL group (P<0.05).*

***Conclusion:*** *Although, URS seems to be more successful in the treatment of ureteral stones, further prospective studies with more patients are needed to clarify our results.*

***Key Words:*** *ESWL, URS, ureteral stones, effectiveness*

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## INTRODUCTION

Which method is the optimal treatment for ureteral stones is not completely clear, yet. Depending on the size and locations of the stones, current treatment methods are follow-up therapy, extracorporeal shock wave lithotripsy (ESWL), ureteroscopic stone extraction (URS) or ureterolithotomy (1).

Nowadays, URS and ESWL are the most commonly applied treatment modalities for the cases where the stones can not pass spontaneously (2,3). Both ESWL and URS have popularity in modern urology due to their minimal invasiveness. Both modalities have advantages and disadvantages. In previous studies it has been reported that both of the methods have high effectiveness, close to each other. However many of these studies had reported data belonging to lower ureteral stones (2,3, 4-13) and only few of them included upper ureteral stones (5,14,15).

In present study, we aimed to compare treatment results of the URS and ESWL methods both for lower and upper ureteral stones.

## MATARIALS AND METHODS

The data belonging to a total of 186 patients, who were treated by URS and/or ESWL due to ureteral stones in our Medical Center between January 2007 and June 2008, was retrospectively reviewed and the effectiveness of both methods were compared.

The patients had medical treatment of 14-21 days soon after they were diagnosed as ureteral stones. Patients having infection together with stones were treated with appropriate antibiotics and analgesic-antispasmolytic agents in accordance with their age and medical situation. The patients whose stones were not cleared following the medical treatment period were advised to receive either ESWL or URS. The decision was made based on the patient's choice. URS was performed to 90 (48.4%), while ESWL performed to 96 of them (51.6%). The stones under the lower limit of sacroiliac joint were classified as lower ureteral stones, the ones above the upper limit of this joint accepted as upper ureteral stones and the ones at the level of this joint as middle ureteral stones. Upper and lower ureteral stones were included and middle ureteral stones were excluded from the study.

ESWL was applied by PCKV5 lilithotripter (PCK, Turkey) under intravenous sedation. We used either midazolam (dormicum) 1.5 mg/kg or fentanyle 2 mg/kg for this purpose. ESWL was applied using by 18-20 kV was power on the average 4410 (2000-15000) shock waves. The session intervals varied between 5 to 10 days and the stones which could not be fragmented satisfactorily at the end of four sessions were classified as failure of ESWL.

URS was applied under spinal anesthesia for both upper and lower ureteral stones using rigid 9.5 Fr ureteroscope (Karl Storz). All patients undergoing URS had antibiotic prophylaxis. Each of them took one dose Ciprofloxacin (Ciproxin 200 mg infusion) intravenously 1 hour before URS. Many of the patients did not need balloon dilator for orifice entrance. Narrow ureters where URS could not pass were dilated. The stones were generally collected by basket. For 52 of patients the stones were fragmented by pneumatic lithotripter and then extracted out by forceps or basket. No stone fragment was left as much as possible. Stent is not routinely used for each patient having URS treatment. Double-J stent was used for patients who had apparent edema, were traumatized or had stone fragment after URS. Ureteral catheters were removed 1 day after the operation, double-j stents were removed 15- 20 days after the operation. Patients were discharged from the hospital one day after URS application.

All patients in each group were evaluated by direct urinary system radiography (DUSG), ultrasound (USG), intravenous pyelography (IVP) and/or non-contrast spiral computerized tomography (CT) before the treatment. Informed consent from each patient was obtained prior to any application

### Statistical analysis

The data was presented as mean plus/minus standard deviations. One-sample Kolmogorov-Smirnov test was performed in order to determine if the data complies with normal distribution. Pearson correlation analysis was used to research the correlations, and Student t-test and Chi-square test to determine the differences between the groups. The data was statistically analyzed with SPSS 12.0 software. p value less than 0.05 was considered statistically significant

## RESULTS

The URS group had 2.2:1 male/female ratio (62 male, 28 female) and the ESWL group had 3:1 male/female ratio (72 male, 24 female) ($p>0.05$). The mean age of URS group was 40.5 years (22-66), and that of the ESWL group was 40.7 years (17-87). The patients' kidneys were evaluated for caliectasia before the applications.

*Table 1. Baseline characteristics of the patients*

| | Ureteroscopy (n=90) | ESWL (n=96) | p |
|---|---|---|---|
| **Male / Female** | 62/28 | 72/24 | ns |
| **Age (year)** | 40.5±11.3 | 40.7±12.0 | ns |
| **Stone localization (Upper/Lower ureter)** | 30/60 | 53/43 | 0.004 |
| **Stone size (mm)** | 10.3±2.8 | 10.5±2.6 | ns |

*ESWL: Extracorporeal shock-wave lithotripsy, ns: not significant*

In URS group 45 patients (50.0%) had grade 1 caliectasia and 45 patients (50%) had grade 2 caliectasis; while in ESWL group 54 patients (56.3%) were found with grade 1 caliectasis and 42 patients (43.7%) with grade 2 caliectasis (p>0.05). The mean stone diameter was 10.3 mm (5-20 mm) in URS group, and 10.5 mm (7-18 mm) in ESWL group (p>0.05).

In the URS group, 30 patients (33.3%) had upper ureteral stones and 60 patients (66.7%) had lower ureteral stones while in the ESWL group 53 patients ( 55.2%) had upper and 43 patients (44.8%) had lower ureteral stones. Considering the stone localization there was a significant difference between the two groups (p=0.004). Baseline characteristics of the patients are shown in Table 1.

The mean time duration for URS application was 36 minutes (between 15-100 minutes). There was a positive correlation between the stone size and operation duration time in patients treated by URS (r=0.778, p<0.001).

We applied ESWL to 53 patients and URS to 30 patients all having upper ureteral stones. The stone size was 10±2 mm in both groups. One month after the applications, stone clearance in URS group was 93.3% and in ESWL group 69.8% (p<0.05)

The mean stone burden was 10.3±2.8 mm for URS and 10.5±2.6 mm for ESWL (p>0.05). In URS methods, 88 of 90 patients were successfully cleared from stones thus the effectiveness rate was determined as 97.8% for URS. Using URS all lower ureteral end stones were cleared. Of proximal ureteral stones 28 one (93.3%) were cleared. In remained two patients open surgery was performed due to ureteral perforation. Regarding the stone clearance, there was no statistical significant difference between upper and lower ureteral stones for the patients treated with URS (P>0.05). However, total stone clearance ratio of URS group was found to be higher than that of the ESWL group (97.8% vs. 68.8%, respectively, p<0.001) (Table 2).

In 38 of URS applied patients the stones were extracted by basket and the mean size of them was 8.0±1.3 mm. In 52 patients stones were disintegrated by pneumatic lithotripter at first and then were extracted either by basket or forceps; here the mean size of stones was 11.7±2.0 mm.

Ureteral stent was placed only to 12 (13.3%) patients

*Table 2. The comparison of effectiveness, failure and complication ratios in ESWL and ureteroscopy groups*

| | | Ureteroscopy (n:90) | ESWL (n:96) | p |
|---|---|---|---|---|
| Effectiveness, n (%), | Total | 88 (97.8) | 66 (68.8) | |
| | Upper ureteral stones | 28 (93.3) | 37 (69.8) | <0.001 |
| | Lower ureteral stones | 60 (100.0) | 29 (67.4) | |
| Failure, n (%) | | 2 (2.2) | 30 (31.2) | <0.001 |
| Complication, n (%) | | 7 (7.7) | 34 (35.4) | <0.001 |
| Patient complaint after the application, n (%) | | 15 (16.6) | 16 (16.7) | NS |
| Number of visits | | 2.27±0.98 | 3.92±1.43 | <0.001 |

*ESWL: Extracorporeal shock-wave lithotripsy, NS: not significant*

after URS application and they were removed in the first postoperative day. Seven patients (7.7%) developed complications during URS (Table 2). Two patients had perforation and 5 patients had epithelial trauma. Two patients who developed perforation were the ones who had failure in URS either. Their stone diameters were 16 and 18 mm. The stones of both patients were extracted by ureterolithotomy in the same session, the ruptured ureter was repaired and double-j stent was placed. The patients who had epithelial trauma were placed a double-j stent too and those stents were removed 20 days after the placement. Also 4 patients (4.4%) developed urinary system infection and 3 patients (3.3%) had fever in the postoperative period. They were managed by antibiotics. Fifteen patients (16.6%) had lateral lumbar pain, urinary burning sensation and frequent urination feeling lasting for 1-3 days. After the 3rd day of operation these complaints were disappeared (Table 2).

Sixty-six of the 96 patients (68.8%) who had ESWL were cleared off the stones 3 weeks after the end of the application and the effectiveness was 68.8%. This success rate was significantly lower than that of URS group ($p<0.001$) (Table 2). With ESWL, 29 of the 43 patients (67.4%) who had distal ureteral stones and 37 of 53 patients (69.8%) who had proximal ureteral stones were cleared off the stones. In ESWL group, there was no significant relationship between the location and the clearance of the stone ($p>0.05$). For the patients who had ESWL treatment, we compared the pelvicaliectasia grade of the kidney with the clearance rate. 43 of 54 patients (79.6%) who had grade 1 pelvicaliectasia were cleared off the stones after ESWL while 23 of 42 patients (54.8%) who had grade 2 pelvicaliectasia were cleared off. In the patients treated with ESWL, there was a statistically significant negative relationship between the pelvicaliectasia grade of the kidneys and stone clearance ($p=0.009$). Double-j stent was placed to 13 patients who had stones of 15 mm and larger, before ESWL.

In ESWL group, there was significant positive correlation between stone size and number of sessions ($r=0.486$, $P<0.001$), and between stone size and number of visits ($r=0.442$, $p<0.001$)

Of 30 patients with unsuccessful results with ESWL method, 13 (43.3%) were treated by URS, 7 (23.3%) by ureterolithotomy, and 10 patients went to other medical centers. Thirty-four of the ESWL treated patients (35.4%) developed complications. 18 patients (18.8%) had urinary hemorrhage, 5 (5.2%) had fever, 8 (8.3%) had lumbar pain and 3 (3.1%) had skin ecchymosis (Table 2).

## DISCUSSION

The primary method for the treatment of ureteral stones is not clearly determined yet and there is a much debated question with no agreement. Nowadays, the most applied methods are ESWL and URS. Both applications have been subject of favoring and opposing thesis. The preference between these two modalities depends on the experience of the urologist and the availability of the equipment (1,2).

ESWL requires more application tools and follow-up time in order to reach a satisfactory stone-free situation. It also requires more number of visits (Table 2). Though the re-treatment necessity in ESWL is more than URS, ESWL's advantages are, its noninvasiveness and not necessitate of local or general anesthesia. On the other hand URS is considered as a one step intervention under anesthesia in many of the studies. There are some studies comparing the URS and ESWL, however many of them are focused on distal ureteral stones (1-13).

Honeck and his colleagues (4) had reported stone-free ratio of 84% with ESWL and 98% with URS in a study with 124 patients with distal ureteral calculi. In our study the effectiveness of ESWL and URS on distal ureteral stones were 67.4% and 100% respectively. The average stone size in our present study was 10 mm while it was 7 mm in the aforementioned studies.

There are not many studies comparing the effectiveness of these two methods for upper ureteral stones. In their study done with 71 patients having upper ureteral stones of 5 to 10 mm, Karlsen and his colleagues (5) have applied ESWL to 33 patients and URS to 38 patients and recorded stone clearance of 58% in ESWL group and 78% in URS group, 3 weeks after the applications. The same patients had 88% stone clearance in ESWL and 89% in URS, after 3 months. The need for analgesics, dysuria, hematuria and lumbar pain has been significantly higher in ESWL group patients (5).

Depending on the results of our study we have the opinion that URS is a more effective modality for upper ureteral stones. However, two patients developed perforation with URS and in the same session the stones were extracted by ureterolithotomy and the rupture was repaired. The stone sizes of these two patients were large (16 and 18 mm) and the operation lasted long. As the stone size rises,

URS effectiveness rate decreases. The requirement of ureteral stent for 12 patients (13.3%) as an additional intervention after URS can also be regarded as a disadvantage. Increased operation time period for big stones can be regard as another disadvantage.

In an extensive report covering 18.825 patients treated with ESWL in USA it is stated that 84% of the patients had complete stone clearance. The re-treatment rate in those patients was 11% (6). The stones in different levels of the ureter show various difficulty grades. The effectiveness of ESWL modality applied to proximal, middle and distal ureteral stones was recorded as 77.4% (between 63-100%), 80.3% (between 60-98%) and 77.9% (between 59-100%) respectively ( 6-14).

In our study, 29 of 43 patients (67.4%) having distal ureteral stones and 37 of 53 (69.8%) having proximal ureteral stones were cleared off completely. As the pelvicalyceal ectasia grade increases, we observed that the stone clearance rate decreases.

Ahmet et al. (16) have investigated relationships between grade of hydronephrosis secondary to stone obstruction and stone-free ratio of ESWL and reported no correlation between these two variables. But they have reported that the necessity of recurrent interventions was more frequent and treatment duration was longer in patients with stone-related obstruction.

We observed in our study that URS modality is more effective than ESWL modality for ureteral stones. This effectiveness is valid both for lower and upper ureter stones. In our study approximately 1/3 of the patients who were treated by ESWL required a secondary treatment modality for stone disintegration. However, in almost all of successfully treated patients with URS complete stone clearance was achieved at the first time. One limitation of this study is that the proportion of upper ureteral stones is not equal in our URS and ESWL groups. Therefore, the higher rate of upper ureteral stones of ESWL group (33.3% against 55.2%) can be a contributor factor for the ineffectiveness observed in ESWL group.

In conclusion, in comparison with ESWL, URS method can be preferred due to its high effectiveness and lower complication rate in ureteral stones. However more prospective studies with higher number of patients will help to reach more clear conclusions.

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