



## Ureteroscopic lithotripsy compared with extracorporeal shockwave lithotripsy in the treatment of urolithiasis

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### ABSTRACT

**Introduction:** Urolithiasis is a common and frequently occurring disease with high recurrence rate. Ureteroscopic lithotripsy (URSL) and extracorporeal shock wave lithotripsy (ESWL) are two most popular modalities in the treatment of urolithiasis. The efficacy of these two methods is reviewed on the treatment of ureteral stones in this systematic review.

**Method:** PubMed was searched for the relevant randomized control trials (RCTs). Stone-free rate and retreatment rate were extracted from each article as the main outcomes, and Odds ratio was reported in each study.

**Result:** Based on calculated odds ratio of each article, URSL has an odds ratio of <1 for the event of stone-free rate, and odds ratio of >1 for the event of retreatment rate compared with ESWL.

**Discussion:** Performing URSL in the treatment of urolithiasis could be associated with higher stone-free rate and lower retreatment rate; however duration of the surgery seems to be longer during URSL compared with ESWL.

**Conclusions:** There was high discrepancy between included RCTs regarding the study design, stone location, types of ureteroscope, intracorporeal lithotripsy devices, time to follow-up, and surgeon experience, which might affect the decision regarding type of surgery.

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### Introduction

Urolithiasis (ureteral calculi) is a common urological complication and public health problem that frequently leads to renal colic and eventually obstructive uropathy. Urolithiasis has a prevalence of 13% in men and 7% in women which is dependent on geographical area, age, and sex; its peak incidence is estimated to be at the third to fourth decades of life (1).

Socioeconomic status, environmental factors, genetic predisposition, and certain metabolic disorders are the possible risk factors of

this renal condition.

Its occurrence rate is increasing in children which is associated with high morbidity rate and serious consequences to patient's quality of life that might be due to the relapse of the disease (2).

Colic pain due to stone movement and irritation of submucosal nerve fibers, dark or bloody urine, painful urination, nausea, vomiting, and fever are the most common signs of urolithiasis.

Stones usually form in renal collecting system and store in ureteropelvic junction, over the iliac

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vessels, and at the ureteric meatus. Various treating strategies are used for ureteric stones based on stone size, symptom severity, degree of obstruction, kidney function, stone location, and urinary tract infection status including observational to surgical methods.

Almost, 98% of all ureteral calculi <5 mm are supposed to pass spontaneously. Extracorporeal shockwave lithotripsy (ESWL) and ureteroscopic lithotripsy (URSL) are the two most popular therapeutic modalities that are used when there is no advantages through conservative or medical expulsive treatments. Both techniques have some specific advantages, disadvantages, and complications (3). Although both surgical strategies have high successful rate in range of 80-100%, the selection between these two mentioned surgical strategies is a controversial issue.

ESWL is a non-invasive method which is more accepted, does not need general anesthesia, and it can be performed in out-patients facilities. During the ESWL, high-energy sound waves (shock-waves) are passed through body via outside sources to break the stones that they can easily move through urinary tract and outside the body. In this strategy, no instrument will be needed to be placed through the skin.

Ureteroscope will be placed into the affected ureter through the urethra and bladder. In this technique, stones will be broken into smaller pieces using laser fiber or lithoclast probe; thus, small stones can pass out spontaneously. Therefore, it is important to reveal that which modality has benefits over another technique in the management of ureteric stones. In this regard, we decided to review the existed publications assessing the efficacy of each method in the treatment of urolithiasis to evaluate the advantages of one method over another.

## Methods

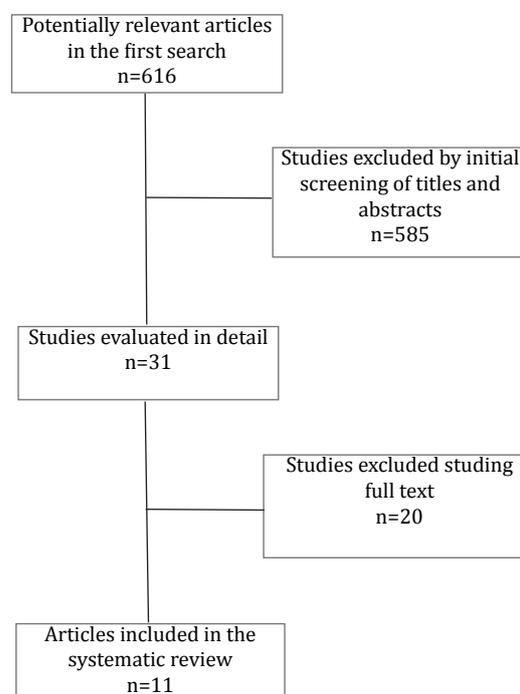
We performed a systematic review to compare the benefits and complications following ESWL and URSL for the treatment of urolithiasis. PubMed was searched to obtain all the English language articles relevant to the scope of this review. Search strategy consisted of the following terms: ureteroscopy AND extracorporeal shockwave lithotripsy AND ureteral calculi AND ureteral stones. Reference list of the excluded studies were also searched for any additional article. Inclusion criteria were any randomized control trial which studied the treatment of ESWL or URSL in adult patients with ureteral disease confirmed by imaging. Results of the stone-free rate and retreatment rate were extracted from each article and both have been proposed as the odds ratio

of ESWL compared with URSL. Odds ratio higher than 1 means that the URSL group has lower possibility to experience the event (stone-free rate and retreatment rate). Odds ratio lower than 1 means that URSL group is more likely to experience the event.

## Results

Based on the mentioned search strategy, a total of 616 articles were extracted primarily. Reviews, case reports, retrospective and prospective studies with no randomization were excluded after studying the title, abstract, and eventually the full text of the retrieved articles. All the included RCTs were published in English from 1999 to 2015.

**Figure 1.** Flow chart of the included articles is presented below



Finally, we obtained 11 articles as the most relevant publications. Baseline characteristics and outcomes of these studies are summarized in Table 1. Overall, 1663 patients were considered in this systematic review which were under the ESWL treatment or URSL. The sample size was 30 as the minimum and 390 as the maximum in the included studies. The majority of enrolled patients were male.

Total of five included RCTs were about small proximal ureteric calculi, and other six articles were about distal ureteric stones. Patients were almost at similar ages within studies. Most of the studies performed ESWL by applying intravenous sedation, and only one study performed by Peschel, in 1999, used general anesthesia for conducting this modality (9).

**Table 1.** Quality assessment of the included study

Author Year Reference	Groups: <sup>1</sup> N: age: male %: Stone size: Assessment endpoint	Lithotripsy	stone location	Stone free, N(%) Retreatment rate, N(%) Operation time, N(%)	Odds ratio (ESWL to URSL)	Randomization/blinding/
<b>Kumar 2015 (4)</b>	ESWL(Gr1): 37; 37.3±2.2; 54.1%; 15.2 ± 1.3; 3months URSL(Gr2): 41; 36.3±2.3; 51.2%; 15.3±1.2; 3months	<sup>2</sup> Gr1: Dornier Compact Delta <sup>3</sup> Gr2: Holmium laser	Proximal	<sup>4</sup> SFR: Gr1: 29 (78.4)-Gr2: 35 (85.4) <sup>5</sup> RR: Gr1: 29 (78.4)-Gr2: 7 (17) OT: Gr1: 49.2 ± 1.7-Gr2: 39.1 ± 1.5	SFR: 0.621 RR: 17.607	Computer generated randomization table
<b>Manzoor 2013 (5)</b>	ESWL(Gr1): 199; 44.32±10.07; 72.6%; 13.4±2.7; 10.84 ± 4.25; 1 week URSL(Gr2): 199; 45.41 ± 13.21; -; 11.32± 3.74; 1 week	Gr1: Holmium:YAG laser Gr2: Electromagnetic generator	Proximal	SFR: Gr1: 98 (49.2)-Gr2:115(57.8) RR: Gr1:80(40)-Gr2:22(11) OT: -	SFR: 0.709 RR: 5.409	
<b>Lopes 2012 (6)</b>	ESWL(Gr1): 14; 46.0±13.5; 50%; 13.8±2.5; 1 month URSL(Gr2): 16; 49.6±15.5; 62%; 14.4±4.1; 1 month	Gr1: Dornier Compact Delta S Gr2: Pneumatic lithoclast	Proximal	SFR: Gr1:5(35.7%)-Gr2: 10(62.5) RR: Gr1:12(85.7)-Gr2:2(12.5) OT: Gr1: 44.5 ± 10.3-Gr2: 72.8 ± 42.0	SFR: 0.556 RR: 42.000	
<b>Salem 2009 (7)</b>	ESWL(Gr1): 42; 35.4; 64.3%; 12.5; 2 weeks URSL(Gr2): 48; 36.7; 62.5%; 12.2; 2 weeks	Gr1: Dornier HM3 Medical System Gr2: Pneumatic lithoclast	Proximal	SFR: Gr1:25(60)-Gr2:44(88) RR: Gr1:12(28.6)-Gr2:4(8.3) OT: Gr1:65.7-Gr2:38.1	SFR: 0.134 RR: 4.400	A flawed randomization methodology/ <sup>6</sup> NA
<b>Lee 2006 (8)</b>	ESWL(Gr1): 22; 54.2±16.7; 86.4%; 17.9± 3.9; - URSL(Gr2): 20; 48.5 ± 13.3; 80%; 18.5± 2.9; -	Gr1: Siemen AG Lithostar 2 Lithotripter Gr2: Lithoclast, electrohydraulic, or ultrasound lithotripter	Proximal	SFR: Gr1:14(63.6)-Gr2:7(3.5) RR: Gr1:7(31.8)-Gr2:0 OT: Gr1:43.2 ± 5 - Gr2:109.0 ± 50.0	SFR: 0.867 RR: 19.839	Drawing lots/NA
<b>Peschel 1999 (9)</b>	ESWL(Gr1): 40; -; < 5 mm (20) and > 5 mm (20); 6 weeks URSL(Gr2): 40; -; < 5 mm (20) and > 5 mm (20); 6 weeks	Gr1: Dornier MFL 5000 lithotripter with general or epidural anesthesia. Gr2: Lithoclast; 6.5 or 9.5 F semirigid ureteroscope	Distal	SFR: Gr1: 36 - Gr2:40 RR: Gr1:0 - Gr2:0 OT: -	SFR: 0.1	NA/NA
<b>Pearle 2001 (10)</b>	ESWL(Gr1): 32; 41.2±14.9; 26%; 7.4± 2.3; 3 months URSL(Gr2): 32; 41.2±12.8; 25%; 6.4±2.7; 3 months	Gr1: HM3 lithotripter Gr2: 6.9F semirigid ureteroscope	Distal	SFR: Gr1: 29 - Gr2:29 RR: Gr1: 0- Gr2:0 OT: Gr1: 71.8±22.4 - Gr2: 96.6±43.2	SFR:1	Batching in sets of 10 according to a random number table/NA
<b>Zeng 2002 (11)</b>	ESWL(Gr1): 210; 51; 125(N); 0.5-2.1; 4 weeks URSL(Gr2): 180; 40; 110(N); 0.6-2.0; 4 weeks	Gr1: HB-ESWL-V lithotripter Gr2: Wolf 7.5~9.0 <sup>7</sup> Fr ureteroscopy	Distal	SFR: Gr1: 164 - Gr2: 168 RR: Gr1: 25 - Gr2: 4 OT:-	SFR: 0.254 RR: 5.95	NA/NA
<b>Verze 2010 (12)</b>	ESWL(Gr1): 137; 50.5; 70%; 1.0; 3 months URSL(Gr2): 136; 49.4; 68%; 1.0; 3 months	Gr1: Modulith SLX-MX electromagnetic Lithotripter Gr2: Storz semi-rigid ureteroscope	Distal	SFR: Gr1: 127 - Gr2: 129 RR: Gr1: 57- Gr2: 10 OT: Gr1: 33.94 - Gr2: 33.75 (mean; <sup>8</sup> min)	SFR: 0.69 RR: 8.97	NA/NA
<b>Islam 2012 (13)</b>	ESWL(Gr1): 68; 35.4±9.2; 50%; 12.82±3.5 (mm); 3 months URSL(Gr2): 68; 35.3±9.5; 46%;12.8±3.7(mm); 3 months	Gr1: Modulith SLX-F2 Gr2: semi rigid 8 <sup>7</sup> Fr. all patients received oral or parenteral analgesia Korl Storz Ureteroscope	Distal	SFR: Gr1: 50 - Gr2: 64 RR: Gr1: 5 - Gr2: 13 OT:-	SFR:0.173 RR:0.33	Lottery method/NA
<b>Khalil 2013 (14)</b>	ESWL(Gr1): 37; 37.1±8.8; 31 (83.8%) ; 13.2±2.9 (mm); 3 months URSL(Gr2): 45; 35.2±10.4; 37 (82.2%); 13.4±2.7(mm); 3 months	Gr1: SIEMENS Lithostar Multiline). Gr2: 8.6/9.8F semi-rigid ureteroscope	Distal	SFR: Gr1: 29 - Gr2:37 RR: Gr1: 16 - Gr2:1 OT:-	SFR:0.78 RR:33.5	NA/NA

<sup>1</sup>N: number; <sup>2</sup>Gr1: group one; <sup>3</sup>Gr2: group 2; <sup>4</sup>SFR: stone free rate; <sup>5</sup>RR: retreatment rate; <sup>6</sup>NA: not applicable; <sup>7</sup>Min: minutes; <sup>8</sup>Fr: French

### Stone-free rate

Among studies performed on proximal and distal ureteric stones, calculated odds ratio showed that the event of stone-free rate was possibility higher in patients under URSL compared with those under ESWL.

### Retreatment rate

The calculated odds ratio of event of retreatment rate showed that ESWL method in patients with proximal ureteric stones was likely associated with higher retreatment rate while compared with URSL method.

### Operation time

This outcome was almost longer in groups of patients with proximal or distal ureteral stones under the method of URSL compared with ESWL.

## Discussion

ESWL and URSL are the most prevalent therapeutic methods in the treatment of ureteric stones. The advantages of one modality over another in the treatment of proximal and distal ureteric stones are still under debate. Thus, this systematic review aimed to evaluate the efficacy of each method on stone-free rate, retreatment rate, and operation time through previous RCTs.

Obtained odds ratio for patients with proximal and distal ureteral stones were lower than 1 regarding the stone-free rate in each study, which indicate that URSL is favored over ESWL regarding this event. However, odds ratio higher than 1 for the retreatment rate shows higher possibility of retreatment rate during ESWL modality which eventually proposes URSL as a favorable method for reducing the incidence of this event. Retreatment is defined as subsequent intervention similar to the initial intervention used for the disease condition. Therefore, URSL was a more invasive modality compared to the method of ESWL; and according to the included studies on patients with proximal and distal ureteric stone disease, URSL method revealed better efficacy on stone-free rate, but lower benefits regarding retreatment rate compared with ESWL. These two methods were also compared regarding the operation time which revealed longer operation time with URSL compared with ESWL which was due to its higher invasiveness. No principal complication was reported following any of these modalities. Although ESWL might be associated with lower stone-free rate and higher retreatment possibility, in some studies, ESWL was proposed as the preferred method due to lower subsequent complications and no general anesthesia requirement (15,16). However in some other studies, surgeon

expertise during the URSL modality was proposed as an influential factor which could reduce the subsequent complications (17,18). In one meta-analysis, URSL modality was also reported to be associated with longer hospital stay and postoperative complications compared with ESWL. Technological improvements of small diameter semi-rigid and flexible ureteroscopes has resulted in increased progression in the treatment of ureteral stones and lower complications. These developments have demonstrated the ureteroscopy with lithoclast as an acceptable and first line therapeutic modality in the treatment of large proximal ureteral stones (19). Stone size is also an important factor which could affect the stone-free rate, thus it is suggested to be estimated before the operation. Plain x-ray of kidney-ureter-bladder (KUB) and computed tomography with coronal reconstruction are proposed as routine strategies for the determination of the ureteric stone size preoperatively (20,21). One study also reported the negative effect of high body mass index (greater than 30 kg/m<sup>2</sup>) on ESWL outcome.

## Conclusion

In the treatment of proximal and distal stones, URSL has been a favorable procedure due to higher stone-free rate and lower retreatment rate compared to the ESWL. However URSL is more invasive and is associated with longer operation time. Moreover, it is concluded that the high heterogeneity of some influential factors in evaluated studies including the study design, stone location, types of ureteroscope, intracorporeal lithotripsy devices, time to follow-up, and surgeon experience might affect the choice of an appropriate operation type.

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## Conflict of Interest

The authors declare no conflict of interest.

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