

# Extracorporeal Shock-Wave Lithotripsy in Renal and Ureteric Calculi: Role in Resource Poor Developing Countries in Modern Era

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## ABSTRACT

**Introduction:** Extracorporeal shock-wave lithotripsy (ESWL) is an established non-invasive treatment modality for renal and ureteric stones. However, treatment outcome and efficacy depends on multiple factors like stone size, location and type of machine used. We aimed to assess efficacy of ESWL as a primary treatment modality in renal and ureteric stones in a busy hospital setting having significant renal stone disease burden.

**Material and methods:** 1187 patients who underwent ESWL between January 2015 to December 2016 in our department were included in the study. Patients with nephrolithiasis and ureterolithiasis having functional kidney, without any absolute contraindication to ESWL were included. Dornier Med Tech Compact Delta 2 machines were used for all the patients. Stone localization was done using both fluoroscopic and ultrasound-guided methods by same expert.

**Results:** Out of 1187 patients, 887 patients had solitary renal stones, 170 had solitary ureteral calculus and 130 patients had multiple renal calculi. Stone size ranged from 8mm–20mm. Renal pelvic stones, upper calyceal stones and proximal ureteric stones had stone free rate of 84%, 86% and 82.5% respectively. 89% and 84% of patients were stone free when size of stone was between 8-12mm, it decreased to 77% and 73% when size increased between 13-16mm for kidney and ureteric stones respectively.

**Conclusions:** ESWL is an effective primary treatment modality for appropriately selected patients with stone size less than 2 cm in favorable location with a normal functioning kidney. Use of both fluoroscopic and ultrasound imaging improves localization of stones thus improving success. It is an important modality in hands of urologist treating huge volume of urolithiasis patients in busy hospitals with long waiting list and with limited resources.

**Keywords:** Extracorporeal Shock-Wave Lithotripsy, Renal and Ureteric Calculi, Resource Poor Developing Countries

worldwide using shock wave lithotripsy.<sup>2,3</sup> In developing countries with huge population and poor infrastructure, the government run hospitals have limited resources relative to the patient inflow. Advance machines like lasers and flexible scopes are unavailable in many centers. Thus patients with urolithiasis are left with limited options of open renal surgery or morbid procedures. However due to long waiting list, it is very difficult to operate each and every patient within a specific time frame. In addition small stones in calyceal systems may not qualify for invasive procedures. ESWL is a suitable treatment option in these cases.

ESWL is based on a technique where a source external to the patient's body generates a shock wave, which help in breaking stones. ESWL remains good treatment option in urolithiasis including ureteric stones.<sup>4</sup> Use of ESWL machines with dual localization of stones using USG and fluoroscopy has improved results of the procedure. However treatment outcome and efficacy depends on multiple factors like stone size, location and type of machine used.

With the advent of endo-urological procedures for stone disease, role of ESWL has declined in recent years.<sup>5</sup> We aimed to assess efficacy of ESWL as a primary treatment modality in renal and ureteric stones in a busy hospital setting having significant renal stone disease burden. We wanted to evaluate the importance of this procedure in the hands of urologist in resource poor region like ours where significant patients with stone disease are waiting for surgical procedures.

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## MATERIAL AND METHODS

After approval from institutional ethical committee, total of 1187 patients visiting our out-patient department were selected for ESWL between January 2015 to December 2016. Patients with nephrolithiasis and ureterolithiasis having functional kidney, without any absolute contraindication to ESWL were included in the study. Dornier Med Tech Compact Delta 2 machine was used for all the patients. Stone localization was done using both fluoroscopic and ultrasound-guided methods by same expert. Patients with stones greater than 15 mm or stones in solitary kidney were pre DJ stented. The body mass index (BMI) was calculated in kg/m<sup>2</sup>. Stone details were assessed with plain X-ray KUB and/or intravenous urography (IVU)/CT urography series. For inferior pole calculus, infundibular length (IL), infundibular width (IW) and infundibulopelvic angle (IPA), was measured using CT urogram with 3-D reconstruction.

All patients with renal stone less than 20 mm and ureteric stone less than 16 mm were included in the study. For inferior calyx stones, CT urogram suggestive of favorable anatomy were selected. All available treatment options were explained to the patients and only those patients giving consent for the procedure were included in the study.

Patients with uncorrected blood clotting disorders or on anticoagulation medications, renal artery stenosis, acute urinary tract infection (UTI) or urosepsis, uncorrected obstruction distal to the stone, abdominal aortic aneurysm, previous surgery for stone disease, coronary artery disease or history of arrhythmias, BMI>30 and pregnant females were excluded from the study. The procedure was started at low level energy of 18 kV which is subsequently increased by 1 kV with every 400 shock waves. Maximum energy level used was 22 kV. Frequency was set at 60 shocks per min with maximum 3000 shocks per session given to a patient. It was not changed in any of the patients. ECG and patient vitals were continuously monitored. Also the progress of stone fragmentation was monitored by fluoroscopy or ultrasonography. After completion of the procedure, patients were encouraged to take more fluids and to maintain an active ambulatory status to facilitate stone passage. Urine alkalinizers,  $\alpha$ -blockers and low dose steroids were given for 2 weeks post procedure. Repeat X-ray KUB was done at 3 weeks and 3 months. No residual stone at 3 months was considered as stone free at 3 months and was regarded as successful treatment outcome. Residual stone fragments greater than 4 mm were considered as treatment failure at 3 months.

## RESULTS

Out of 1187 patients, 654 (55.1%) were males and rest 533 patients (44.9%) were females. 602 patients (50.7%) had right side calculus, 500 patients (42.1%) had left side and 85 patients (7.2%) had bilateral calculi. 887 patients (74.7%) had solitary renal calculus, 170 patients (14.3%) had solitary ureteric calculus and 130 (10.9%) had multiple calculi (table-1,2). Stone size ranged from 8mm to 20 mm and mean shock waves applied per session of ESWL was

Stone Location	Number	% age	Stone Free Rate
Upper Calyx	101	8.5	87 (86.1%)
Mid Calyx	91	7.6	78 (85.7%)
Lower Calyx	111	9.3	66 (59.4%)
Renal Pelvis	584	49.2	491 (84.1%)
Proximal Ureter	149	12.5	123 (82.5%)
Mid Ureter	17	1.4	7 (41.1%)
Distal Ureter	4	0.3	1 (25%)
Multiple	130	10.9	77 (59.2%)

**Table-1:** Stone free rate in relation to position of calculus.

Age (years)	Number of patients	Percentage (%)
<20	106	8.9
20-39	424	35.7
40-59	399	33.6
>60	258	21.7
Total	1187	100

**Table-2:** Age distribution of the study population.

Stone Size	Stone Free Rate as per size in Kidneys	Stone Free Rate as per size in Ureters
5-10mm	89%	84%
10-20mm	77%	73%
>20mm	40%	

**Table-3:** Stone free rate as per size of calculus in kidneys and ureters.

Stone location	Number	Stone free at 3 months	%age
Renal stone	887	722	81.39%
Ureteral stone	170	131	77.1%
Multiple stones	130	77	59.2%

**Table-4:** Over all stone free rates

Number of sessions	Stone free rates (%)
One	51.1%
Two	25.9%
Three	14.7%
More than three	9.3%

**Table-5:** Number of sessions in Renal stones:

Number of sessions	Stone free rates (%)
One	49.1%
Two	26%
Three	13.7%
More than three	11.4%

**Table-6:** Number of sessions in Ureteral stones:

2658+\_276. For small renal stones between 8 to 12 mm, success rate was 89% while larger renal stones between 13 to 16 mm, the success rate was 77% (table-3). For ureteric stones between 8 to 12 mm success rate was 84% while it dropped to 73% for stone size between 13 to 16 mm. As far as stone free rate is considered in relation to position of calculus, renal pelvic stones, mid calycial stones and

Mild	
Dysuria	13.1%
Flank pain	44.6%
Suprapubic discomfort	13.3%
Moderate	
Gross hematuria	6.7%
Uti	2.1%
Ureteric obstruction/steinstrasse	2.6%
Severe	
Hospital admission	1.8%
Sepsis	<1%
<b>Table-7: Complications</b>	

proximal ureteric stones had stone free rate of 84%, 80% and 82% respectively. Over all stone free rate for solitary renal and ureteric stones were 81% and 77% respectively (table-4). Multiple stones had success rate of 76%. 77% of patients were stone free at  $\leq 2$  sessions of ESWL (table-5,6). Majority of patients had mild complications like dysuria and loin pain requiring intravenous analgesics. Gross hematuria, urinary tract infections, ureteric obstruction/steinstrasse was present in 6.7%, 2.1% and 2.6% of patients respectively. Sepsis/pyonephrosis was seen in less than 1% of the patients (table-7).

## DISCUSSION

ESWL is an established treatment modality for urolithiasis. It is a non invasive method of breaking stones with acceptable morbidity and less complications.<sup>6,7</sup> There is a declining trend of ESWL in recent years.<sup>5</sup> However, in a hospital where there is significant stone burden disease and lack of facilities like laser and flexible scopes, all urolithiasis patients cannot be subjected to PCNL or open surgical procedures. PCNL being an invasive procedure has significant morbidity (15%) and mortality (3%).<sup>8</sup>

Success of ESWL depends on many factors like stone size, location and type of machine used.<sup>9</sup> Greater the stone size lesser is the fragmentation and stone free rate (10,11). Body mass index and skin to stone distance have been evaluated as independent factors for outcome of ESWL in stone diseases. BMI greater than 30 kg/m<sup>2</sup> has been generally considered as cut off for ESWL.<sup>12</sup> Measurement of Hounsfield Unit (HU) Attenuation Values has an impact on stone clearance. Hard stones with HU greater than 1000 are generally hard to break.<sup>12</sup> However being from a developing country and most of our patients being from low socioeconomic status, NCCT and HU cannot be calculated in every case. In our setup, we compare radiolucency of tip of transverse process of spine and radiolucency of stone for predicting its hardness. Keeping all these parameters in mind, successful rate of ESWL is around 80%.

Stone location has a bearing on successful treatment outcome. Upper ureteric stones have better outcome as compared to lower or mid ureteric stones.<sup>13</sup> In our study, we found that renal pelvic, upper calyx and upper ureteric stones had an excellent stone free rate as compared to inferior calyx and mid and lower ureteric stones.

Use of newer and latest lithotripsy machine has an impact on stone free rate and success of treatment. Gerber et al concluded that newer lithotripsy machines disintegrate stones in a better way with less complications.<sup>14</sup> In our study, we have used Dornier delta 2 machine having dual localization techniques, thus justifying our good stone free rates. In a country where most of our patients are from lower middle class or are below poverty line, cost of treatment has a bearing on treatment compliance. ESWL being a day care procedure, and less costly than other invasive procedures like PCNL has become one of the primary treatment modality in our setup. However, all the patients could not be subjected to CT urogram which forms an important limitation of our study. None of our patients were subjected to ESWL without functional study/IVU. Frequency of shock waves was set at 60 shocks per min which was not changed in any of the patients. This forms a limitation of our study as we could not evaluate the effect of change of frequency on the fragmentation rates as reported in some studies.<sup>15</sup>

## CONCLUSION

ESWL is an effective primary treatment modality for appropriately selected patients with stone size less than 2 cm in favorable location with a normal functioning kidney. It is an important modality in hands of urologist treating huge volume of urolithiasis patients in busy hospitals. Use of both fluoroscopic and ultrasound guided imaging improves localization of stones thus improving success rate.

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