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Success Factors of Extracorporeal Shock Wave Lithotripsy (ESWL) for Renal & Ureteric Calculi in Adult

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Abstract

The purpose of this study was to define factors that have a significant impact on the stone-free rate after ESWL. Methods: A total of 417 patients harboring renal or ureteral stones underwent extracorporeal shock wave lithotripsy (ESWL) between October 2008 and July 2012. Eighty five patients were lost on follow up. The remaining (*n* = 332). All patients were >18 yr of age. Siemens and SLX-F2 electromagnetic machines were used to impart shock waves. Patients were stratified according to localization (pelvic, calyceal, or ureteral stones) and stone size (up to 10 mm, 10 - 20 mm, and >20 mm). Result: The overall success rate was 251/332 (75.6%) achieve stone free status. Repeated ESWL sessions were needed in 258 (61.9%). Of eleven variables were studied including age, sex, side, location (pelvic, calyx, ureter), ureteric stent, previous renal surgery, stone size, number of shock waves, opacity of stone, renal system state, and type of lithotripter, three variables were significantly affect the success rate namely stone size, number of shock waves and location of stone. Conclusions: ESWL remains one of the most commonly utilized treatments for patients with upper urinary tract calculi; Stone diameter, location, and number of shock waves, are the most important predictors determining stone clearance after ESWL of renal and ureteric calculi. To optimize treatment outcomes with ESWL the presence of treating urologist is essential to optimize the final result.

Keywords

ESWL; Renal Stone; Ureteric Stone; Success Factors

1. Introduction

Extracorporeal shock wave lithotripsy (ESWL) is considered the first line treatment for the majority of patients

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with renal and ureteric calculi. There is a considerable variability in reported treatment results of SWL with success rates from contemporary series varying from 60% to 90% [1]-[4].

Many factors are thought to influence the final results of ESWL, including patient selection, stone size, stone location and lithotripter type, in addition to experience level of the operator, total shock number, energy delivered, shock frequency and method of shock delivery [5] [6].

Success rates with modern lithotripters are less than those reported historically. Therefore, a fundamental question remains unresolved: how can we maximize the likelihood of treatment success when performing ESWL [5]?

We conducted analysis to determine the most significant factors that influence on the success of ESWL of renal and ureteric calculi.

2. Patients and Methods

From October 2008-July 2012, a total of 417 patients age harboring renal or ureteral stones, all patients >18 yr. underwent extracorporeal shock wave lithotripsy (ESWL). Eighty-five patients were excluded lost on follow up. Remaining (n = 332).

This study included 233 males (70.1%) and 99 females (29.9%). Patients with a mean (SD, range) age of 42.8 yr ($\pm$12.85).

2.1. Stones

Stones (n = 332) were stratified according to localization (pelvic, calyceal, or ureteral stones) and stone size (upto 10 mm, 10 - 20 mm, >20 mm). The localization of ureter and calyceal stones was not further specified. Stone size was determined by measuring the longest diameter on KUB for opaque stone, while lucent stone diameter measured by ultrasound scanning or CT scan.

Pre-procedural evaluation included urinalysis and serum creatinine. Plain abdominal film was taken routinely to evaluate radio-opacity and stone size [7].

2.2. Technique of ESWL

All treatments were done using electromagnetic lithotripter, Siemens (n = 200) and Storz SLX-F2 (n = 132). Treatment session consist of 3000 shock waves, all procedures were performed under analgesia. Briefly, tramadol 1 - 2 mg/kg and diclofenac 75 mg IM.

Post ESWL patient were asked to pass urine into container, we found that stone either pass into small pieces or sand like particularly in lucent stone **Figure 1**.

Figure 1. Types of gravels post ESWL 1st picture reveals macroscopic gravels, 2nd stone fragmented into sand like material.

3. Follow Up

The patients were followed up with plain radiography and ultrasound to assess the stone-free status. Treatment was classified as stone free, presence of residual fragments >5 mm (RF), and non-broken stone. Complications, ESWL re-treatments, and adjuvant procedures were documented.

3.1. Statistic

The statistical analysis in this study was performed using the Statistical Package for Social Sciences (SPSS), version 16 computer program.

In all tests, a *p*-value of ≥0.05 was considered as statistically not significant, a value <0.05 was considered a statistically significant, and a level <0.001 was considered as statistically highly significant.

3.2. Results

A total of 332 patients 233 were males (70.1%). patients with a mean (SD, range) age of 42.8 yr. Cases were categorized into stone free $n = 251$ (75%), presence of residual fragment $n = 45$ and 36 (10.8%) cases stones were not broken.

The overall success rates for renal and ureteral stones were $n = 251/48$ 75% and 77.4% respectively.

45 (13.5%) were have residual fragments. Failure to break the stones after three sessions was recorded in 36 cases (10.8%).

Pelvic stone130 (39%), calyceal stones 140 (42%) and 62 ureteric stones. 266 (80.1%) were opaque, while 66 (19.9%) were lucent stone. Ureteric stent were used in 32 (7.7%) patients. 150 stone were on right side, 169 on left side and 13 were bilateral. The rates of stone clearance were 81.4% and 73% for 10 mm or less and 10 - 20 mm respectively.

Multiple ESWL treatment sessions were required in 232/332 cases (69%). Complete stone fragmentation were achieved after one session in 86/332 (25.9%) case, two sessions in 93 (28%), three sessions in 47 (14.1%), and more than three sessions in 25 (7.5%). While 45 (13.5%) ended with residual fragments.

Post-ESWL complications are listed in **Table 1**. Steinstrasse were recorded in 35 cases (10.5%) and passed spontaneously in (71%). 5 cases were treated with ESWL on leading fragment, two treated with meatotomy and 2 treated with ureteroscopy and stone extraction; one case ended with ureterolithotomy.

Five cases of 10 mm renal stone were migrated as a whole to upper ureter after one session of ESWL **Figure 2**. Three cases treated by ESWL on ureter and two cases managed by push bang and JJ stent insertion.

The stone-free rate was correlated with patient characteristics, stone features and type of lithotripter using the Chi-square test (**Table 2**). Of the 11 prognostic factors studied, 3 had a significant impact on success rate, namely the size of the stones, stone localization, and number of shock waves.

4. Discussions

Extracorporeal shock wave lithotripsy (ESWL) has been a major tool in the treatment of urinary stones for nearly three decades. In recent years, ESWL technology has been less effective at fragmenting stones than earlier devices [3] [5] [6].

The major draw-back of ESWL may be the need of repeated treatment sessions in a significant number of patients [3] [6].

The outcome of treatment after ESWL is variable due to the close relation between the final result with the stone burden, the existence of various types of lithotripters, different concepts of success and the way patients

Table 1. Post-ESWL complications.

Complications	No.	(%)
Pyelonephritis	6	1.8
Steinstrasse	35	10.5
Renal stone migrated to ureter	5	1.5
After ESWL		

Table 2. Post-ESWL complications.

	Parameter Stone Free	%	Residual Fragments	%	p Value
Age (yr)					>0.05
<40	126	42.5	15	5	
>40	125	42	30	10	
Sex					0.252
Males	183	61.8	27	9	
Females	68	22.9	18	6	
Stone Size Mm					0.000
Up to 10	114	38.5	6	2	
10 - 20	124	41.8	31	10.4	
>20 mm	13	4.3	7	2.7	
Stone Side					0.381
Right	114	38.5	20	6.7	
Left	126	42.5	23	7.7	
Bi	11	3.7	2	0.6	
Localization					
Pelvic	103	34	19	6.4	0.005
Calyx	100	33	25	8.4	
Ureter	48	16	1	0.3	
Stone Radiology					
Opaque	199	67.2	36	12.1	0.82
Non Opaque	52	17.5	9	3	
JJ stent					
NO	230	77.7	42	14	0.006
Yes	21	7	3	2	
Renal Surgery for Stone					0.406
No	226	76	37	12	
Yes	25	8	8	2.7	
No. of Shock Waves					0.0
3000	86	8			
3000 - 6000	93	13			
6000 - 9000	47	11			
>9000	13				
Renal System State					0.554
Perfect	158	53.3	30	10	
Hydronephrotic	93	31.4	15	5	
Lithotripter					
Siemens	153	51.6	31	10.4	0.3
Storz SLX F-2	98	33%	14	4.7	

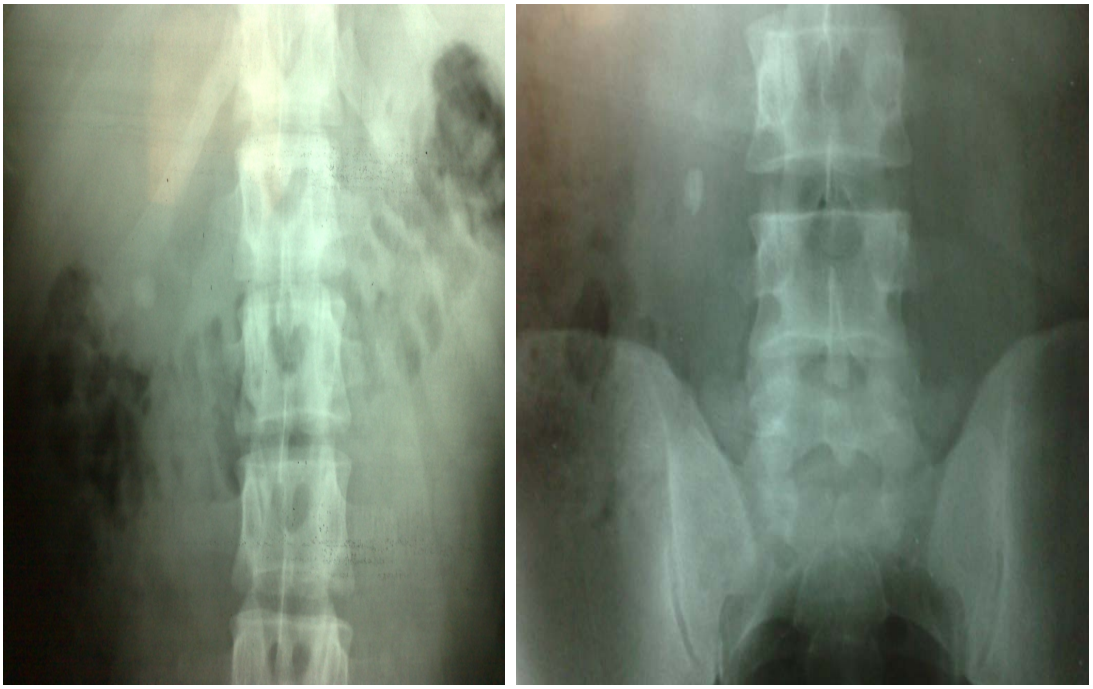

Figure 2. 1st KUB film renal stone 2nd film stone migrated to upper ureter after ESWL.

are evaluated after treatment. Because of these factors, stone-free rates following SWL vary from 14% to 91% [1] [5] [6].

We have observed that ESWL relieves renal pain in many patients, this might be a reason that we have large number 85 individual in whom received a session of ESWL and lost on follow up. How SWL relieve pain? Reasons are not fully understood, but might be the new blood vessels ("neovascularization") that are created by ESWL relieve pain [8].

Many factors are thought to influence the final results of SWL, including patient selection, stone size, stone location and composition, lithotripter type, experience level of the operator, total shock number, energy delivered, shock frequency and method of shock delivery [9]-[13].

In our study, the overall success of renal stone was 75% while 69% needed repeated sessions of ESWL. In our study, the stone free rate were 81% and 56.5% for stone less than 10 mm and larger than 20 mm respectively. Many investigators found that stone size play a key role in predicting the success of ESWL [1] [6] [11].

In general, as stone burden increases, the treatment success rate of ESWL will decline. When stone burden is less than 2 cm, success rates are reported to be approximately 70% or greater [14].

Age and sex have no effect on ESWL success rate also in other studies these factors found play no effect [6].

We found pelvic stone has higher stone free rate 79% with p value 0.005, this factor also found by many investigators that increase the probability of success of ESWL [6] [15].

In this study we found that the number of shock wave greatly influence the success of ESWL Multiple ESWL treatment sessions were required in 232 patients (69%). 251 patients were stone completely fragmented. 86 (35.2%) fragmented after one session, two sessions in 93 (37%), three sessions in 47 (18.7%), and more than three sessions in 25 (9.9%). With p value 0.000 was highly significant.

In our study, 232 (69%) required retreatment in comparison to other studies Assamy mention that (56.9%) 338 required retreatment probably might due to Dornier MFL 5000 lithotripter machine that used [6].

We found no effect of previous renal surgery, ureteric stent and renal system state (hydronephrosis) on stone free rate.

Other study state that hydronephrotic kidney achieve lower success rate due to weak peristalses that lead to poor clearance of the fragments [6].

Many investigators believe that pre-ESWL JJ stenting of large renal stones helps to prevent Obstruction and facilitates passage of fragments [5]. On the other hand, many investigators showed that in situureteric stents im-

pair ureteric peristalsis and/or trap large fragments, thus delaying stone clearance [15]-[19]. In our study, we found that pre-ESWL JJ stents did not significantly affect the incidence of neither complications nor stone clearance

In this study, the incidence of stenistrasse (SS) was 10.5% which is comparable to the other series. Steinstrasse is an uncommon event after ESWL and seems to occur more frequently with larger pelvic stones. All patients should be followed after ESWL, but SS should be specially suspected if there is macroscopic gravel elimination, flank pain and/or fever [16].

In this study, 5 patient with 10 mm pelvic stone were migrated to ureter after one session of SWL, that leads to repeated sessions of SWL, two cases need cystoscopy and using double J stent to push the stone back to renal pelvis.

We believe to avoid such misshapen need not to use high energy shock wave in small pelvic stone.

Its best to our knowledge that this misshapen not mention elsewhere.

The importance of factors such as stone size, stone site, and number of shock waves are important in predicting the ESWL success. In addition, modifications in shock wave delivery by altering shock rate and voltage have been researched in an effort to improve shock wave efficacy.

We didn't find statistical difference between the lithotripters Siemens and SLX F2, although the rate of stone free on Siemens was 76.5% while Storz SLX F2 was 74.2%. As shown in **Table 1**, *p* value 0.10.

5. Conclusions

ESWL remains one of the most commonly utilized treatments for patients with upper urinary tract calculi; Stone diameter, location, and number of shock waves, are the most important predictors determining stone clearance after ESWL of renal and ureteric calculi.

To optimize treatment outcomes with ESWL, the presence of treating urologist is essential to optimize the final result.

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