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Research Article

Outcome of Extracorporeal Shockwave Lithotripsy (ESWL) in Cases with Renal Calculi in a Local Community

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Abstract

Background: The goal of renal stone treatment is to achieve maximal stone clearance with minimal morbidity. Extra Corporeal Shock Wave Lithotripsy (ESWL) has revolutionized the treatment of kidney stone disease and majority of cases can be treated satisfactorily with this modality.

Objective: To determine the outcome of Extracorporeal Shock wave Lithotripsy (ESWL) in cases with renal calculi.

Material and methods: This cross-sectional study was done at Department of Urology in collaboration with the Department of Diagnostic Radiology, Lahore General Hospital Lahore for one year. Hundred patients of solitary renal calculus of 0.6 cm to 2 cm in size were included through Non probability/Consecutive sampling technique. All patients were treated with ESWL (Storz Medical Modulith SLX-F2). During each ESWL session maximum of 3000 shock waves were given. CT scan was done to determine the outcome of ESWL, i.e. pain during procedure and clearance of the calculi.

Results: The mean age of patients was 37.7 ± 10.9 years. Of the 100 patients, 54 (54%) were male and 46 (46%) were female. About 44 (44%) had right renal calculus, 51 (51%) had left renal calculus and 5 (5%) had bilateral renal calculus. There were 11(15%) patients had 1 ESWL to 2 ESWL visits, 60 (60%) patients had 3 ESWL to 5 ESWL visits and 29 (29%) patients had 6 ESWL visits. Pain was observed in 8 (8%) cases while complete clearance was observed in 98 (98%) patients.

Conclusion: It was conclude that ESWL is a highly successful modality for removal of renal calculi in adult population. Now we can rely on ESWL for future application to remove the renal calculi.

Keywords: Renal calculi; Extracorporeal shock-wave lithotripsy; Pain; Stone density, Computed tomography; X-ray, Renal ultrasound

Introduction

Urinary tract stone is a problem that has plagued humans since the beginning of recorded history. Men are affected three times as commonly as women and whites four to five times as commonly as blacks. Urolithiasis is a lifelong disease, with an average of 9 years intervening between episodes. The peak incidence is in the third to fifth decades. In a patient who has passed stone once, the likelihood of passing another stone is about 15% by 3 years and 30% by 15 years [1]. Urinary calculi are the third most common affliction of the urinary tract, exceeded only by urinary tract infections and the pathologic conditions of the prostate [2].

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The goal of kidney stone treatment is to achieve maximal stone clearance with minimal morbidity to the patient. Multiple options are currently available, including Extra Corporeal Shock Waves Lithotripsy, Percutaneous Nephrolithotomy, Retrograde Intrarenal Surgery and in rare cases open or laparoscopic stone surgery. Among all these methods that have been developed in the past none has had as much impact as that of endourology and ESWL in the last decade [3].

Extra Corporeal Shock Wave Lithotripsy (ESWL) has revolutionized the treatment of kidney stone disease and majority of "simple" renal calculi (about 80% to 85%) can be treated satisfactorily with this modality. It has eliminated the need for open surgical removal of urinary calculi in vast majority of patients. The outcome of ESWL depends on many factors including stone size, location, composition, fragility, the shockwave generator and the presence of obstruction and/or infection [4].

Many authors have reported that stones fragility on ESWL varies between different stones and within stones of the same composition.

The composition of urinary stones can be predicted on the basis of the differences in their Hounsfield Unit (HU) densities as detected by Non-Contrast Helical Computed Tomography (NCHCT). The mean HU densities of the stones composed of calcium oxalate, struvite and

uric acid are 812 +/- 135, 614 +/- 121 and 413 +/- 143 respectively [5]. Use of NCHCT for determining the attenuation values of urinary calculi before ESWL might help to predict the treatment outcome, and help in planning alternative treatment in patients with a likelihood of a poor outcome from ESWL [6].

Thus, those patients with high- density stones could be managed endoscopically rather than by ESWL, since the stones composed of calcium oxalate monohydrate and cystine typically do not fragment well with ESWL.

Hence, it is vital to know the fragility of a calculus before ESWL, to increase its efficacy and reduce the number of hospital visits and ultimately cost. We do not find any publication in local literature about it till now. It would be pertinent to conduct a study at this juncture, to help us in examining the application of International Studies and Values in our local environment on Pakistani ethnic population.

Material and Methods

It was a cross-sectional study done at Department of Urology, Lahore General Hospital Lahore, in collaboration with the Department of Diagnostic Radiology, Lahore General Hospital Lahore. Hundred patients of solitary renal calculus of 0.6 cm - 2 cm in size were included in this study. Non probability/Consecutive sampling method was used for patient selection. Patients aged >16 years of ether gender, with solitary renal pelvic calculus of 0.6 cm - 2 cm were included in this study. While exclusion Criteria was based on congenital anomalies requiring reconstructive surgery, compromised renal functions (Serum Creatinine >3 mg/dl), calyceal stone, bleeding disorder, pregnancy, uncontrolled hypertension and urinary tract infection.

Data collection

One hundred patients with solitary renal calculus were identified. Clinical assessment was the basis of inclusion from OPD and indoor patients. An informed consent was obtained for using their data in the study. Patient history including the demographic information like name, age, sex, and ethnicity was recorded. Subjects were examined for positive signs and their magnitude like Blood Pressure (BP), Pulse rate, Temperature, Weight, etc., they were investigated for routine tests like Urine complete Examination, Blood Urea, Creatinine, Plain X-Ray (Kidney, Ureters, Bladder).

Shock wave method

Before ESWL, all patients had NCCT, with 5 mm contiguous sections through the renal calculus, using a soft tissue setting of a window width and level of 300 HU and 40 HU, respectively, at 120 kV, 150 mA on CT scanner. The longitudinal calculus dimension was calculated using collimation thickness, the reconstruction interval and the number of images in which the calculus could be visualized. The maximum diameter and the mean density of the stone were calculated by drawing a region of interest over the calculus. Calculus attenuation value was measured in HU on unenhanced CT sections through the calculi. All patients were treated with ESWL (Storz Medical Modulith SLX-F2). A maximum of 6.0 kV was given to each patient, starting at 0.5 kV and increasing gradually stepwise after every 20 shock waves. During each ESWL session maximum of 3000 shock waves were given. The fragmentation of the calculus during the therapy was monitored by fluoroscopy or ultrasonography. A plain film or ultrasound for kidney, ureter and bladder was taken before each ESWL session to document fragmentation, to ascertain position and clearance of the fragments. A maximum of six sessions required to fragment the stone.

CT values in terms of stone fragility was analyzed with outcome of ESWL, the number of shockwaves, number of sessions required for complete fragmentation of the stone and clearance of the calculi. Clearance was documented by a plain abdominal film or USG 12 weeks after the first ESWL session and was defined as excellent if there was complete disappearance of the renal calculus or <5 mm fragment detected on CT scan. All the information was recorded proforma.

Data analysis

The collected information was entered into SPSS version 11 and analyzed accordingly. The quantitative variables like age and stone size were presented as mean and standard deviation. The qualitative variables like sex, occupation, site of pain, character of pain, severity of pain, radiation of pain, urine complete examination, visits of ESWL, stone density, number of shockwaves, pain during ESWL and clearance of stone were presented as frequency and percentages.

Results

The mean age of patients was 37.7 ± 10.9 years. Of the 100 patients, 54 (54%) were male and 46 (46%) were female. Regarding site of pain, 44 (44%) had right renal calculus, 51 (51%) had left renal calculus and 5 (5%) had bilateral renal calculus. There were 63 (63%) patients who had colicky pain, 21 (21%) had dull pain and 16 (16%) had stabbing pain. About 3 (3%) patients had mild pain, majority 91 (91%) had moderate pain and 6 (6%) patients had severe pain. Similarly 35 (35%) patients had no radiation of pain, pain radiating toward groin in 50 (50%) patients and 15 (15%) patients had radiating towards back (Table 1).

Table 1: Demographic and clinical presentation.

N	**100**
Age, years	37.7 ± 10.9
Male : Female	54:46
Site of pain	
Right renal calculus	44%
Left renal calculus	51%
Bilateral renal calculus	5%
Type of pain	
Colicky pain	63%
Dull pain	21%
Stabbing pain	16%
Severity of pain	
Mild	3%
Moderate	91%
Severe	6%
Localization of pain	
No radiation	35%
Reradiating towards groin	50%
Radiating towards back	15%

In cases of urine complete examination, 64 (64%) had microscopic hematuria, 22 (22%) had pus cell in the urine and in 14 (14%) patients no abnormality detected. The stone size ranged between 5 mm - 10 mm on x-ray, ultrasound and CT scan as 19%, 15% and 14% respectively. Whereas stone size between 11 mm - 15mm on x-ray, ultrasound and CT scan was 40%, 38% and 42% respectively. Similarly stone size between 16 mm - 20 mm on x-ray, ultrasound and CT scan was 41%, 47% and 44% respectively. There were 11 (15%) patients had 1 - 2 ESWL visits, 60 (60%) patients had 3 - 5 ESWL visits and 29 (29%) patients had 6 ESWL visits. The stone density of <500 was in 11 (11%) patients, 500 to 1000 was in 60 (60%) patients and >1000 was in 29 (29%) patients.

It was observed during study that out of 100 patients 8 (8%) had pain during ESWL while majority 92 (92%) had no pain. In 98 (98%) patients clearance of stones was excellent and only 2 (2.0%) patients were those who had poor clearance of stones.

Discussion

Urolithiasis is prevalent worldwide and it is considered third commonest urological problem [2]. Prevalence of the lithiasis in western countries is around 3% [7]. According to multiple population studies 5% to 15% of population will have symptomatic stone disease by the age of 70 years [8]. Incidence of urolithiasis is high in areas populated by Asians and whites [9]. Pakistan is included in the so-called "stone-belt" constituted by areas with high incidence of urolithiasis [7].

Urolithiasis is common in middle age persons, age wise peak incidence is in second to fourth decade [9]. Mean age of patient in a study of urolithiasis patients conducted at Sir Ganga Ram Hospital, Lahore was 29 years [10]. In a study from Quetta, the peak incidence was in the age group of 21 years to 40 years [11]. In another study from PGMI/Lahore General Hospital, Lahore, the mean age was 42 years [12]. In this study, the peak incidence was in the age group of 21 years to 40 years, with a mean age of 37.7 ± 10.9 with a range of 16 years to 60 years, so our most patients are in their middle age (Table 2).

Table 2: Radiological findings of stone.

Urine examination			
Microscopic hematuria	64%		
Pus cells	22%		
No abnormality	14%		
Stone size	**X-ray**	**Ultrasound**	**CT scan**
5 mm - 10mm	19%	15%	14%
11 mm - 15 mm	4%	38%	42%
16 mm - 20 mm	41%	47%	44%
ESWL visits			
1-2 visits	11%		
3-5 visits	60%		
6 visits	29%		
Stone density			
<500	11%		
500-1000	60%		
>1000	29%		

According to population surveys male are more frequently affected by urolithiasis [13]. Life time risk of stone formation is 10% to 15% for male and 5% to 10% for female [14]. It has also been noted that at least three males are affected for every female [9]. Contrary to male predominances in adults, there is an equal tendency towards lithiasis in both groups during childhood [9]. Male to female ratio in three local studies were 4:1, 3.8:1 and 3:1 [10-12]. Majority (54%) of our patients were male, ratio being 1.17:1.0 (Table 3).

Table 3: Clinical findings of ESWL.

Pain during ESWL	8%
Stone clearance	98%

Non-contrast helical computed tomography has emerged at the mode of choice in the investigation of acute flank pain. The basic advantages of NCHCT were the imaging methods include high sensitivity and specificity in the detection of ureteral and renal stones, speed, safety, detection of non-urological pathology and cost. Stones such as those composed of cystine and uric acid, are barely visible or are invisible on routine radiographs, belt can be demonstrated clearly with CT scan.

Once urinary stone disease is identified, CT is also useful in providing necessary management of the stone size, location, and now perhaps, it's based on the measurement of its density. It is considerable that the ability to predict stone composition before treatment could enable the urologist to group patients according to density and treat them accordingly. Thus those patients with high density stones could be managed endoscopically rather than by ESWL; since stones composed calcium oxalate monohydrate and cystine typically not fragment well with ESWL [15].

NCCT is noninvasive and provides better density discrimination than conventional radiography; it can be used to detect a density difference of 0.5%, where as plain radiography requires a density difference of = 5% [16]. The same principle was exploited to analyze the composition of urinary calculi. Segal et al. [17] measured the density of urinary calculi and reported values of 50 CT to 170 CT units, roughly equivalent to 100 HU to 240 HU, for three uric acid calculi. In a study Federle et al. [18] the calculus was identified as a high density object (370 HU to 586 HU) and calcium oxalate and cystine calculi had higher attenuation values than uric acid or xanthine calculi. Hillman et al. [19], reported that uric acid calculi would be differentiated clearly from skuvile and calcium oxalate calculi, but in last two were less easily differentiated.

Mostafavi et al. [15], were able to determine the chemical composition of stones and found the attenuations to range from 409 HU for uric acid to 1703 HU for struvite. They reported that single-energy scanning kV was accurate in separating the three most common stone types (uric acid, struvite and calcium oxalate); however, dual-energy scanning necessary to differentiate between struvite and cystine and between calcium oxalate and brushite stone. Nakada et al. [20], evaluated NCHCT in predicting stone composition *in vivo*. They found significant different between the Hounsfield measurement of uric acid and calcium oxalate stones. Motley et al. [21], and Nakada et al. [20], suggested that attenuation/stone size ratio was an important predictor differentiating uric acid and calcium oxalate stones. ESWL has revolutionized the treatment of kidney stone disease and the majority of "simple" renal calculi (about 80% to 85%) can be treated satisfactorily with ESWL. The outcome of ESWL is measured in terms of fragmentation and clearance of the calculus fragments. Fragmentation of a calculus largely depends on its site and composition and the ability to predict stone composition would help to increase the efficiency of ESWL [22,23].

Stone burden remains the primary factor in deciding the appropriate treatment for a patient with kidney calculi and multiple authors have attempted to provide guidelines for the appropriate selection of ESWL based on stone size and stone number [22]. Studies of ESWL treatment of renal calculi, using a variety of lithotripters, have reported a reduction in stone free rates, an increase in the need for ancillary procedures and re-treatments and an increase in the rate of residual fragments when an increasing stone burden (size and number) is treated with ESWL [24-30].

In the present study, when the patients were categorized by calculus density 11 (11%) with calculi of <500 HU needed one or two ESWL sessions and 100% had complete clearance. Conversely, 60 (60%) of the patients with calculus density ranges between 500 HU to 1000 HU required three to five sessions for complete clearance whereas 29 (29%) of the patients having calculus density >1000 HU needed six sessions for complete clearance. The best outcome was

in patients with stone diameter of <1.5 mm (56%) and a density of <1000 HU, 46% needed three or fewer sessions and the clearance rate is 92%. The worst outcome was in patients with stone diameter of >1.5 cm (49%) and a density of >1000 HU (29%), 41% needed five to six ESWL session and the clearance rate is 80%. Analysis indicated that the attenuation value (calculus) and the calculus size. Had a greater impact on outcome.

In developing countries the concept of utilization of stone density is gaining acceptance and more studies from other centers need to be done from such countries to look for the different factors affecting stone clearance after shock wave lithotripsy.

Conclusion

Thus ESWL is a highly successful modality for removal of renal calculi in adult population. However there are higher failure rates in stones having stone density between 500 HU to 1000 HU and above. Further trials in other centers are warranted to determine the effect of calculi size and density on outcome of ESWL.

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