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Frequency of stone clearance after extracorporeal shockwave lithotripsy for renal stones in adult patients with renal insufficiency



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KEYWORDS

Renal stone;
Extracorporeal shockwave lithotripsy;
Serum creatinine;
DJ stent

Abstract

Objective: To determine the rate of stone clearance after extracorporeal shockwave lithotripsy (ESWL) for renal stones in adult patients with renal insufficiency.

Subjects and methods: This is a cross-sectional descriptive study of 117 adult patients who underwent ESWL. The indications for ESWL were determined by the stone size and serum creatinine. All adult patients including males and females (≥ 18 years) with renal stones ≤ 2 cm in size and serum creatinine between 1.5–5.0 mg/dl were included in the study. All patients underwent ureteral double J (DJ) stent placement before ESWL. The initial success of treatment was assessed on the basis of plain radiographic imaging and ultrasonography which was performed 1 month after ESWL. Final stone clearance was evaluated at 3 months after the first ESWL session. Data were analyzed using SPSS version 18.0.

Results: A total of 117 patients underwent ESWL in this study. Out of these, 88 (75.2%) were males and 29 (24.8%) females with a male to female ratio of 3.0:1. The mean age was 38.2 ± 14.1 years. The mean serum creatinine and stone size were 2.4 ± 0.8 mg/dl and 1.4 ± 0.3 cm, respectively.

The overall frequency of stone clearance after ESWL for renal stones was 70.9% (83/117) in patients with renal insufficiency. The rate of stone clearance was 76.4% (42/55) in cases with serum creatinine of 1.5–2 mg/dl, 69% (20/29) in patients with serum creatinine of 2.1–3 mg/dl, 70.4% (19/27) in patients with serum creatinine of 3.1–4 mg/dl and 33.3% (2/6) in those with serum creatinine of 4.1–5 mg/dl ($p = 0.175$).

Conclusion: Our results show that ESWL may be used as the first line of management for renal stones in patients with mild to moderate renal insufficiency.

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Introduction

Renal stone is a common worldwide problem. It is endemic in Pakistan and the reported prevalence at Sindh Institute of Urology and Transplantation (SIUT) in Pakistan is 10–15% and is high because of Pakistan's geographical location, economic and dietary factors, dehydration, exposure to heat and possible genetic factors [1,2]. In developing countries like Pakistan, patients may present with complications like acute or chronic renal failure (8.2%), pyelonephritis, pyonephrosis, perinephric abscess and acutely obstructed kidneys [1,2].

In this part of the world, fear of open surgery is one of the main reasons for delay in seeking treatment, and results in complications of stone disease as described above [2]. This fear has been reduced by the use of extracorporeal shockwave lithotripsy (ESWL) [2]. During the last three decades, ESWL has proven to be an effective, non-invasive treatment modality for most upper urinary tract stones as it can remove over 90% of stones in adults [3,4]. Size of renal stones is one of the most important factors in determining the appropriate treatment modality [1]. Currently, ESWL is the treatment of choice for stones up to 2 cm in size, whereas for stones larger than 2 cm, percutaneous nephrolithotomy (PCNL) is a better treatment option [5].

The effectiveness of ESWL for renal stone clearance depends on adequate urine production whereas renal insufficiency is a predictor of decrease urine production which decreases the stone clearance [6]. Lee et al. reported the frequency of stone clearance of 56.9% in patients with renal insufficiency [6]. A few other studies have also reported that there is a decrease in stone clearance after ESWL in patients with renal insufficiency and clearance decreases proportionally with increasing renal insufficiency [7,8]. Moreover, the low clearance rate in renal insufficiency may be due to lack of routine double J (DJ) stent placement before ESWL [8].

To the best of our knowledge, there is no study in the Pakistani population which has evaluated the stone clearance rate in patients with renal insufficiency and DJ stent in place. Since ESWL is a non-invasive, effective treatment modality for renal stones and its role is not clear in the presence of renal insufficiency, we set out to determine its role with temporary DJ stent in patients with renal stones and renal insufficiency at presentation.

Subjects and methods

This was a cross-sectional descriptive study done over six months from Oct 2013 to March 2014 at the Department of Urology, SIUT. The sampling technique was non-probability, purposive sampling. The indications for ESWL were determined by the stone size and the serum creatinine levels. All adult patients including males and females (age: ≥ 18 years) with renal stones ≤ 2 cm in size and serum creatinine between 1.5–5.0 mg/dl were included in the study. Patients with lower calyceal stones and normal renal function (serum creatinine < 1.5 mg/dl) were excluded from the study. Patients were admitted through stone clinic or urology emergency room. Patients were counseled concerning pros and cons of ESWL for given stone and written informed consent was obtained. Patients' demographic data, stone size and serum creatinine were recorded and entered into a proforma. All patients underwent ureteral DJ stent placement before ESWL. All patients in the lithotripsy arm were treated as out-patients. Electromagnetic lithotripter Doli (Doli 50, Dornier,

Germany) was used for the treatment of renal stones. The rate of administration of shockwaves was 60–90/min. The initial success of treatment was assessed on the basis of no residual stone fragments on plain radiographic imaging and ultrasonography, which was performed 1 month after the ESWL session. Repeated treatment with ESWL was offered if there was no fragmentation of the stone or a residual fragment larger than 4 mm in maximum diameter. X-ray abdomen and renal ultrasound was repeated at 1 month after second ESWL session. Patients with no fragmentation after 2 sessions of ESWL were offered alternative treatment. However, those with fragments larger than 4 mm were administered third ESWL dose at least 1 month after the second session. Final stone clearance was assessed at 3 months after first treatment, again with plain X-ray abdomen and renal ultrasound. Successful treatment was defined as the complete stone clearance anytime till 3 months post-ESWL. The study was approved by the institutional ethical review committee (SIUT-ERC-B4-2013).

All clinical and radiological data were collected and analyzed using Statistical Package for Social Sciences Program (SPSS) version 18.0 (SPSS Inc., Chicago, Illinois, USA). Descriptive statistics were used. Continuous variables such as age, size of stones, serum creatinine were presented as mean \pm standard deviation (SD), while numbers and percentages were used for categorical variables such as number of ESWL sessions and frequency of stone clearance. Effect modifiers like age, gender and number of ESWL sessions were controlled through stratification. Chi-square test was applied and p value < 0.05 was considered as statistically significant in all analysis.

Results

A total of 117 patients underwent ESWL during the above study period. The mean age of was 38.2 ± 14.1 years. On stratification, 17 (14.3%) patients were ≤ 20 years of age, 29 (24.8%) were 21–30 years, 19 (16.2%) were 31–40 years, 29 (24.8%) were 41–50 years and 23 (19.6%) were above 50 years of age. The mean serum creatinine and stone sizes were 2.43 ± 0.8 mg/dl and 1.4 ± 0.4 cm, respectively, as shown in Table 1.

Out of 117 patients, 88 (75.2%) were males and 29 (24.8%) females. The categorization of serum creatinine levels is presented in Fig. 1. Regarding number of ESWL sessions, three ESWL sessions were performed in 65.8% cases, two in 29.9% and one ESWL session was performed in 4.3% cases.

The overall frequency of stone clearance after ESWL for renal stones was 70.9% (83/117) in patients with renal insufficiency. With respect to age groups, frequency of stone clearance was 77.4% in patients < 40 years of age patients while it was 64.4% in those > 40 years of age. The frequency of stone clearance was 70.5% (62/88) in males and 72.4% (21/29) in females. No significant difference was

Table 1 The main characteristics of the study patients ($n = 117$).

Total number of patients	117
Mean age, years	38.2 ± 14.1
Males, n (%)	88 (75.2%)
Females, n (%)	29 (24.8%)
Male to female ratio	3.0:1
Mean serum creatinine, mg/dl	2.4 ± 0.8
Mean stone diameter, cm	1.4 ± 0.4

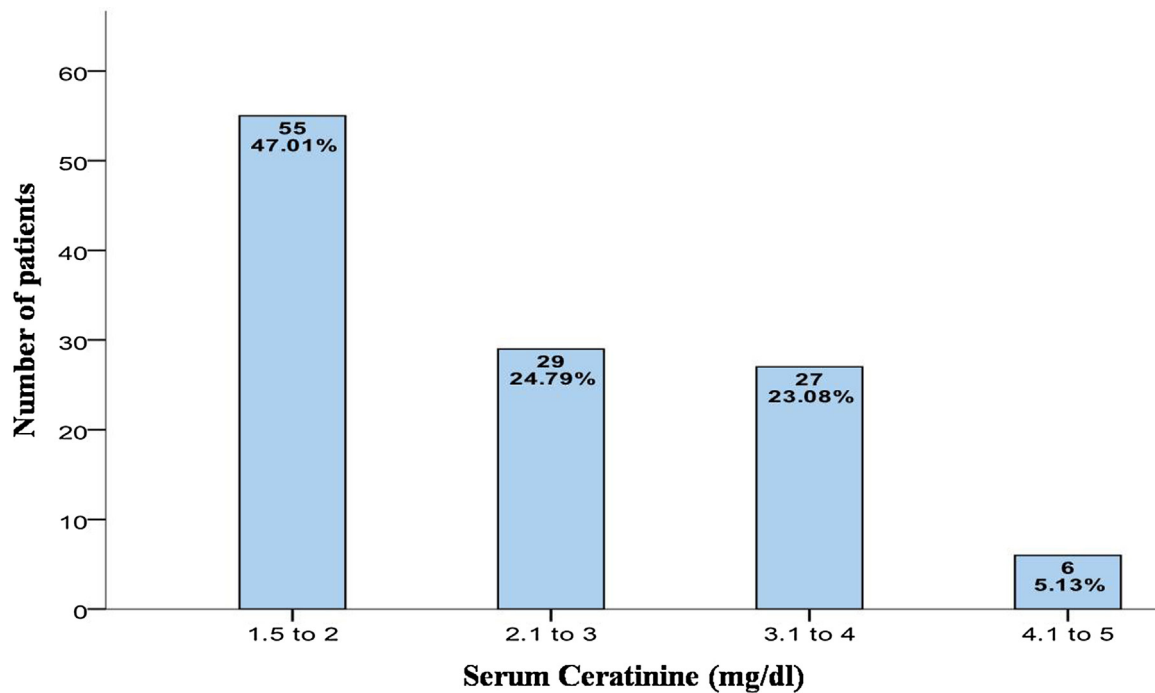


Figure 1 Categorization of serum creatinine into four degrees of increasing severity.

Table 2 Frequency of stone clearance after extracorporeal shock-wave lithotripsy (ESWL) with respect to serum creatinine level of patients ($n = 117$).

Serum creatinine	Number of patients	Stone clearance rate	p Value
1.5–3 mg/dl	84	62 (73.8%)	0.145 ^a
3.1–5 mg/dl	33	21 (63.6%)	

^a Chi-square test.

observed between genders. The rate of stone clearance was 73.8% (62/84) in cases with serum creatinine of 1.5–3 mg/dl, and 63.6% (21/33) in those with serum creatinine of 3.1–5 mg/dl. However, this was not statistically significant ($p = 0.145$) as shown in [Table 2](#).

Discussion

Kidney stone disease is a major problem in Pakistan, as this country belongs to the so-called stone belt. ESWL is the non-invasive treatment modality for urinary and biliary stones [9]. It was developed in early 1980s in Germany and, within very short period, became a treatment of choice for majority of stones in the upper urinary tract [10]. Its importance can be appreciated by the fact that more than one million patients are treated annually with ESWL in USA alone [11].

The ESWL works optimally for stones between 4 mm to 2 cm in diameter that are localized in the kidney and up to 1 cm stones in the upper ureter [11,12]. It is however, not completely free of complications. These include; renal colic, bleeding, steinstrasse, hypertension, abdominal discomfort, and exceptionally, death [12,13]. ESWL is contraindicated in pregnancy, uncontrolled bleeding disorder, uncontrolled hypertension, urinary tract obstruction downstream of the stone, and urinary tract infection [12].

The role of ESWL in the treatment of stones in kidneys with deranged function has not been thoroughly investigated [14,15] and very few studies have attempted to characterize its effectiveness of ESWL treatment based on the degree of renal dysfunction. Most studies, which have assessed the efficacy and safety of ESWL or surgical treatment on kidney stones in kidneys with impaired renal function, have evaluated renal function in terms of serum creatinine or global creatinine clearance [14]. Thus, they might obscure the likelihood of detecting even a severe unilateral renal dysfunction that is compensated by the opposite normal functioning kidney.

The mean age of patients was 38.2 ± 14.1 years in this study. Similar result was also reported in a local study by GulWazir et al. [16]. In this study, the mean age was 40.1 years. Akhtar and Akhtar [17] reported mean age of 38.2 years. In another study conducted by Butt et al. [18], the mean age was 37.7 years.

In the present study, out of 117 patients, the vast majority were males. Our result is also comparable with the study of GulWazir et al. [16]. Arain and Malik [19] reported male to female ratio of 4:1. Akhtar and Akhtar [17] and Rajput et al. [20] also reported male predominance with male to female ratio of 2.5:1 and 3.8:1, respectively. Butt et al. [18] also reported male to female ratio of 2.2:1.

In the present study, regarding the number of ESWL sessions, 3 ESWL sessions were performed in 65.8% cases, two in 29.9% and one in 4.3% cases. The rate of stone clearance was significantly higher in patients undergoing 1 and 2 ESWL sessions.

Earlier, Cevik et al. [21] have demonstrated that ESWL performed by either a single-shot or twin-shot shockwave technique has a transient detrimental effect on renal function in their study.

The stone clearance rate after ESWL is influenced by a number of factors, i.e., stone, patient and machine-related factors [22–25]. In the present study, the overall frequency of stone clearance after ESWL for renal stones ≤ 2 cm was 70.9% (83/17) in patients with renal insufficiency.

In a local study, the stone free rate was 89% and insignificant stone fragments, i.e. <4 mm size were found in 7% [16]. However, in this study renal functions were not assessed. In a study by Lee et al. the frequency of stone clearance was reported to be 56.9% in patients with renal insufficiency. The 3-month stone clearance rate with ESWL in patients with impaired renal function was 68% in the study by Bhatia et al. [14], in which routine ureteral JJ stenting was used in all patients. Singh et al. [25] reported stone clearance rates of 60% in such kidneys with residual stones after alternative forms of treatment such as PCNL and pyelonephrolithotomy. The low stone-free rate (34.2%) in Srivastava et al.'s study [8] may be due to lack of routine stenting in their patients or the small sample size.

A few other studies have also reported that there is a decrease in the stone clearance after ESWL in patients with renal insufficiency and clearance decreases proportionally with increasing renal insufficiency. Kamran [23] noted stone clearance rate of 90% in upper ureteric stones in patients with normal renal function. Coz et al. [24] and Butt et al. [18] reported stone clearance rates of 87% and 96.5%, respectively. These studies were carried out in patients with normal function. The frequency of stone clearance was 70.5% (62/88) in males and 72.4% (21/29) in females. This was statistically insignificant difference. Similarly, no significant difference was observed between different age groups and serum creatinine levels in this study. The lack of statistical difference with respect to serum creatinine may be related to small number of patients in some categories. Interestingly, the difference in stone-free rate for kidneys with glomerular filtration rate (GFR) between 20 and 30 ml/min and normally functioning kidneys was not statistically significant in the study by Srivastava et al. [8]. This was in contradiction to the stone clearance rate of kidneys with GFR values between 10 and 20 ml/min and normally functioning kidneys. Thus, it was apparent that the efficacy of ESWL in kidneys with moderately deranged function is probably similar to that in normally functioning kidneys [8].

There are certain limitations in the present study. These include its single center origin, relatively small sample size in some of the subgroups, lack of information on the composition or density of stones, and relatively short duration of follow-up. We used the plain X-ray abdomen and ultrasound to detect the stone free rate rather than computerized tomography (CT) scan, which is more sensitive for this purpose. Despite the above shortcomings, we feel that this study is a significant contribution to the existing scanty literature on the subject.

Conclusion

ESWL is a non-invasive, effective treatment modality for renal stones and may be used as the first line of management for patients with mild to moderate renal insufficiency.

Authors contributions

AK (dr.abdulkhalique2k1@yahoo.com), conception, study designing, data collection, drafting of manuscript, statistical analysis;

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Ethical approval

ERC approval letter No. SIUT-ERC-B4-2013, dated 15 September. 2013, Chairman: Ali Lanewala.

Conflict of interest

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