DOI: https://doi.org/10.53350/pjmhs2023174291

ORIGINAL ARTICLE

Effectiveness of Extracorporeal Shockwave Lithotripsy in Removing Small and Large Stones

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ABSTRACT

Objective: To examined the efficacy of extracorporeal shockwave lithotripsy in the removal of small and large stones.
Study Design: Observational prospective study.
Place and Duration of Study: Department of Urology, Liaquat University of Medical and Health Sciences, Jamshoro from 1st January 2018 to 31st January 2019.
Methodology: Two hundred patients, 139 males and 61 females, who underwent extracorporeal shockwave lithotripsy for stones were enrolled. The participants were separated into two groups based on stone size group A (stones measuring between 1.5 to 2.0 cm) and group B (stones measuring between 2.0 and 2.5 cm). Patients who were pediatric or had co-morbidities were excluded. The number of extracorporeal shockwave lithotripsy sessions and the number of beams per session were determined based on the clearance of the stones, if the radiology report indicated that the stones were completely cleared or if fragments smaller than 2 mm in diameter were present.
Results: In group A, only 26 patients had partial clearance while in group B only 2 patients had partial clearance. The majority of the patients in both groups did not report any complications. The most common complaint was isolated haematuria, with 9 (4.5%) patients in the one session group, 16 (8%) in the two session group, and 5 (2.5%) in the three or more session group reporting this symptom Two patients in group A had hematoma along with haematuria, one patient in group A had massive haematuria that required transfusion, and one patient in each group reported having steintrasse with haematuria. In addition, one patient in group A had an isolated hematoma.
Conclusion: Extracorporeal shockwave lithotripsy is effective and first-line treatment option for small renal stones. For ureteric stones, the location of stones should be taken into account, as this can have an effect on the stone-free rate and efficacy of extracorporeal shockwave lithotripsy.
Keywords: Extracorporeal shockwave lithotripsy (ESWL), Stone removal, Ureteric Stones, Haematuria

INTRODUCTION

The prevalence of urinary tract stones is a significant health concern, with approximately 1,500 to 2,000 people per million inhabitants in countries with developed industries affected.[1] The burden of disease due to these stones is significant in the working age group, resulting in a large healthcare load.[2] In the last quarter of a century, reports have been showing a rise in the number of people suffering from kidney stone disease in Western countries. Estimates show that approximately 10-15% of adults in the United States will experience a kidney stone diagnosis at some point in their adult lives. Epidemiological data from selected US communities have revealed that kidney stones are most common in males and that the incidence of the disease increases with age.[3]

The prevalence of renal stones in Pakistan is reported to be 10-15%, which is comparatively higher than in other countries. This can be attributed to a range of factors, such as economical and dietary circumstances, exposure to high temperatures, and genetic factors. Dehydration is also a common cause of renal stones, as it can be caused by a variety of factors, including inadequate water intake, excessive sweating, and certain medical conditions. Additionally, certain dietary habits, such as consuming a high-salt diet can also increase the risk of developing renal stones.[4,5]

Ureteric stones are a medical condition that can affect both paediatric and adult populations. This condition is known to be caused by various factors, including socioeconomic status, location and size of the stone, abnormalities in renal anatomy, and climate situation. The development of ureteric stones can be influenced by these factors and others. It is important to understand these potential risk factors in order to properly diagnose and treat this condition. These factors can influence the treatment outcome and the choice of intervention to be used. Understanding the various causes of ureteric stones can help healthcare providers to better assess, diagnose, and treat the condition [6]

In developing countries such as Pakistan, renal stones often present with symptoms such as renal failure, perinephric abscess, and pyonephrosis.[7] Unfortunately, fear of open surgery often leads to delayed treatment seeking in South Asia, which can lead to serious complications.[4,7] In industrialized nations, it was indicate that the overwhelming majority of stones (approximately 97%) are present in the kidney and ureter. The precise dimensions and placement of the stone are critical elements that guide the selection of the most appropriate method for extracting it.[7]

Around 80% of ureteric stones tend to pass out spontaneously[8], and recurrence is reported within 10 years in around 50% of cases.[6,8] ESWL has been a first-line treatment for the removal of urinary stones less than 20mm in size since its introduction in 1980.[9] In cases of complicated renal colic, treatment is often supplemented with additional interventions such as double J (DJ) stenting or percutaneous nephrostomy to create a diversion for urine drainage.[10] Prognostic factors associated with the success of ESWL include size, location, degree of impaction, and hydronephrosis.[11] The effectiveness of combining ESWL with other treatment modalities to treat larger stones has yielded conflicting results. In ESWL, fragmentation of calculi is accomplished by using low-frequency; high-intensity acoustic pulsatile waves directed at the stone.[12] In order to optimize the efficacy of lithotripsy, various technical considerations must be carefully considered. These include the selection of an appropriate device, determination of the optimal frequency of the shock waves, optimization of coupling between the lithotripsy instrument and the patient's body, selection of an appropriate focal zone, implementation of an appropriate aesthetic technique, and identification of the precise location of the calculi. Proper attention to these technical factors can greatly enhance the success of the lithotripsy procedure.[13]

MATERIALS AND METHODS

This prospective observational study was conducted at the Department of Urology, Liaquat University of Medical and Health Sciences, Jamshoro from 1st January 2018 to 31st January 2019. All patients who underwent ESWL in this period were included. The participants were divided into two groups based on the size of the stone. Group A patients had stones ranging from 1.5 to 2.0 cm, while Group B patients had stones ranging from 2.0 to 2.5 cm. Patients with co-morbidities such as diabetes mellitus,

hypertension, and previous heart surgery were excluded as well as pediatric patients. All patients underwent ESWL. The number of subsequent sessions, the number of beams per session, and their intensity were regulated based on stone clearance. When ESWL was unsuccessful, other modalities such as DJ stenting or URS were considered. If the radiological report showed either complete stone clearance or fragments with a maximum diameter of less than 2 mm, then stone clearance is done. The data collected includes demographic details and medical histories, including age, gender, stone size, and number of treatment sessions. Statistical analysis was carried out using SPSS-25.

RESULTS

There were 139 males and 61 females. Group A consisted of 165 participants, while Group B had 35 participants (Table 1). In both groups, most of the patients had calycle stones while the least had upper ureteric stones and number of sessions of ESWL was that each patient underwent (Table 2). The clearance rate in both groups was remarkable. In group A, only 26 had partial clearance while in group B, only 2 had partial clearance (Table 3). For ESWL, most of the patients had radio-opaque stones in the radiological studies and were given 6 joules of wave energy. Most of the patients had to be given 3000 shock waves/ session while only 3 in group A and 1 in group B had 300 wave/session. While most of the patients had a House filed score of more than 800, the number of waves per session and Hounse Field score (Table 4). The majority of the patients didn't require any auxiliary procedure for the removal of stone, while only Group A had both DJ and URS along with ESL (Table 5).

Table 1: Gender distribution

Gender	Group A		Group B	
	No.	%	No.	%
Male	114	69.09	25	71.1
Female	51	30	10	28

Table 2: Number of sessions of ESWL undergone by patients in both groups

Number of session	Group A		Group B	
	No.	%	No.	%
One	90	54.5	1	2.8
Two	70	43.2	8	22.8
Three or more	5	3.03	26	74.28

Table 3: Frequency of clearance rate

Clearance	Group A		Group B	
	No.	%	No.	%
Cleared	139	84.2	33	94.2
Partial cleared	26	15.8	2	5.8

Table 4: Number of waves per session and Hounse Field score for patients in both groups

Energy	Group A		Group B	
	No.	%	No.	%
Waves				
4	3	1.8	-	-
4.5	10	6.0	1	2.8
5	36	21.0	3	8.5
5.5	32	19.3	8	22.8
6	47	28.4	14	40.0
6.5	28	16.9	5	14.2
7	7	4.2	2	5.7
7.5	2	1.2	2	5.7
No. of waves				
300	3	1.8	1	2.8
2000	39	23.6	5	14.2
3000	123	74.5	29	82.8
Score				
< 800	28	16.9	12	34.2
≥ 800	137	83.0	23	65.7

Table 5: Auxiliary treatment

Treatment	Group A		Group B	
	No.	%	No.	%
DJ Stenting	29	17.5	6	17.1
URS	2	1.2	-	-
None	133	80.6	29.0	82.8
DJ+URS	1	0.6	-	-

The majority of the patients didn't report any complications in the groups. The most common complaint among both groups was isolated haematuria, while two individuals in Group A also experienced haematuria. One patient in group A had massive haematuria that required transfusion. One patient in both groups reported having steintrasse with haematuria. While only 1 patient in group A had steintrasse while one had isolated hematoma. With the increase in the number of subsequent sessions, the number of additional procedures needed to be decreased (Table 6). While Table 7 shows complications according to the number of sessions. Overall, our study found that ESWL was an effective treatment option for the small removal of stones. However, it is important to note that there can be some associated side effects and complications that should be taken into consideration.

Table 6: Frequency of auxiliary procedure

Procedure	One session		Two session		Three or more sessions	
	No.	%	No.	%	No.	%
DJ Stenting	16	8.0	14	7.0	5	2.5
URS	1	0.5	1	0.5	-	-
None	71	35.5	62	31.0	26.0	13.0
DJ + URS	88	44.0	1	0.5	-	-

Table 7: Complication according to number of sessions

Complication	One session		Two session		Three or more sessions	
	No.	%	No.	%	No.	%
Haematuria requiring blood transfusion	1	0.5	1	0.5	-	-
Steintrasse	1	0.5	58	29.0	-	-
Haematuria and steinstrasse	1	0.5	2	1.0	-	-
Haematuria	9	4.5	16	8.0	5	2.5
None	76	38.0	1	0.5	26	13.0

DISCUSSION

Extracorporeal shockwave lithotripsy is the commonly used treatment for ureteric stones.[14] Males constituted the majority of patients in our study, which is consistent with the findings of most studies showing a greater incidence of stones in males. Furthermore, when it comes to stones located above the pelvic rim in the ureter, extracorporeal shock wave lithotripsy (ESWL) is the preferred initial treatment option.[15,16] Research has demonstrated that using this method for stone removal is both safe and effective.[14] Moreover, the study showed that the likelihood of successfully removing stones decreases as their size increases.which is corroborated by other studies which have found larger stones to be more resistant and require higher energy waves and multiple sessions for successful removal.[17-19] Additionally, studies suggest that larger stone sizes lead to an increased risk of hematuria and pain. This is in line with previous studies showed that that stone size is the most influential factor in predicting ESWL outcomes.[20,21]

Based on our result, ESWL was found to be effective in removing larger kidney stones, although this effectiveness may vary depending on the location of the stone. These results are consistent with several other studies that have demonstrated the reliability and safety of ESWL in treating kidney stones of different sizes, including larger stones. However, the success of ESWL in removing stones also depends on the specific location of the stone.[22] However, it is important to note that multiple sessions of ESWL may be required for successful removal.[23] In such cases where multiple sessions are necessary, other auxiliary approaches such as stenting may be beneficial. Additionally, ESWL can be used in combination with other treatments such as ureteroscopy or percutaneous nephrolithotomy to achieve better outcomes. In order to further improve the treatment of ureteric stones, it is important for future studies to explore the effectiveness of combining ESWL with auxiliary approaches. Additionally, it is important to assess the long-term safety and effectiveness of ESWL. However, ESWL remains a safe and convenient treatment

option for ureteric stones in all locations, with minimal risk of complications and without the need for surgery or hospitalization.[14]

When considering the appropriate treatment for ureteric stones, it is important to consider both the size and location of the stone. One recommended option is ESWL, which can be further improved by combining it with other treatments.[18]

In a recent investigation by Cakiroglu et al[23], shock wave lithotripsy (SWL) emerged as the preferred initial treatment for kidney stones, even those measuring less than 400mm in diameter. This is primarily due to SWL's non-invasive nature and its ability to effectively fragment stones into smaller pieces that can be passed through the urinary system. Furthermore, in the TISU trial, McClinton et al[24] suggested that EWSL is a better option than other treatments. However, for stones larger than 400mm, multiple sessions of SWL may be required. The study also found that stone size and House Field score were the most influential factors in predicting SWL outcomes, with larger stones and higher House Field scores being more resistant to shock wave lithotripsy.

Ureteral stone treatment with extracorporeal shock wave lithotripsy (ESWL) has been shown to be an effective and safe option, with a high success rate and low complication rate, according to our study and other research.[24] Our study found that both groups had notable clearance rates, with only 26 patients in group A and 2 patients in group B experiencing partial clearance. In addition, the most frequently reported symptom was isolated hematuria.

The efficacy rate of the initial ESWL session was 65.3%, but this improved to 90.0% after the third session in the first study, demonstrating a significant improvement.[25,26] The success rate of ESWL is affected by stone size and the house field unit, and the intensity of ESWL may be personalized based on the patient's pain tolerance and the degree of stone fragmentation.[27]

Overall, our study and previous research support the use of ESWL as a reliable and secure method for treating ureteral stones, with a high success rate and low risk of complications. Therefore, it can be considered a primary treatment option for managing ureteral stones.

CONCLUSION

Extracorporeal shockwave lithotripsy is the preferred initial treatment for small renal stones, while for ureteric stones, the success of ESWL is dependent on the stone location, which can affect the rate of achieving a stone-free state. Despite being an established procedure, ESWL remains a popular choice among patients due to its non-invasive approach and ability to be performed on an outpatient basis.

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