



Extracorporeal Shock Wave Lithotripsy Success Rate and Prognostic Factors

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Abstract

Background: Urinary tract stones are common urological problems with a considerable burden worldwide. Management strategies mostly rely on the stone's characteristics and the patient's clinical conditions. Extracorporeal shock wave lithotripsy (ESWL) is a method of choice for managing small calculus. However, the success rate of ESWL and the prognostic factor of success widely vary among different studies. The aim of the present study was to evaluate these prognostic factors in an Iranian population undergoing ESWL.

Methods: The present retrospective study was conducted in Imam Ali Hospital of Bojnord, Iran. Every patient who was referred for the ESWL of distal urethral calculus (5-20 mm) and failed to respond to medical treatment enrolled in this study. The prevalence and relationship between various individual factors and ESWL outcomes were evaluated among the study patients.

Results: Among 49 patients (24 males and 25 females) who had urinary tract stones, the mean (\pm standard deviation) of age was 42.7 (14.04) years. ESWL could successfully treat urinary tract stones in 43 patients (85%). The kidney stone diameter was not related to having a successful procedure ($P=0.447$). Moreover, the stroke number and receiving tamsulosin were not significantly associated with favorable ESWL outcomes ($P=0.909$ and $P=0.590$, respectively). Twenty-seven patients (45.1%) received pethidine during the procedure. There was a significant relationship between receiving analgesics and favorable ESWL outcomes ($P=0.033$).

Conclusion: The results demonstrated that 85% of the distal urinary tract stones that are smaller than 20 mm can be successfully managed by ESWL, and providing analgesics was significantly related to better outcomes.

Keywords: Extracorporeal shock wave lithotripsy, Nephrolithiasis, Analgesic

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Introduction

Nephrolithiasis is a common urinary complication that is rising in prevalence. This problem affects all groups of ages, and the lifetime risk of developing urinary stones is up to 10% in the United States (1). Unfortunately, nephrolithiasis has a considerable disease burden, and more than 3600 emergency department daily visits are related to urinary stones (2). Management of urinary stones varies among different clinical settings, and patients are mostly managed based on their clinical characteristics (3, 4). Approximately 20% of the daily visits because of urinary stones result in hospitalization, and most of the patients are managed as outpatients (2). Recently, non-invasive and minimally invasive surgeries have been developed for treating urinary stones (4). Percutaneous nephrolithotomy, extracorporeal shock wave lithotripsy (ESWL), laparoscopic ureterolithotomy, and retrograde

intrarenal surgery are among these surgical techniques which have their own efficacy and complications (3, 4). ESWL is one of the oldest techniques considered as the first-line treatment because of its lower costs and less exposure of patients to anesthesia (4). During ESWL, a lithotripter produces shattering forces as low-frequency and high-intensity acoustic waves fragmenting urinary stones (5). This technique is usually considered for stones less than 1 cm (3). Although larger stones located in the proximal ureter can also be successfully managed by this technique, most recent guidelines indicate that ESWL should be preferred for urinary stones smaller than 2 cm (3, 6). The clinical success rate of ESWL depends on many technical and individual factors (5). The energy level, frequency pulses, and previous experiences with ESWL are among the important technical factors during the procedure (5, 7). Moreover, patient-related factors,

including obesity, presence of chronic renal disease, or urinary tract infection, as well as the location of stones, can influence the results (5, 7). The present study aimed to evaluate the relationship of such individual and technical issues with ESWL outcomes in patients with urinary stones smaller than 20 mm.

Methods

The current retrospective study was performed in Imam Ali Hospital of Bojnurd, Iran. All patients who were referred for the ESWL of distal urethral calculus (5-20 mm) between October 2017 and March 2018 and responded to no medical treatment enrolled in the present study. Patients who had a urinary infection, coagulating disorders, or abnormal urinary system anatomy were excluded from the study. Moreover, pregnant patients and those who did not agree to complete the informed consent form were not included in this study. Before the procedure, intravenous access was taken from every patient, and then patients lay down on the bed in a supine position. Every patient received a session of ESWL (Dornier MFL 5000 and Toshiba Echolith) by mean duration and stroke number of 45 minutes and 84 strokes/minute and 2400 shocks/session (75 Hz). Intravenous pethidine (25 mg) was used whenever a patient experienced pain. Those patients who experienced severe pain or severe changes in their vital signs were excluded from the study and managed accordingly. After the procedure, every patient was monitored for 2 hours and discharged with oral antibiotics if having stable vital signs. The modality of response to treatment was evaluated by ultrasound and CT-scan. The patients' demographic data and their urinary tract calculus characteristics were documented, and the study data were analyzed by Statistical Package for the Social Sciences (SPSS) software (version 16). To assess the association between qualitative variables, Chi-square test and to compare quantitative variables at the levels of qualitative variables, one-way analysis of variance (ANOVA) were used. To assess the association between qualitative variables, Chi-square test and to compare quantitative variables at the levels of qualitative variables, one-way analysis of variance (ANOVA) were used. *P* value less than 0.05 was considered statistically significant.

Results

A total number of 49 patients (24 males and 25 females) who had urinary tract stones (ranging from 5 to 20 mm) enrolled in the present study. The mean (\pm standard deviation) of age was 42.7 (14.04) years. The mean operation time was 40.83 minutes, and the operation took 45 minutes in more than half of the patients. ESWL successfully treated urinary tract stones in 43 patients (85%). The clinical characteristics of kidney stones are provided in Table 1. The kidney stone diameter was not related to having a successful procedure ($P=0.447$).

Table 1. Distribution of Stone Diameter Among the Study Population

Stone Diameter (mm)	Number of Patients (%)
5	7 (14.3)
6	8 (16.3)
7	5 (10.2)
8	5 (10.2)
9	3 (6.1)
10	7 (14.3)
11	4 (8.2)
12	4 (8.2)
13	1 (2)
15	3 (6.1)
18	2 (4.1)
Total	49 (100)

Moreover, gender and addiction were not significantly associated with successful ESWL ($P=0.936$ and $P=0.559$). Although most of the urinary stones were located on the right side, the location was not related to ESWL outcomes ($P=0.252$). Although some patients had a history of ESWL (7 patients, 14.3%) and surgery (7 patients, 14.3%), none of these variables were considered to be related to a successful ESWL procedure ($P=0.286$ for both). Seventeen patients (34.7%) received tamsulosin because of their clinical conditions. There was no significant relationship between receiving tamsulosin and ESWL outcomes ($P=0.590$). Twenty-seven patients (45.1%) received pethidine during the procedure. There was a significant relationship between receiving analgesics and favorable ESWL outcomes ($P=0.033$). The ESWL intensity varied from 45 to 75 strokes (Table 2). The stroke numbers varied from 2400 to 3800 strokes/minute according to the stones' characteristics. However, the stroke number was not significantly related to favorable ESWL outcomes ($P=0.909$).

Discussion

Nowadays, ESWL is considered a method of choice for treating small urinary tract stones. The findings of the present research revealed that in our center, the ESWL procedure was successful in 85% of patients. Additionally, neither the stone diameter and the patients' characteristics nor the ESWL stroke numbers were related to a successful procedure. The only important factor affecting the success rate of ESWL was receiving analgesics.

ESWL and flexible ureterorenoscopy (URS) are considered the first-line treatments for kidney stones smaller than 2 cm (3). However, some guidelines demonstrated that choosing URS may be more favorable in lower pole stones in the absence of adverse factors, including anatomical problems and stone composition (6). It has been indicated that ESWL is a desirable choice mostly in developing countries because of its

Table 2. Number of Strokes, as well as Intensity and duration of ESWL

	Number of Patients (%)
Number of strokes	
2400	2 (4.1)
2700	1 (2)
3200	22 (44.9)
3300	1 (2)
3400	3 (6.1)
3500	11 (22.4)
3600	2 (4.1)
3700	2 (4.1)
3800	5 (10.2)
Total	49 (100)
ESWL intensity (stroke/min)	
45	1 (2)
55	3 (6.1)
60	11 (22.4)
65	4 (8.2)
70	13 (26.5)
75	17 (34.7)
Total	49 (100)
ESWL duration (min)	
30	7 (14.3)
35	2 (4.1)
40	6 (12.2)
45	28 (57.1)
50	3 (6.1)
60	3 (6.1)
Total	49 (100)

Note. ESWL: Extracorporeal shock wave lithotripsy.

low morbidity and noninvasiveness (8). Similar to any other treatment approaches for urinary tract stones, this technique has specific prognostic factors of success. However, these factors vary among various studies from different countries and clinical settings. The findings of a previous study on a relatively large population with both single and multiple stones (largest diameter of 3 cm) represented that stone size, location, and radiological renal anomalies are the predictors of ESWL success (9). Similarly, Salman et al reported that stones with a transverse diameter smaller than 8 mm and those located in the lumbar ureter are associated with more favorable stone-free rates (10). Scotland et al found that ESWL provides 78.8% and 87.5% success rates for distal ureter stones in the first and second sessions, respectively (11). Similar to our results, their findings showed that the stone's diameter is not related to ESWL success. In contrast to the results of Kawano et al, those of Murota-Kawano et al demonstrated that the stone diameter, location, and the patient's gender significantly affect the

outcomes (12). They reported that the procedure success is 98% with stones smaller than 10 mm, while larger stones have lesser procedure success (91.2%). A possible explanation behind the different results of our study and those of Murota-Kawano et al could be their greater sample size and ESWL machine that were different from ours (12).

In terms of using tamsulosin after the procedure, Gravas et al reported receiving this medication might not affect the outcomes (13), which is in line with our results. However, they concluded that using tamsulosin after ESWL significantly reduces the need for analgesics (13). Further, Gravina et al found that using tamsulosin after ESWL is more effective than ESWL alone in patients with larger renal stones (smaller than 2 cm). Similar to Gravas et al, they also reported that the administration of tamsulosin decreases the need for analgesic drugs (14). Ismail Mohamed et al evaluated smaller ureteric stones (5-15 mm) and represented similar results regarding the effectiveness of tamsulosin (15), which corroborates our findings. In contrast to our study, they demonstrated that using tamsulosin can reduce analgesic use (15). Regardless of the effect of tamsulosin on analgesic use, many patients may require analgesics during the procedure. Waqas et al investigated the effect of different analgesic drug regimens on controlling the pain during the ESWL session (16). They found that the application of local 2% lignocaine gel did not affect the analgesic requirement during the ESWL procedure (16). According to their results, taking naproxen sodium with on-demand anesthesia could be a safe and feasible option for managing the procedural pain (16). A recent systematic review and meta-analysis revealed that both non-steroidal anti-inflammatory drugs (NSAIDs) and opioids can reduce ESWL-associated pain. However, analgesia is described more adequately for opioids than NSAIDs in the literature (17). Pain control during ESWL is beneficial for relieving the patient's discomfort and increasing the success rate (17). Reducing the pain decreases pain-induced movements and facilitates stone targeting, and therefore increases the ESWL success rate (17). Fankhauser et al concluded that choosing the best treatment option for treating urinary stones may also depend on the previous history of renal calculi treatment (18). They demonstrated that among ESW and URS, choosing URS will be superior in patients who previously untreated urinary stones smaller than 2 cm (18). Although they reported that URS has higher stone-free rates and fewer reinterventions, ESWL has similar morbidity (18).

Considering that the ESWL is an operator-dependent technique and many confounding factors, including patient-specific factors, are present in almost every study, the comparison of the results of such studies should be made with caution. Even though, regardless of the operator skills in ESWL, the recent advance in the ESWL

machine has also been addressed in the literature. Murota-Kawano et al evaluated the efficacy of the third-generation lithotripter as the first-line treatment of urinary stones and reported that the third-generation lithotripter can be recommended for all ureter stones (12). They found that the third-generation machine can archive a high stone-free rate in comparison with the earlier versions with a rather small number of sessions (12).

Conclusion

Overall, ESWL is now considered a common non-invasive method for the treatment of urinary tract calculus. Our study results demonstrated that 85% of the distal urinary tract stones smaller than 20 mm in diameter will be successfully managed by ESWL. Moreover, providing analgesics was significantly related to better outcomes. Using analgesics may facilitate the positioning of patients and thus increase the success rate.

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Authors' Contribution

ES: data collection and manuscript drafting, AS: study design TZ: data collection and manuscript reviewing. RG and MG contributed to the development of the study. All authors read and signed the final paper.

Conflict of Interest Disclosures

The authors declare that they have no conflict of interests.

Ethical Statement

The project was approved by the Ethics Committee of North Khorasan University of Medical Sciences (IR.NKUMS.REC.1398.005).

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Informed Consent

The authors confirm that more data for supporting the findings of this study and informed consent are available from the corresponding author upon reasonable request.

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