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Predictive Variables of Success in Extracorporeal Shock Wave Lithotripsy

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Abstract

Introduction: Kidney stone is a prevalent disease, especially in desert and arid areas like Rafsanjan in Iran. Extracorporeal Shock Wave Lithotripsy (ESWL) is a non-invasive treatment of kidney stones that success rate of which depends on various factors. This study aimed at investigating predictive variables of success in ESWL in patients referred to the ESWL Unit of Moradi hospital (Rafsanjan, Kerman, Iran) in 2016.

Methods: All patients referred to the ESWL unit in the hospital during a 6-month period in 2016 were included in this study. Demographic information, size, location, and orientation of stones were collected from interviews and sonography observations. Finally, the obtained data was investigated with the statistical Chi-square and logistic regression tests.

Results: The male to female ratio in patients with kidney stones was almost 2:1, and the overall estimated rate of lithotripsy was 71.7%. There was no difference between the male and female patients in the success of lithotripsy and, in addition, stone location did not affect the rate of success. The only successful predictor of ESWL was stone size. The larger stones were more successful broken than smaller.

Conclusions: Stone size plays an important role in the selection of treatment method. Breaking of larger stones is more successful in ESWL due to the greater absorption of ultrasonic energy emitted by the machine and because of the more accurate determination of their location.

INTRODUCTION

Kidney stones are a relatively prevalent disease (with prevalence of about 1-15%) in all societies. This prevalence varies depending on age, gender, race, and geographical location. Kidney stones are 2-3 times more common in men than in women and rarely observed before the age of 20, but their incidence rates reaches its peak between the ages of 40 to 60. When PH, ionic strengths and concentrations of dissolved substances in urine reach the supersaturated state, stone formation begins [1]. Severe pain begins with acute urinary tract obstruction and dilation by stones. Stones in middle and upper ureter cause severe and incisive pain in the back or the sides; whereas, stones at the lower end of the ureter can cause symptoms of urinary tract infection such as frequent urination and a burning sensation when urinating. Among various types of stones, calcium oxalate stones are the most common urinary tract stones [2]. Various factors, the most important of which are stone size and location, are considered in treating patients with urinary tract stones [3]. Patients are examined by obtaining their history and carrying out diagnostic radiology such as sonography. Selection of proper treatment by physicians can decrease the complications of the disease such as pain and infection, and reduce consumption of analgesics. Maintenance treatment includes taking liquids and the standard treatment for large stones (up to 15mm) in the kidneys and the upper ureter by ESWL. Surgical procedures are applicable in the treatment of larger stones and stones in the lower ureter [4]. With the technological advances made over the past two decades, medical sciences have experienced dramatic changes in diagnosis and treatment of diseases. The invention of ESWL device is an example of these impressive improvements in treating urinary tract stones. This device uses high-energy sound waves directed at the stone to break it up into smaller pieces so that they may be more easily passed. The invention of ESWL method was a revolution in the treatment of Kidney stones that became a substitute for surgery, which was

associated with many complications [5].
The efficiency of ESWL devices has been investigated in different studies. For example, the findings of Mehrabi's study showed that the employed lithotripter (Arian 101) had a success rate of 42.8% complete response in breaking up kidney stones larger than 10mm and of 40% complete response in breaking up the stones in the upper ureter [6]. Obek also estimated the effectiveness rates of ESWL in breaking up the stones in the lower, middle, and upper ureter were 36, 46, and 41%, respectively [7]. Park reported stone density and size to be significant predictors of effectiveness of ESWL in breaking kidney stones smaller than 20mm [8]. According to Chaussy, ESWL was the front-line treatment of calcium stones larger than 10mm [9]. Every treatment has its own complications. Inability to pass stone particles resulting from breaking up the initial stone can cause obstruction of urinary tract, prolong disease duration, and result in such complications as infection and damaged renal function [10]. Considering the points mentioned above, it was determined that the efficiency and effectiveness of this type of treatment depended on different personal factors including age, gender, stone size and material, and/or the type of the lithotripter. Identification of factors affecting the effectiveness and efficiency of a type of treatment in each geographical region is one of the requirements of every medical system. Therefore, this study aimed at investigating predictors of ESWL success in patients visiting the Lithotripsy Unit of Moradi Education and Treatment Center in 2016. Results of such studies can help physician's select efficient treatment methods.

METHODS

The statistical population of this descriptive study included all 138 patients who visited the Lithotripsy Unit of Moradi Education and Treatment Center from June to December, 2016. The research objectives were explained to them and their written informed consent to participate in the research was obtained. The patients were first weighed with minimum clothing on (disposable hospital clothing), using a Seca balance. Demographic information was recorded in a checklist based on interviews with the patients or from their medical records. Data on stone sizes, locations, and orientations was extracted from sonography reports and entered into the checklist. Then, a trained and experienced specialist started the lithotripsy process. The patients were first put in a sleeping position on the ESWL device, and then the precise location of the stone was determined with ultrasound or fluoroscopy. After that, the lithotripsy process was performed with 3,000 shocks, on average, at 0.1-3 kV. It is worth noting that, during this study, one specialist only carried out all the lithotripsy procedures. This procedure lasted for about one hour. After the completion of lithotripsy, its success was evaluated with sonography or by observation of stones passed by the patients. It must be mentioned that the lithotripter used in the Moradi Hospital of Rafsanjan was a German made model Dornier device. Finally, data was analyzed SPSS and the Chi-square and logistic regression tests. It should be explained that according to the treatment processes, only stones with diameters of 8-20 mm were treated with this lithotripter.

RESULTS

Among the 138 subjects, 63.8% were men and 36.2% were women with the mean age of 45.45 ± 15.56 years. The minimum and maximum stone sizes were 8 mm and 20 mm, respectively, with the mean size of 12.62 ± 3.26 mm. Frequency distribution of the stones was as follows: 6.5% in the upper calyx, 15.2% in the middle calyx, 27.5% in the lower calculus, 23.9% in renal pelvis, and 26.8% in the ureter. In all, 73.2% of the stones were renal and 26.8% ureteral. In addition, 34.1% of the stones were on the right side and 65.9% on the left side of the body. The overall success rate of lithotripsy was 71.7%. This success rate was measured based on the classification of stone sizes. The success rates of breaking 8-10 mm, 11-15 mm, and 16-20 mm stones were 23.7, 55.7, and 20.6%, respectively. According to the Chi-square test, this difference in the success rates of ESWL was significant (P = 0.007). In addition, the success rate of ESWL was measured based on stone location. According to the results, 7.1, 14.1, 29.3, 19.2, and 30.3% of the stones the in the upper calyx, the middle calyx, the lower calyx, the renal pelvis area, and in the ureter were broken with the ESWL device, respectively. In all, 68.3% of the renal stones and 81.1% of ureteral stones were broken with ESWL, indicating there were no significant differences in the success rate of lithotripsy in these two areas (P = 0.218). The Chi-square test showed no significance differences in the success rate of ESWL between men and women (P = 0.218), between stones on the right and left sides of the body (P = 0.493), and between the upper, middle, and lower ureteral and renal pelvis stones (P = 0.224). In addition, no significant correlation was observed between the success rate of ESWL and age of the patients (P = 0.404). Among the 41 patients with no success in the first lithotripsy session, 16.7% underwent a second session and 13% received surgery, and the rest did not revisit the Center (Table 1).
Logistic regression was used to predict the success of ESWL. Gender, age, stone location, stone orientation, and stone size entered the equation as predictive variables, and explained 41.5% of the variance in ESWL success rates. According to the logistic regression model, only the stone size among the predictive variables affected the success of ESWL (P = 0.006, Wald = 7.6). In other words, stone size increased the success rate of ESWL 0.42 fold (Table 2).

Table 1: Descriptive Indicators of Variables

Variables	Group	Success, No (%)		Chi-square
		OK	Fail	
Gender				P = 0.218
Male		60 (68.2)	28 (31.8)	
Female		39 (78)	11 (22)	
Stone orientation				P = 0.493
Right		32 (68.1)	15 (31.9)	
Left		67 (73.6)	24 (26.4)	
Stone size				P = 0.007
8-10		23 (53.5)	20 (46.5)	
11-15		54 (78.3)	15 (21.7)	
16-20		20 (83.3)	4 (16.7)	
Stone location				P = 0.218
Renal		69 (68.3)	32 (31.7)	
Ureter		30 (81.1)	39 (28.3)	

Table 2: Summary of Regression Model to Predict the Success of ESWL

	EXP (B)	Wald	P-value
Age	0.994	0.001	0.98
Stone location	0.425	2.85	0.091
Stone orientation	0.7	0.651	0.42
Gender	0.48	2.47	0.116
Stone Size	0.42	7.6	0.006

$P < 0.05$.

DISCUSSION

In this study, the ratio of male to female patients was approximately two to one. The same ratio was also reported by Bozkurt, Wiesenthal, Chung, Keshvari, and El-Nahas [5, 10-13], and an almost identical one by Junuzovic [14]. The Chi-square test showed no significant differences between the male and female patients in the success rate of ESWL, which was consistent with the finding of Tavakkoli [15]; whereas, Gupta and Park reported a higher rate of ESWL success in male patients [8, 16].

The overall success rate of ESWL in the present study was 71%. However, different success rates have been reported in various studies. For example, the overall success rate reported in the studies carried out Abdel, Park, Saeidi, and Murota-Kawano were 87, 68.7, 55, and 94.5%, respectively [8, 17-19]. Moreover, Jee reported a 90.9% overall success rate in the treatment of renal stones in children [20]. In that study, 68.3% of renal stones and 81.1% of ureteral stones were broken with ESWL. The corresponding rates were 74% and 88% in Al-Marhoon's research [21]. These findings were consistent with those of the current study. However, Badawy reported 83.4 and 58.46% success rates in breaking renal and ureteral stones, respectively, and the corresponding rates were 68.8% and 62.3% in Wiesenthal's study, and indicated a greater success rate in breaking renal stones [12, 22]. Javanmard also showed that lithotripter performed better in breaking stones in renal pelvis (in the kidney region) [23]. Location usually plays a role in the success of treating stones in urinary system. In the current study, the success rate was higher in treating ureteral stones than renal stones; however, this difference was not statistically significant. Sonography is very sensitive in diagnosing renal stones and determining their exact locations, but it has a very low efficiency in diagnosing ureteral stones, which is due to interference from intestinal gases. Therefore, ureteral stones are usually detected on X-Ray. Because of this, it is not possible to determine the exact location of ureteral stones, which can explain the lower success rates of lithotripsy in treating renal stones. The author believes that since renal stones are in a more open space in the urine, they are more successfully broken up into smaller particles by ultrasonic waves and passed more easily and better; whereas, ureteral stones are usually packed in the limited space within the ureteral edema (compacted within the ureter). This disrupts fragmentation of stones by the waves the device emits into the inade-

quate ureteral space. However, technological advances in determining the exact location of ureteral stones have increased the success rates in breaking ureteral stones to those in breaking renal stones. This difference in results has various reasons including volume, size, number of stones, and differences in the time the evaluations are made after the ESWL treatment. Certainly, the probability of passing broken particles, even those larger than 5 mm, increases with time and improves ESWL success rates. In addition, in this research, the majority of patients received ESWL once and only 16.7% of them underwent this procedure a second time. In some studies, ESWL procedure was performed several times in a three-month period, which certainly increased the probability of its success.

As for predicting the success rate of ESWL, it was found that stone size was a significant predictor of ESWL success (regardless of age, gender, and stone location and orientation). From this perspective also, results of the current study are consistent with those of the research conducted by Saedi and El-Nahas, and confirm the importance of the correct selection of patients based on stone size (< 20 mm) in ESWL [5, 19].

Findings of this study confirm that ESWL is an effective minimally invasive technique for treating urinary tract stones smaller than 20 mm, and that this technology can be used with greater certainty for this purpose.

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CONFLICTS OF INTEREST

There is no conflict of interest for the present study.

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AUTHORS' CONTRIBUTION

Both authors participate in study design, performing the study and writing the manuscript.

REFERENCES

1. Wein AL, Kavoussi LR, Partin AW, Peters CA. Campbell-Walsh Urology. 11 ed ed: Elsevier; 2015.
2. Alkhunaizi AM. Urinary stones in Eastern Saudi Arabia. Urol Ann. 2016;8(1):6-9. DOI: 10.4103/0974-7796.164841 PMID: 26834393
3. Arrabal-Martin M, Gonzalez-Torres S, Cano-Garcia MD, De Haro-Munoz T, Abad-Menor F, Arrabal-Polo MA, et al. Urine Calcium and Bone Mineral Density in Calcium Stone-Forming Patients Treated with Alendronate and Hydrochlorothiazide. Urol Int. 2016;97(3):292-8. DOI: 10.1159/000443484 PMID: 26800461
4. Ergenoglu P, Akin S, Eker E, Aribogan A. 992 Anesthesia management of a patient with samters syndrome for extracorporeal shockwave lithotripsy (ESWL). . Europ J Pain. 2009;13(1):S279.
5. El-Nahas AR, Ibrahim HM, Youssef RF, Sheir KZ. Flexible ureterorenoscopy versus extracorporeal shock wave lithotripsy for treatment of lower pole stones of 10-20 mm. BJU Int. 2012;110(6):898-902. DOI: 10.1111/j.1464-410X.2012.10961.x PMID: 22372915
6. Mehrabi S, Karimzadeh-Shirazi K, Hadinia A. Comparison of fentanyl and combination of pethedine and midazolam for pain control during extracorporeal shock wave lithotripsy. JSKUMS. 2011;13(3):70-6.
7. Obek C, Onal B, Kantay K, Kalkan M, Yalcin V, Oner A, et al. The efficacy of extracorporeal shock wave lithotripsy for isolated lower pole calculi compared with isolated middle and upper caliceal calculi. J Urol. 2001;166(6):2081-4; discussion 5. PMID: 11696710
8. Park YI, Yu JH, Sung LH, Noh CH, Chung JY. Evaluation of possible predictive variables for the outcome of shock wave lithotripsy of renal stones. Korean J Urol. 2010;51(10):713-8. DOI: 10.4111/kju.2010.51.10.713 PMID: 21031093
9. Chaussy C, Bergsdorf T. Extracorporeal shockwave lithotripsy for lower pole calculi smaller than one centimeter. Indian J Urol. 2008;24(4):517-20. DOI: 10.4103/0970-1591.44260 PMID: 19468510
10. Keshvari M, Darabi MR, Shakibi MH. Comparison of distal ureter stones treatment with extracorporeal shock wave lithotripsy and transurethral lithotripsy techniques. Journal of Gorgan University of Medical Sciences. 2010;12(2):53-7.
11. Bozkurt Y, Sancaktutar AA, Bostancı Y, Kapan M, t Çaycı HM. Comparison of Extracorporeal Shock Wave Lithotripsy Versus Ureteroscopic Stone Extraction in the Treatment of Ureteral Stones. Eur J Gen Med 2010;7(1):29-34.
12. Wiesenthal JD, Ghiculete D, RJ DAH, Pace KT. Evaluating the importance of mean stone density and skin-to-stone distance in predicting successful shock wave lithotripsy of renal and ureteric calculi. Urol Res. 2010;38(4):307-13. DOI: 10.1007/s00240-010-0295-0 PMID: 20625891
13. Chung VY, Turney BW. The success of shock wave lithotripsy (SWL) in treating moderate-sized (10-20 mm) renal stones. Urolithiasis. 2016;44(5):441-4. DOI: 10.1007/s00240-015-0857-2 PMID: 26743071
14. Junuzovic D, Prstojevic JK, Hasanbegovic M, Lepara Z. Evaluation of Extracorporeal Shock Wave Lithotripsy (ESWL): Efficacy in Treatment of Urinary System Stones. Acta Inform Med. 2014;22(5):309-14. DOI: 10.5455/aim.2014.22.309-314 PMID: 25568579
15. Tavakkoli Tabassi K, Mohammadi S, Madani A. Investigation Patients with Urinary Stones from the Aspect of Epidemiologic Parameters Admitted at Urology Department of Imam Reza Hospital During Years 2005-2008. AUMJ. 2013;2(4):197-204.
16. Gupta NP, Ansari MS, Kesarvani P, Kapoor A, Mukhopadhyay S. Role of computed tomography with no contrast medium enhancement in predicting the outcome of

extracorporeal shock wave lithotripsy for urinary calculi. BJU Int. 2005;95(9):1285-8. DOI: 10.1111/j.1464-410X.2005.05520.x PMID: 15892818

17. Abdel-Khalek M, Sheir KZ, Mokhtar AA, Eraky I, Kenawy M, Bazeed M. Prediction of success rate after extracorporeal shock-wave lithotripsy of renal stones--a multivariate analysis model. Scand J Urol Nephrol. 2004;38(2):161-7. DOI: 10.1080/00365590310022626 PMID: 15204407
18. Murota-Kawano A, Ohya K, Sekine H. Outpatient basis extracorporeal shock wave lithotripsy for ureter stones: efficacy of the third generation lithotripter as the first line treatment. Int J Urol. 2008;15(3):210-5. DOI: 10.1111/j.1442-2042.2007.01970.x PMID: 18304214
19. Saedi D, Molavi M. Association between some CT characteristics of renal stones and extracorporeal shockwave lithotripsy success rate. TUMJ. 2012;70(3):169-75.
20. Jee JY, Kim SD, Cho WY. Efficacy of extracorporeal shock wave lithotripsy in pediatric and adolescent urolithiasis. Korean J Urol. 2013;54(12):865-9. DOI: 10.4111/kju.2013.54.12.865 PMID: 24363869
21. Al-Marhoon MS, Shareef O, Al-Habsi IS, Al Balushi AS, Mathew J, Venkiteswaran KP. Extracorporeal Shock-wave Lithotripsy Success Rate and Complications: Initial Experience at Sultan Qaboos University Hospital. Oman Med J. 2013;28(4):255-9. DOI: 10.5001/omj.2013.72 PMID: 23904918
22. Badawy AA, Saleem MD, Abolyosr A, Aldahshoury M, Elbadry MS, Abdalla MA, et al. Extracorporeal shock wave lithotripsy as first line treatment for urinary tract stones in children: outcome of 500 cases. Int Urol Nephrol. 2012;44(3):661-6. DOI: 10.1007/s11255-012-0133-0 PMID: 22350835
23. Javanmard B, Razaghi MR, Ansari Jafari A, Mazloomfard MM. Flexible Ureterorenoscopy Versus Extracorporeal Shock Wave Lithotripsy for the Treatment of Renal Pelvis Stones of 10-20 mm in Obese Patients. J Lasers Med Sci. 2015;6(4):162-6. DOI: 10.15171/jlms.2015.12 PMID: 26705461