Accuracy of Radiological Features for Predicting Extracorporeal Shock Wave Lithotripsy Success for Treatment of Kidney Calculi

Hamid Arshadi,[1] Seyed Saied Dianat,[2] Leila Ganjehei[2]

Introduction: Our aim was to assess the accuracy of radiological characteristics observed by the urologist in estimating the success rate of extracorporeal shock wave lithotripsy (SWL) in patients with kidney calculi.

Materials and Methods: Patients with kidney calculi sized 10 mm to 15 mm who underwent SWL in our center were enrolled. One urologist estimated the success chance of SWL based on plain abdominal radiography. Accordingly, the patients were categorized into 2 groups with more than 75% chance of fragmentation (group 1) and with 50% to 75% estimated chance of fragmentation (group 2). Factors used for estimation included calculus shape, homogeneity, and density as compared with the adjacent 12th rib. The estimations were compared with the resulted stone-free rate after a 3-month follow-up.

Results: A total of 137 patients were studied, of whom, 92 (67.2%) were categorized in group 1 and 45 (32.8%) in group 2, before the lithotripsy. Successful treatment was recorded in 101 patients (73.7%). Eighty-five patients with favorable estimated chance of successful lithotripsy (92.4%) had successful SWL, and 29 with less favorable estimate (64.4%) did not have successful fragmentation following 2 sessions of SWL ($P < .001$). The sensitivity and specificity of radiological parameters for prediction of treatment success were 84.2% and 80.6%, respectively.

Conclusion: We found that certain radiographic features of urinary calculi such as calculus density, as compared with the adjacent bone, and calculus shape could have predictive impression for the success rate of SWL.

Keywords: urinary calculi, abdominal radiography, lithotripsy, treatment outcome

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[1]Department of Urology, Children's Medical center, Tehran University of Medical Sciences, Tehran, Iran
[2]School of Medicine, Tehran University of Medical Sciences, Tehran, Iran

Corresponding Author:
Hamid Arshadi, MD
Department of Urology, Children's Medical Center, Keshavarz Blvd, Dr Gharib St, Tehran, Iran
Tel: +98 21 6691 7646
E-mail: drhamidarshadi@yahoo.com

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INTRODUCTION

Extracorporeal shock wave lithotripsy (SWL) was first introduced into clinical practice as a treatment of ureteral calculi in the early 1980s.[1] Despite of the recent advances in endourologic methods for calculus removal, such as ureteroscopy and percutaneous nephrolithotomy, SWL still remains the primary treatment of most uncomplicated upper urinary tract calculi. However, the location, size, and composition of the calculus might affect the outcome of SWL.[2,3] Certain radiographic features of calculi and the urinary tract could have an impact on calculus clearance after therapy with SWL. It has been proposed that calculi with certain characteristics such as smooth shape, higher density than bone, lower calyx location, and

larger than 15 mm in diameter have less favorable success rate with SWL. [4]

Considering radiological features that could predict SWL success, it would be possible to select this type of treatment only for calculi that are more likely to respond to this modality. Alternatives such as percutaneous nephrolithotomy, ureteroscopy, and open surgery can be used in other situations. However, studies on the predictive role of radiological features are conflicting. Bon and colleagues studied the predictive value of shape and radiologic density of urinary calculi for SWL success and showed that smooth dense calculi had less success rate than rough and less dense calculi.[5] In another study by Aebreli and colleagues, no correlation was reported between radiographic appearance of the calculus and SWL treatment outcome.[6] To address some of these controversies, we designed the present study to assess the accuracy of radiological characteristics in estimating the success rate of SWL in patients with kidney calculi.

MATERIALS AND METHODS

A total of 143 consecutive patients (101 men and 36 women) were enrolled in the present study. They had kidney calculi sized 10 mm to 15 mm who were treated in our lithotripsy center between January and November 2007. Pregnancy, calculi smaller than 10 mm or larger than 15 mm, body weight more than 90 kg, large abdominal aortic aneurysm, and uncorrectable bleeding disorders were the exclusion criteria. The patients were diagnosed based on plain radiography, ultrasonography, and intravenous urography in suspected cases such as residual calculi in the ureter. Written informed consent was obtained from all of the patients for registering their imaging data and outcome of lithotripsy in our study. Lithotripsy was performed by Edap Technomed LTo2X (Vaulx-en-Velin, France) with ultrasound wave as the source of energy emitted to the calculus.

Pretreatment plain abdominal radiographies of the kidneys, ureters, and bladder were evaluated by one urologist in order to categorize the patients into 2 predictive groups based on certain radiological criteria (shape, size, and density of the calculus). The 1st group was estimated to have more than 75% chance of fragmentation (more favorable response to SWL), and the 2nd group constituted those with 50% to 75% estimated chance of fragmentation (less favorable response to SWL). Factors used for estimation included calculus shape, homogeneity, and density as compared with the adjacent 12th rib. It has been proposed that calculi with higher density compared with the adjacent bone and smooth surface are more difficult to be successfully treated with SWL.[5] Accordingly, the patients were categorized in either group 1 or group 2.

The patients were followed up for the outcome of lithotripsy, and a stone-free status within 3 months after lithotripsy was considered as successful treatment. The follow-up was performed by plain abdominal radiography and ultrasonography. Statistical analysis for the relationship between success rate and estimated chance of fragmentation was performed by the chi-square test, using the GraphPad Prism software (version 3.0, GraphPad Software Inc, La Jolla, California, USA). *P* values less than .05 were considered significant.

RESULTS

Six of the enrolled patients did not return for follow-up, finally, 137 patients were studied and considered in the analyses. Of those, 92 patients (67.2%) were categorized in group 1 and 45 (32.8%) in group 2, before the lithotripsy (Table). The maximum calculus diameter in both groups was 15 mm. Successful treatment was recorded in 101 patients (73.7%). Eighty-five patients with favorable estimated chance of successful lithotripsy (92.4%) had successful SWL,

Estimate of Shock Wave Lithotripsy Success Using Radiological Parameters*

	Estimation of Success		
Patients and Outcome	**> 75%**	**50% to 75%**	***P***
Number of patients	92	45	…
Sex			
Male	70 (69.3)	31 (30.7)	
Female	22 (56.5)	14 (43.5)	.37
Stone-free patients	85 (92.4)	16 (35.6)	< .001

*Values in parentheses are percents. Ellipsis indicates not applicable.

and 29 with less favorable estimate (64.4%) did not have successful fragmentation following 2 sessions of SWL (Table; $P < .001$). Accordingly, the sensitivity and specificity of radiological parameters for prediction of treatment success were 84.2% and 80.6%, respectively. The positive predictive value and the negative predictive value were 92.4% and 64.4%, respectively.

DISCUSSION

Shock wave lithotripsy was introduced to clinical practice as a treatment for urinary calculi in the early 1980s.[1] Currently, even with the refinement of endourologic methods for calculus removal such as ureteroscopy and percutaneous nephrolithotomy, SWL keeps its position through the therapeutic options for most of the urinary calculi sized less than 20 mm. Several factors might influence the success rate of SWL, including the size, location, and composition of calculi, as well as the type of energy used for lithotripsy. Although SWL is considered the treatment of choice for calculi less than 20 mm, certain calculus compositions are not considered favorable to fragmentation using this modality. However, it is not yet practical to identify the exact composition of most of the urinary calculi before the treatment in order to predict the chance of fragmentation.

Some investigators have studied the correlation of calculus composition with radiographic features. Dretler and Polykoff investigated the correlation of calculus composition of a calcium oxalate calculus crystallographically with radiographic parameters observed on plain radiography, in order to predict the success rate of lithotripsy for this type of calculi. They showed that shape and calculus radiodensity correlated with calculus composition. Therefore, smooth highly radiodense calculi were usually composed of calcium oxalate monohydrate which were less likely to be fragmented by SWL.[7]

To our knowledge, 3 clinical studies have been performed to determine the radiographic correlations with calculus fragmentation rate. In a study by Bon and coworkers, success rate for rough and less radiodense calculi was considerably higher than that of smooth and more radiodense ones (79.4% and 33.6%, respectively).[5] In another study by Aeberli and associates, no correlation was observed between calculus radiodensity and fragmentation using a Dornier HM-3 machine.[5] The most recent study was conducted by Krishnamurthy and colleagues to identify the proposed correlation between radiodensity of solitary renal pelvic calculi sized less than 2 cm and the outcome of lithotripsy. No correlation was found between calculus radiodensity and calculus composition. Calculi with the size of less than 10 mm were similarly fragmented regardless of radiodensity differences. However, higher success rate in calculi sized 10 mm to 20 mm with lower radiodensity was reported as compared to the adjacent rib (71% versus 60%).[4]

In the present study, we investigated the accuracy of the estimation of lithotripsy success rate with plain radiography by considering the success rate of lithotripsy after a 3-month follow-up. The overall success rate in our sample was 73.7%. We found that calculi with certain favorable radiographic features including size of less than 15 mm in diameter, lower radiodensity as compared to the adjacent rib, and smooth surface could be predicted to have also high success rate after treatment with SWL. Estimation of the success rate based on radiographic features could predict calculus fragmentation in our sample with sensitivity and specificity of 84.2% and 80.6%, respectively. Accordingly, it is suggested that several radiographic parameters observed by the urologist could predict the success rate of urinary calculi treatment using SWL. Also the present study shows that the urologist can predict successful treatment more reliably than failure to fragmentation. The limitation of our study was the lack of adjustment for calculus size to detect the independent predictive radiographic factor as well as using an inaccurate method to quantitatively assess calculus radiodensity. However, in order to overcome the interindividual bias on estimation of fragmentation, all of the radiography images were evaluated by a single urologist.

CONCLUSION

We found that certain radiographic features of urinary calculi could have predictive impression

for the success rate of treatment by lithotripsy. Considering several calculus radiographic features might be useful to recommend SWL for patients with more favorable estimate of response to treatment, and in another way, to recommend other therapeutic options such as endourologic treatments. This may be save time and reduce the costs in the treatment of this common urologic disease. Future studies in large samples are needed to confirm the results of the present study.

CONFLICT OF INTEREST

None declared.

REFERENCES

1. Schmiedt E, Chaussy C. Extracorporeal shock-wave lithotripsy (ESWL) of kidney and ureteric stones. Int Urol Nephrol. 1984;16:273-83.
2. Stroller ML. Urinary stone disease. Tanagho EA and Mcanineh JW. Smith's general urology, 17th ed. New York: Lange Medical Books/McGraw-Hill; 2008. p. 246-77.
3. Atala A, Steinbock GS. Extracorporeal shock-wave lithotripsy of renal calculi. Am J Surg. 1989;157:350-8.
4. Krishnamurthy MS, Ferucci PG, Sankey N, Chandhoke PS. Is stone radiodensity a useful parameter for predicting outcome of extracorporeal shockwave lithotripsy for stones < or = 2 cm? Int Braz J Urol. 2005;31:3-8.
5. Bon D, Dore B, Irani J, Marroncle M, Aubert J. Radiographic prognostic criteria for extracorporeal shock-wave lithotripsy: a study of 485 patients. Urology. 1996;48:556-60; discussion 60-1.
6. Aeberli D, Muller S, Schmutz R, Schmid HP. Predictive value of radiological criteria for disintegration rates of extracorporeal shock wave lithotripsy. Urol Int. 2001;66:127-30.
7. Dretler SP, Polykoff G. Calcium oxalate stone morphology: fine tuning our therapeutic distinctions. J Urol. 1996;155:828-33.