General Urology Genel Üroloji

Impact of gravity-related radiographic anatomic features on clearance of renal pelvis stones after extracorporeal shock wave lithotripsy

Vücut dışı şok dalga litotripsi sonrası böbrek pelvis taşlarının temizlenmesinde yerçekimine bağlı radyografik anatomik özelliklerin etkisi

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Abstract

Objective: To assess the effect of the gravity-related radiographic features on the success rate of extracorporeal shock wave lithotripsy (SWL) in renal stones.

Materials and methods: A total of 79 patients (mean age 47.34±12.9 year) who underwent SWL due to renal pelvis stones (mean area 162.58±130.31 mm²) between 2005 and 2008 were enrolled. Three angles on the pretreatment excretory urography were measured; the inner angle between the axis of the lower pole infundibular and ureteropelvic axis (angle 1), lower pole infundibular axis and main axis of pelvis-ureteropelvic junction point (angle 2), and lower pole infundibular axis and perpendicular line (angle 3). Age, number of session, stone burden, numbers of shock waves, and presence of hydronephrosis were defined for all patients. The significant predictors of stone-free rate after the application of SWL was defined.

Results: The success rate was 53.2%. All angles, number of sessions, stones burden, and number of shock waves were significant predictors of stone free rate. However, age, sex and the presence of hydronephrosis did not show similar effects.

Conclusions: Gravity-related factors have significant role on the stone-free rate in patients treated with SWL for renal pelvis stones. These radiographic parameters may be used to determine the patients who will benefit from SWL.

Key words: Renal anatomic features; shock wave lithotripsy; urolithiasis.

Özet

Amaç: Böbrek taşlarında vücut dışı şok dalga litotripsi (SWL) başarı oranında yerçekimine bağlı radyografik özelliklerin etkisini değerlendirmek.

Gereç ve yöntem: 2005-2008 yılları arasında böbrek pelvis taşı (ortalama alan 162.58±130.31 mm²) nedeniyle SWL uygulanan 79 hasta (ortalama yaş 47.34±12.9) çalışmaya dahil edildi. Tedavi öncesi çekilen intrvenöz peylografide üç acı ölçüldü; alt pole infindubular akseni ile ureteropelvic ekseni (açı 1), alt pole infindibular ekseni ile pelvis-ureteropelvic bileşik noktasının orta ekseni arasındaki açı (açı 2), alt pole infindibular ekseni ve perpendiküler hat arasında açı (açı 3). Her hasta için yaş, seans sayısı, taş yükü, vuruş sayısı ve hidronefroz varlığı belirlendir. SWL uygulanması sonrası taşsızlık oranını anlamlı belirleyicileri değerlendirildi.

Bulgular: Başarı oranı %53.2 idi. Tüm açılar, seans sayısı, taş yükü ve vuruş sayısı, taşsızlık oranını anlamlı olarak öngörmekteydi. Ancak yaş, cinsiyet ve hidronefroz varlığı ayni etki göstermedi.

Sonuç: SWL ile böbrek pelvis taşları kırılan hastalarda yerçekimine bağlı faktörler taşsızlık oranını anlamlı derece etkilemektedir. Bu radyografik parametrelerin SWL'den fayda görebilecek hastaları öngörmede yaralı olabilir.

Anahtar sözcükler: Böbrek anatomik özellikleri; böbrek taşı; şok dalga litotripsi.

Submitted (Geliş tarihi): 06.04.2010 *Accepted after revision (Düzeltme sonrası kabul tarihi):* 09.06.2010

Urolithiasis is a common disorder affecting 2-3% of the population in the developed countries.[1] In the guidelines of American Urology Association (AUA) and European Association of Urology (EUA) for renal calculi, extracorporeal shock wave lithotripsy (SWL) was recommended as the first-line treatment option when the largest diameters of the stone is less than 20 mm.[1,2] The success rates were reported to be between 58.3-83% in different series.[3,4] Although the significant predictors of the success rate after SWL therapy were not completely defined; stone related factors like, size, composition, and location were mostly accepted as significant factors. However, patient-related factors like obesity, renal function, and hydronephrosis, and renal anatomic features remain to be under discussion.[5-7] Some studies denied the effect of radiographic anatomic features on the success rate,[6,7] however, many studies confirm the opposite. The stone clearance was shown to be poorer for an actually angled than an obtusely angled inferior calyce and better for a shorter calyce with wider than a longer calyce with narrower infundibulum. Many studies investigated the impact of radiographic features of the lower calyce on the stone clearance of lower pole stones, but few studies evaluated the influence of the lower calyce anatomic features on the clearance of renal pelvis stones after SWL therapy. In this retrospective study, we aimed to define the effect of the gravity-related renal radiographic anatomic features on the clearance of renal pelvis stone after SWL therapy.

Material and methods

The study cohort consisted of 79 patients with mean age of 47.34±12.97 years (53 men, 26 women), who underwent SWL due to renal pelvis stones between 2005 and 2008. Demographic and clinical data of patients were shown in Table 1. Hydronephrosis was found in 43 patients-34 had mild, 10 had moderate and none had severe hydronephrosis. The inclusion criteria were radio-opaque stone, complete disintegeration of the stone, normal renal function, no stenting, no metabolic abnormalities, no previous renal surgery, and no major renal abnormalities. Complete disintegration was defined as complete fragmentations of the stone on fluoroscopy at the last session of SWL. The patients were treated with hydraulic lithotripter (ELMED, Turkey) on outpatient basis. No anesthesia was given, however non-steroidal analgesics were administered when necessary. Patients were evaluated by plain X-ray of the kidney, ureters and bladder (KUB), intravenous pyelography (IVP), urine analysis, urine culture, serum biochemistry, and coagulation test before the procedure. The stone burden was calculated by measuring two largest dimensions of the stone on the plain abdominal X-ray. The treatment was started at 13 kv, and the energy was increased step by step up to 19 kv. Therapy was terminated when complete fragmentation of the stone was noted on fluoroscopy. All patients were evaluated three months after the last session. The success was defined as complete absence of the fragments at the plain abdominal X-rays. Three angles on the pretreatment IVP were measured; the first angle was measured as an inner angle between the axis of the lower pole infundibular and ureteropelvic axis (angle 1) as defined by Elbahnas et al.[8] Other two angles were between lower pole infundibular axis and main axis of pelvis-ureteropelvic junction point (angle 2), and between lower pole infundibular axis and perpendicular line (angle 3) (Fig. 1). The effect of the gravity-related renal radiographic anatomic features on the stone clearance was assessed by evaluating the influence of these angles on the success rate. The significant predictors of success were calculated for the overall patients and the variations in significant factors of success according to the stone area and sessions number were determined.

Table 1. The demographic and clinical characteristics of the patients

Number of patients	79
Age (years, mean)	47.3
Sex (male/female)	53/26
Number of session (mean)	3.8
Angle 1 (degree, mean)	64.49
Angle 2 (degree, mean)	104.60
Angle 3 (degree, mean)	42.39
Number of shockwaves (mean)	10011
Area (mm^2, mean)	162.58
Hydronephrosis [n (%)]	43 (54.43%)
Success rate (%)	53.2%

Statistical analysis

The parameters of subgroups were compared with Students t test, Mann-Whitney U test, one-way and two-way analysis of variance (ANOVA), Kruskal-Wallis and chi-square tests. Multivariate analysis was used to determine the predictor factors of success rate. ROC Curve

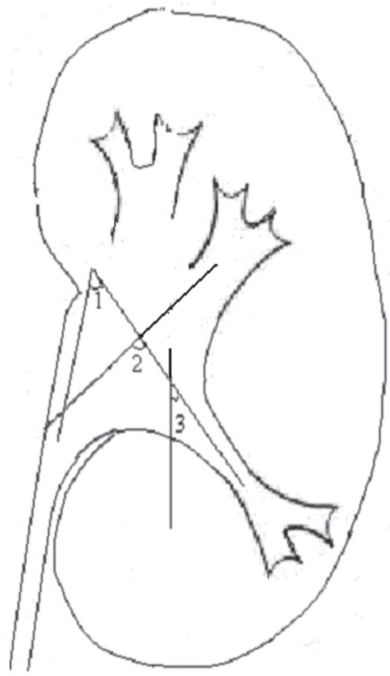

Figure 1 Method of measuring angles. Angle 1 is between the axis of the lower pole infundibular and ureteropelvic axis; angle 2 is between lower pole infundibular axis and main axis of pelvis-ureteropelvic junction point; and angle 3 is between lower pole infundibular axis and perpendicular line.

and Youden index were used for calculating optimal cut-off values for angles. SPSS for windows 10.0 statistical packet was used in statistical analysis. The level of significance was accepted as $p<0.05$.

Results

Forty-two patients (53.2%) became completely stone-free. Angle 1, angle 2, stone area, number of sessions, and total number of shock waves were found to be significant predictors of success ($p<0.05$). Angle 3 was a weak predictor of success ($p=0.053$). The cut-off values for all significant predictors of success were calculated (Table 2). The clinical variables of patients who became stone-free and patients who had residual fragments after SWL therapy were summarized in Table 3. While the presence of hydronephrosis, mean age, and sex distribution were similar in both groups, the mean values of stone burden, sessions number, total number of shockwaves, angle 1, angle 2, and angle 3 showed significant difference (Table 3).

Discussion

Since the first clinical application of SWL by Chausy et al.[9] in 1980 and due to its efficacy, efficiency and low morbidity, SWL became the first-line of treatment for all urinary calculi. However stone clearance after SWL has been shown to be affected by stone size, location, and chemical composition as well as by renal anatomy. The majority of the studies which investigate the effect of renal radiographic anatomic features on the stone clearance can be divided into two categories; gravity-related and non-related features. Calyceal anatomy of the lower pole and it is possible impact on stone clearance with SWL were first described by Sampaio and Aragao[10,11] and subsequently others described its significance.[8,12] The significant effect of infundibular length, width (gravity non-related factors), and infundibulopelvic angle (gravity related factors) on the stone clearance following SWL or ureteroscopy were reported.[13,14,8,10] Most of the studies investigated the effect of the anatomic features of the lower calyce on the stone clearance of the lower pole stones.[10,8,15] Herein, we investigated the probable effect of gravity-related anatomic features on the stone clearance not in patients with lower pole stones, but in patients with renal pelvis calculi.

Three angles were measured and the influence of these angles on stone clearance were assessed. Angle 1 was expected to measure the gravity effect on the lower calyce and this angle was defined firstly by Elbahnasy et al.[8] The angle between lower pole infundibular axis and main axis of pelvis-ureteropelvic junction point (angle 2) was noticeably different from others. The reason for this discrepancy in some reports was due to the difference in methodology of measurement of the angle.[8,12] In those studies the infundibulopelvic angle was the angle subtended by the infundibular and renal pelvis axes, and not the main axes of pelvis-ureteropelvic junction point. Up to our knowledge, the present report is the first on the measurement of the second angle and its influence on the effect of the stone clearance in patients with renal pelvis stones.

Patients with stents or abnormal values of creatinine were excluded. Because, it is well known that the stents may decrease the efficacy of SWL if it comes in the pathway of the waves and may interfere with the passage of the fragments,[16-18] Patients with high creatinine blood values were also reported to have low stone clearance.[5]

Table 2. The cut-off values for the all statistically significant predictors of success [n (%)]

	Clearance	Failure	Chi-square	p value
Angle 1 (degree)				
≤64	11 (28.21%)	28 (71.79%)	19.27	<0.001
>64	31 (77.50%)	9 (22.50%)		
Angle 2 (degree)				
≤107	12 (26.26%)	33 (73.33%)	29.48	<0.001
>107	30 (88.24%)	4 (11.76%)		
Angle 3 (degree)				
≤43	17 (40.48%)	25 (59.52%)	5.79	0.016
>43	25 (67.57%)	12 (32.43%)		
Stone area (mm^2)				
≤125	32 (72.73%)	12 (27.27%)	15.26	<0.001
>125	10 (28.57%)	25 (71.43%)		
Session number				
≤3	37 (88.10%)	5 (11.90%)	35.45	<0.001
>3	8 (21.62%)	29 (78.38%)		
Number of shock waves				
≤9225	38 (82.26%)	8 (17.39%)	38.34	<0.001
>9225	4 (12.12%)	29 (87.88%)		

Table 3. The clinical variables of patients who became stone-free and non-stone-free (mean±standard deviation or n)

	Clearance	Failure	p value
Age (year)	46.81±12.56	47.95±13.57	0.700[a]
Area (mm^2)	113.43±92.22	218.38±145.22	<0.001[a]
Angle 1 (degree)	69.76±11.32	58.43±9.46	<0.001[a]
Angle 2 (degree)	112.88±11.67	94.95±9.61	<0.001[a]
Angle 3 (degree)	44.62±12.34	39.86±8.56	0.046[a]
Number of sessions	2.4±1.47	5.38±1.86	<0.001[a]
Number of total shock waves	6207.12±3829.23	14330.84±5356.43	<0.001[a]
Female/male	15/27	11/26	0.57[b]
Hydronephrosis	21	22	0.40[b]

[a]Anova test, [b]Chi-square test.

Lingeman et al.[19] performed a meta-analysis in 13 published studies on the management of lower calculi with extracorporeal. They reported short-term stone-free rates ranging between 25% and 85%. The overall success rate was 60%. In our study the success rate was 53.2%, which is less than the reported rates.[19-27] This may be due to our definition of stone-free, complete absence of any opacity on plain film, including the absence of clinically insignificant residual fragments, however in the reported studies, patients with clinically insignificant residual fragments were considered as stone-free cases.

The mean values of the three angles for patients who became stone-free were significantly higher from values of those patients who did not become stone free. Angle 1 and angle 2 were found to have significant effect on the stone clearance. Thus the gravity related factors are important factors in predicting the success rate of SWL not only for patients with lower calyce stone as it reported in literature but also for patients with stones located in renal pelvis. Angle 3 was weak predictor of success, which means that gravity effect of the lower calyce or the perpendicularity of the lower calyce is not of determinant effect on the result of SWL therapy in patients with renal pelvis stone. However, the anatomic relation between lower calyce and pelvis (angle 1 and angle 2) seems to be of much significant in determining the stone clearance after SWL therapy.

Angle 1 was >64 degree in 40 patients and the stone free rate was 77.50%. Angle 2 was >107 degree in 34 patients and the stone-free rate was 88.24%. Angle 3 was >43 degree in 37 patients and the stone-free rate was 67.57%. These cut-off values of the angles enable us to determine the optimal position of the kidney where we can obtain the best success, thus to predict which patients may benefit more from SWL therapy. The cut-off values for session number and stone areas were also determined. We found that 37 patients underwent more than three sessions and the success rate was only 21.62% in these patients. Thus, although session number is significant predictor of success, application of more than three sessions seem to be of less benefit. Similarly the patients with stones area more than 125 mm² had low success rate (28.57%). The success rate in 23 patients who were found to have stone volume more than 125 mm² and more than three sessions, was 8.7% (2/23). Therefore, although radiographic angles remains to be significant factors of success in such patients, application of more than three sessions for patients with renal pelvis stone burden more than 125 mm² is not advocated due to low success rate.

Our study revealed that gravity-related radiographic anatomic features as well as stone burden, number of sessions and total number of shock wave play important role in determining the success rate after SWL in patients with renal pelvis stones. The angle between the axis of the lower pole infundibular and ureteropelvic axis (angle 1), and the angle between lower pole infundibular axis and main axis of pelvis-ureteropelvic junction point (angle 2) are easily measured on standard excretory urography. Determining the cut-off values of these angles and other significant predictors of success may help in detecting the renal anatomy and the patients who benefit from SWL.

Conflict of interest

No conflict of interest was declared by the authors.

References

1. Preminger GM. Medical management of urinary calculus disease: pathogenesis and evaluation. AUA Update Series 1995;14:1.
2. Tiselius H, Ackermann D, Alken P, Buck C, Conort P, Galluci M. Guidelines on urolithiasis: active removal of stones in kidney. EUA Guidelines 2006;14:22.
3. Graff J, Diederichs W, Schulze H. Long-term follow-up in 1003 extracorporeal shockwave lithotrpsy patients. J Urol 1988;140:479-83.
4. Ozgur A, Iker Y. Extracorporeal shock wave lithotripsy of renal pelvis stones with PCK stonelithotriptor. Int Urol Nephrol 2005;37:9-11.
5. Lee C, Ugarte R, Best S, Monga M. Impact of renal function on efficacy of extracorporeal shockwave lithotripsy. J Endo Urol 2007;21:490-3.
6. Sameh WM. Value of intravenous urography before shockwave lithotripsy in the treatment of renal calculi: a randomized study. J End Urol 2007;21:574-7.
7. El-Assmy, El-Nahas AR, Abo-Elghar ME, Eraky I, El-Kenawy MR, Sheir KZ. Predictors of success after extracorporeal shock wave lithotripsy (SWL) for renal calculi between 20-30 mm: a multivariate analysis model. ScientificWorldJournal 2006;23:2388-95.
8. Elbahnasy AM, Shalhav AL, Hoenig DM, Elashry OM, Smith DS, McDougall EM, et al. Lower caliciel stone clearence after shock wave lithotripsy or ureteroscopy: the impact of lower pole radiographic anatomy. J Urol 1998;159:676-82.
9. Chaussy C, Schmiedt E, Jocham D, Brendel W, Forssmann B, Walther V. First clinical experience with extra corporeally induced destruction of kidney stones by shock waves. J Urol 1982;127:417-20.
10. Sampaio F, Aragao A. Inferior pole collecting system anatomy: its probable role in extracorporeal shock wave lithotripsy. J Urol 1992;147:322-4.
11. Sampaio FJB, Aragao AHM. Limitations of extracorporeal shockwave lithotripsy for lower caliceal stones: anatomic insight. J Endourol 1994;8:241-7.
12. Sabnis RB, Naik, Patel SH, Desai MR, Bapat SD. Extracorporeal shockwave lithotripsy for lower calyceal stones: can clearance be predicted? Br J Urol 1997;80:853-7.
13. Gupta NP, Singh DV, Hemal AK, Mandal S. Infundibulopelvic anatomy and clearance of inferior calyceal calculi with shock wave lithotripsy. J Urol 2000;163:24-7.
14. Keeley FX Jr , Moussa SA, Smith G, Tolley DA. Clearance of lower-pole stones following shock wave lithotripsy: effect of the infundibulopelvic angle. Eur Urol 1996;36:371-5.

15. Sampaio F, D'Anuncia Áao A, Silva E. Comparative follow-up of patients with acute and obtuse infundibulum-pelvic angle submitted to extracorporeal shockwave lithotripsy for lower calyceal stones: preliminary report and proposed study design. J Endourol 1997;11:157-61.
16. Bierkens AF, Hendriks AJ, Lemmens WA, Debruyne FM. Extracorporeal shock wave lithotripsy for large renal calculi: the role of ureteral stents. A randomized trial. J Urol 1991;145:699-702.
17. Kato Y, Yamaguchi S, Hori J, Okuyama M, Kaneko S, Yachiku S. Utility of ureteral stent for stone street after extracorporeal shock wave lithotripsy. Hinyokika Kiyo 2005;51:309-14.
18. Damiano R, Oliva R, Esposito C, De Sio M, Autorino R, D'Armiento M. Early and late complications of double pigtail ureteral stent. Urol Int 2002;69:136-40.
19. Lingeman JE, Siegel YI, Steele B, Nyhuis AW, Woods JR. Management of lower pole nephrolithiasis: a critical analysis. J Urol 1994;151:663-7.
20. Cass AS, Grine WB, Jenkins JM, Jordan WR, Mobley TB, Myers DA. The incidence of lower-pole nephrolithiasis-increasing or not? Br J Urol 1998;82:12-5.
21. Rassweiler JJ, Köhrman KU, Seman O. Clinical comparison of SWL. In: Coe FL, Favus MJ, Park C, editors. Kidney stones: medical and surgical treatment. Philadelpia: Lippincott-Raven Publishers; 1996. p. 571.
22. Drach, GW, Dretler S, Fair WE, Finlayson B, Gillenwater J, Griffith D. Report of the United States cooperative study of extracorporeal shock wave lithotripsy. J Urol 1986;135:1127-33.
23. Gillenwater JY. Extracorporeal shockwave lithotripsy for the treatment of urinary calculi. In: Gillenwater JY, Grayhack JT, Howards S, editors. Adult and pediatric urology. St Louis: Mosby Year Book; 1991. p. 695.
24. Graff J, Diederichs W, Schulze H. Long-term follow-up in 1,003 extracorporeal shockwave lithotripsy patients. J Urol 1998;140:479-83.
25. May DJ, Chandhoke PS. Efficacy and cost-effectiveness of extracorporeal shockwave lithotripsy for solitary lower pole renal calculi. J Urol 1998;159:24-7.
26. Netto RN Jr, Claro JF, Lemos GC, Cortado PL. Renal calculi in lower pole calices: what is the best method of treatment? J Urol 1991;146:721-3.
27. Chen RN, Streem SB. Extracorporeal shockwave lithotripsy for lower pole calculi: long-term radiographic and clinical outcome. J Urol 1996;156:1572-5.

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doi:10.5152/tud.2010.031