Does Mild Hydronephrosis Induced by Full-Bladder Improve Outcomes in Patients Undergoing Shock Wave Lithotripsy for Lower Calyceal Stones?: A Prospective Randomized Study

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Purpose: To compare the outcomes, sessions and shock wave numbers in patients undergoing standard procedure shock wave lithotripsy (SWL) and patients undergoing SWL with mild hydronephrosis induced by full-bladder following oral hydration before SWL procedure for lower calyceal stones.

Materials and Methods: Between January 2014- January 2016 a total of 371 patients who underwent SWL, for lower pole calyceal stones ≤ 2 cm, were included into the study. 127 patients were treated in the supine position (Group A), 123 in the prone position (Group B) and 121 in the prone position with full bladder and mild hydronephrosis checked by ultrasound before procedure (Group C). There were 286 men and 85 women with a mean ± SD age of 36 ± 11 years

Results: The mean (SD) stone sizes within the group A, group B and group C were 11 mm (±3 mm), 12 mm (±4.1 mm) and 11 mm (± 3.8 mm) respectively. No significant difference was found in age (P = .18) and stone size between 3 groups (P = .07). The median interquartile range (IQR) number of shocks within the group A, group B and group C were 7600 (3855), 6500 (4300) and 6700 (4915) respectively. Significant difference was found in number of shock waves among 3 groups (P < .01). The difference between groups according to stone expulsion rate was found significant in all sessions (P = .01).

Conclusion: The present study suggests that mild hydronephrotic status induced by full-bladder before SWL can lower cost and patient discomfort by decrease in number of sessions and increase in stone clearance.

Keywords: hydronephrosis; lower pole calyx stones; shock wave lithotripsy; Stone free rate.

INTRODUCTION

Shock wave lithotripsy (SWL) is a non-invasive treatment method for kidney stones less than 2 cm in diameter and is recommended in urological guidelines. The number of lower calyceal kidney stones treated with SWL has been increasing as the technique of devices becomes elaborated.[1] However, the difficult clearance of lower calyceal stones after SWL remains to be an important issue.[2] To solve the underlying problem of poor drainage in lower pole renal calices with consequent poor stone clearance rates, auxiliary methods consisting of diuresis and various patient positions have been suggested to increase urine production by high fluid intake or diuretic administration just before the SWL session to flush out stone fragments, and to use gravity force favoring displacement of stone fragments by placing the patient in the prone and/or Trendelenburg position.[3,4] Despite several reports supporting the benefits of diuresis and patient position, the prone position is studied for ureteral stones and diuresis is assured either with water drinking and/or diuretics before procedure. To the best of our knowledge, a study comparing the outcomes of SWL in supine position, prone position and prone position with hydronephrosis induced by full bladder has not been published. The present study compared the stone free (SF) rates, session and shock wave numbers for lower pole kidney stones in patients receiving SWL among these 3 groups.

METHODS

Study population

Between January 2014- January 2016 a total of 371 patients who underwent SWL, for lower pole calyx stones ≤ 2 cm, were included into the study. The study protocol was reviewed and approved by the institutional ethics committee.

Inclusion and exclusion criteria

The inclusion criteria are as follows: age of 18 years or more, solitary renal lower calyceal calculi between 4 and 20 mm, and consent to randomization. Exclusion criteria were non-lower calyceal stones of the same side, renal anatomical deformities such as urethral stricture or ureteropelvic junction obstruction, concomitant

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Table 1. Patients 'and stones 'characteristics.

Characteristics	Group A(n=127)	Group B(n=123)	Group C(n=121)	*P* value
Patients' gender (M/F)98/29	97/24	91/32	0.5	
Patients' age mean ± SD	35 ± 11	35 ± 11	37 ± 11	0.18
Body mass index (kg/m^3)	25.4 ± 3.7	26.1 ± 4	25.9 ± 3.9	0.3
Stone size(mm) mean ± SD	11 ± 3	12 ± 4.1	11 ± 3.8	0.07
Skin to stone distance (cm)	10.7 + 1.5	10.8 + 1.6	10.7 + 1.6	0.6
Stone density (Hounsfield units)	565 ± 153	589 + 168	577 + 166	0.59

distal obstruction, renal insufficiency or grade 3 hydronephrosis of the affected kidney, pregnancy, bleeding diathesis, significant cardiac conditions or uncontrolled hypertension. Flow diagram of the study are summarized in **Figure 1**.

Study design and procedures

All subjects included into this single-blind prospective study were simply randomized to supine (group A), prone (group B) and prone plus hydronephrosis induced by bladder fullness (group C). SWL was performed with Storz Modulite Fx by the attending urologist using real time ultrasound for stone localization. Treatment was initiated at 14 kV, and the energy gradually increased between 20 and 24 kV, depending on the maximum level that the patient could tolerate. The numbers of shock waves (SW) used were determined by calyceal stone sizes; 4-10mm stones (1500 SW), 11-15 mm (2000 SW), and 16-20 mm (2500 SW).

Outcome assessments

Patients' follow-up visits were scheduled immediately at weeks 1, 4, 10, and 6 months after SWL therapy, with an evaluation using plain film of the kidney, ureter, and bladder and ultrasound imaging. The radiologists who performed ultrasonography or reported KUB were totally blind to the study objectives and protocols. The cumulative of patients who became SF at each week designated our total SFR. Cases were accepted as SF if there were no radiological and ultrasonographic evidence of stone as confirmed by a blinded radiologist. Stone Free status was defined as having no visible residual stone or fragment. SF were recorded in all follow-up visits. Complications during and after treatment were recorded.

Statistical analysis

Data were checked and analyzed using SPSS software (SPSS, Chicago, IL). Quantitative data were expressed as mean□standard deviation if the normality assumption was satisfied in groups otherwise they were expressed as median (interquartile range =IQR), whereas qualitative data were expressed with frequencies and proportions. One way analysis of variance (ANOVA) was employed for comparison between groups if the normality assumption was met and Kruskal-Wallis test was employed otherwise. Fisher's exact test and Chi-square test were used to compare groups with respect to nominal variables. The Marascuillo procedure was employed to simultaneously test the differences of all pairs of proportions where a difference is considered statistically significant if its value exceeds the critical range value. *P* = .05 was considered significant.

RESULTS

The mean standard deviation (SD) of stone sizes within the group A, group B and group C were 11 mm (± 3 mm), 12 mm (± 4.1 mm) and 11 mm (± 3.8 mm) respectively. Using a chi-square test, no difference was found in gender proportion between 3 groups (*P* = .5). No significant difference was found in age, body mass index, stone size, stone density and skin to stone distance between 3 groups (**Table 1**).

The median interquartile range (IQR) number of shocks within the group A, group B and group C were 7600 (± 3855), 6500 (± 4300) and 6700 (± 4915) respectively. Using Kruskal Wallis rank sum test, significant difference was found in number of shocks between 3 groups (*P* = .01) (**Table 2**).

After one session, stone expulsion rate of 13% (17 out of 127patients) was observed in group A, 28% (34 out of 123 patients) was observed in group B and 40% (48 out of 121 patients) was observed in group C. The difference between groups was found significant using a Chi-square test (*P* = .01).

After the second session, stone expulsion rate of 48% (62 out of 127patients) was observed in group A, 67% (82 out of 123 patients) was observed in group B and 80% (97 out of 121 patients) was observed in group C. The difference between groups was found significant using a Chi-square test (*P* = .01).

After the third session and more, stone expulsion rate of 67% (115 out of 127patients) was observed in group A, 86% (101 out of 123 patients) was observed in group B and 87% (106 out of 121 patients) was observed in group C. The difference between groups was found significant using a Chi-square test (*P* = .01). The stone expulsion rate in all sessions was found significantly different between group A and group B and between group A and group C. Both group B and C showed a statistical advantage over group A in terms of stone expulsion rate in all sessions. (**Table 2**)

Marascuillo procedure states that the stone expulsion rate after three or more sessions were found significant-

Table 2. Shock wave lithotripsy treatment parameters and the results of treatment

SWL Parameters	Group A(n=127)	Group B (n=123)	Group C (n=121)	*P* value
Number of shockwaves median(IQR)	7600 (± 3855)	6500 (± 4300)	6700 (± 4915)	< 0.01
Stone free after first session, n(%)	17 (13%)	34 (28%)	48 (40%)	< 0.01
Stone free after second session, n(%)	62 (49%)	82 (67%)	97 (80%)	< 0.01
Stone free after third session, n(%)	85 (67%)	101 (82%)	106 (88%)	< 0.01

Abbreviation: IQR, Inter quartile range

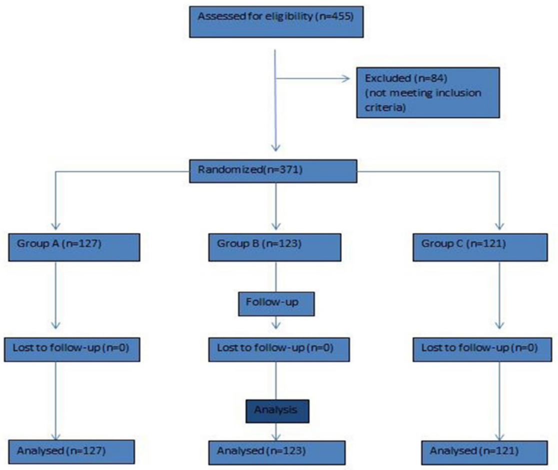

Figure 1. Flow diagram of the study.

ly different between group A and group C. Group C showed a statistical advantage over group A in terms of stone expulsion rate after three or more sessions (**Table 3**).

DISCUSSION

Achieving SF status for renal lower pole stones after SWL treatment remains a controversial issue. SWL is a noninvasive and ambulatory modality for removal of lower calyceal stones. According to the European guidelines for urolithiasis management, SWL is considered the treatment of choice in the absence of unfavorable factors for calyceal stones smaller than 20 mm.(5)
In order to achieve complete clearance of stones after SWL, supportive measures are attempted to overcome unfavorable condition of the lower calyx.(6) Parenteral or oral hydration, inversion and pharmacologic diuresis have been utilized to dislodge stone fragments and all these are well tolerated by patients after SWL.(7)
In several previous series, patients which were placed into prone trendelenburg position at 45º-70º, were administered diuretics and oral hydration immediately before therapy, underwent flank percussion. The results suggest the contributing effect of auxiliary methods in stone fragments expulsion.(7,8) In this study, we prospectively evaluated the combined effect of both hydronephrosis induced by full-bladder and prone positioning in improving the clearance of fragmented lower calyceal stones and overall SF rates. The aim was to enhance the effect of gravity by prone positioning with fragment flushing by induced hydronephrosis during SWL avoiding the discomfort in exagerated inverted position previously reported in other series. The positioning of the patient for all urinary stone locations remains to be a controversial issue; there is a debate about the positioning of patients during SWL. Some authors believe that supine position is cost effective with low morbidity. On the other hand, some authors are in favor of prone positioning.(9) Beside the role of prone or supine positioning, higher fluid amount with lower viscosity in calyces is of utmost important not only to increase pressure for easy expulsion of fragments but also for sufficient acoustic cavitation to assure fragmantation. In order to understand this effect, one must remember that SWL acts through four mechanisms; compressive fracture, spallation, acoustic cavitations, and dynamic fatigue.(10) Cavitation is the leading mechanism of SWL action in fragmentation. This acoustic phenomena requires high amount of fluid with low viscosity. In the actual disintegration process, the high-speed imaging analysis displays the progress of stone fragmentation related to time. First cracks appear to be produced by the initial shockwave. Then, after the surrounding fluid penetrates the cracks, the actual disintegration of stone substance occurs as a result of collapsing cavitation bubble.(11) In the present study as well, we tried to increase hydrostatic pressure in the renal calyces and pelvis through oral hydration and full-bladder without causing positional discomfort to the patient. There are some limitiations to our study; first, we did not classify the SF rates according to stone sizes, second, lack of data on stone composition.

CONCLUSIONS

The prone position and naturally induced hydronephrosis seem to have significantly adjunct effect on SWL treatment of lower calyceal stones. Therefore, we suggest that prone position with bladder fullness coincide with better outcomes in SWL patients.

CONFLICT OF INTEREST

None declared.

REFERENCES

1. Lingeman JE, Siegel YI, Steele B, et al. Management of lower pole nephrolithiasis: a critical analysis. J Urol. 1994; 151: 663-7.
2. Raman JD, Pearle MS. Management options for lower pole renal calculi. Cur Opin Urol. 2008; 18: 214-9.
3. Albanis S, Ather HM, Papatsoris AG, et al. Inversion, hydration and diuresis during extracorporeal shock wave lithotripsy: does it improve the stone-free rate for lower pole stone clearance? Urol Int.2009; 83: 211-216.
4. Cakiroglu B, Sinanoglu O, Tas T, Hazar IA, Balci MBC. The effect of inclined position on stone free rates in patients with lower caliceal stones during SWL session. Arch Ital Urol Androl. 2015; 87: 38-40.

Table 3. Post hoc analyses for expulsion proportions within each week

	1st session Absolute Difference	Critical Range	2nd session Absolute Difference	Critical Range	3rd or later session Absolute Difference	Critical Range
A versus B	0.15*	0.12	0.04	0.15	0.03	0.12
A versus C	0.27*	0.13	0.05	0.15	0.11*	0.10
B versusC	0.12	0.15	0.01	0.15	0.08	0.10

*: significant difference

5. Turk C, Knoll T, Petrik A, et al. EAU Guidelines for Urolitihiasis.2014

6. Leong WS, Liong ML, Liong YV, et al. Does simultaneous inversion during extracorporeal shock wave lithotripsy improve stone clearance: a long-term, prospective, single-blind, randomized controlled study. Urology. 2014; 83:40-4.

7. Chiong E, Hwee ST, Kay LM, Liang S, Kamaraj R, Esuvaranathan K. Randomized controlled study of mechanical percussion, diuresis and inversion therapy to asist passage of lower pole renal calculi after shock wave lithotripsy. Urology. 2005;65:1070-4.

8. Pace KT, Tariq N, Dyer SJ, et al. Mechanical percussion, inversion and diuresis for residual lower pole fragments after shock wave lithotripsy: a prospective, single blind, randomized controlled trial. J Urol 2001; 166: 2065–71.

9. Elahian A, Ghorbani N, Tavoosi A. Comparison of the Effect of Body Position, Prone or Supine, on the Result of Extracorpreal Shock Wave Lithotripsy in Patients with Stones in the Proximal Ureter Afshar Zomorrodi. Saudi J Kidney Dis Transpl 2007; 18: 200-5

10. Zomorrodi A, Golivandan J, Samady J. Effect of diuretics on ureteral stone therapy with extracorporeal shock wave lithotripsy. Saudi J Kidney Dis Transpl 2008; 19(3): 397-400.

11. Azm TA, Higazy H. Effect of diuresis on extracorporeal shockwave lithotripsy treat¬ment of ureteric calculi. Scand J Urol Nephrol. 2002; 36(3): 209-12.