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Assessment of the Ideal Time Interval between Repeated Shock Wave Lithotripsy Sessions for Renal Stones

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ABSTRACT

Background: An extracorporeal shock wave lithotripsy (ESWL) procedure is frequently used to treat upper urinary tract urolithiasis.

Objective: Determining the optimal interval between repeated sessions of shock wave lithotripsy for renal stones.

Patients and Methods: Between June 2021 and February 2022, three groups of thirty-six patients underwent elective outpatient lithotripsy for renal stones. Patients who required many SWL sessions were studied and classified into 3 groups, 12 patients each. The first group's SWL sessions were separated by three days, while the second group's sessions were separated by one week. Those in the third group, sessions were repeated after two weeks. Three groups were compared on the VAS scores they recorded during and after the ESWL.

Results: Stone clearance rates were 83.3%, 75.0%, and 91.7% (P= 0.54) for groups 1, 2, and 3. There was no significant difference between three groups as regard laboratory parameter (B2-microglobulinuria and Microalbuminuria) after 1st session, after 2nd session the laboratory parameter was significantly higher in group 1 with no significant difference between groups 2 and 3. All groups increased after 2nd session then decreased after one month. Steinstrasse was insignificantly associated with group 3 (8.33%, P =0.51).

Conclusion: Our findings support the transient effect of ESWL through measurement and follow up the laboratory parameters and possible complications. We concluded using SWL to treat renal stones is safe and effective, and short-interval treatments do not raise the risk of complications.

Keywords: Laboratory parameter (B2-microglobulinuria and Microalbuminuria), Renal stones, Repeat sessions, Shock wave lithotripsy.

INTRODUCTION

Long before the advent of ESWL in the field of kidney stone treatment, this technique was used to treat kidney stones. SWL has been recommended as an alternative to endoscopy for the treatment of renal calculi larger than 1 centimetre but smaller than 2 centimetres, according to the most recent standards [(1)]. Outpatients can benefit from SWL because it doesn't require anesthesia and has a low risk of consequences [(2)].

Repeated SWL treatment of kidney stones have been linked to renal damage, as is well-documented [(3)]. "There are no solid data on periods required between repeated SWL sessions," as indicated by EUA standards for 2019. However, clinical evidence shows that more sessions can be successfully completed (within 1 day for ureteral stones) [(4)].

We aimed to determine the optimal interval between repeated sessions of shock wave lithotripsy for renal stones.

PATIENTS AND METHODS

The trial included 36 patients who reported to the Urology Department with a kidney stone between June 2021 and February 2022 and were treated with ESWL using an electromagnetic Dornier lithotripter. Patients were grouped equally and randomly in 3 Groups, (Group 1 performed ESWL within 3 days intervals, group 2 within 7 days intervals, and group 3 within 14 days intervals).

Inclusion criteria:

1. Aged > 18 years.
2. Renal stone burden in an adult patient less than two centimeters in a normally functioning kidney.

Exclusion criteria:

1. Uncontrolled hypertension.
2. Renal insufficiency, GFR less than <60 ml/min/1.73m^2.
3. Uncontrolled coagulopathy.
4. Morbid obesity; body mass index (BMI) >35 (stone to skin distance >10 cm).
5. Uncontrolled urinary tract infection.
6. Pregnancy.
7. Patients who had received treatment for less than two sessions were excluded from the study.
8. Single kidney.
9. Massive hydronephrosis.
10. Elevated microalbuminuria prior to 1st SWL session (> 30 mg/day).
11. Radiolucent stone.

Pre-procedural evaluation:

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For all patients enrolled complete history taking including name, age, sex, residence, establishment of the inclusion criteria and exclusion criteria, weight and height measurement to calculate BMI.

Laboratory Investigations:

Blood sample: Kidney function test and a complete blood count (CBC).

An evaluation of the liver's function, Partial thromboplastin time (P.T.T), international normalized ratio (INR), and prothrombin time (I.N.R)**.**

Urine Samples: Urine was obtained before SWL session for urine analysis, culture and sensitivity, microalbuminuria (for glomerular damage) and B2 microglobulinuria (for tubular damage) over 24 hours' collection before and after 1st ESWL session, after 2nd ESWL and after one month from 2nd session.

Radiological Investigation:

- ESWL sessions begin with a pre-treatment NCCT scan, which identified stone criteria based on the volume of the stone, the side of the stone, the location of the stone, the density of the stone, and the presence of hydronephrosis.
- Pelvi-abdominal X-ray (KUB) for assessment of stone between sessions.
- Pelvi-abdominal ultrasound (P.A.U.S) for assessment of kidney injury and perinephric collection, hematoma and renal morphological change after each session.

Postoperative:

All cases recruited after 1 month for NCCT to assess stone free rate (SFR), Microalbuminuria (for glomerular damage) and B2 microglobulinuria (for tubular damage) over 24 hours' collection, pelvi-abdominal ultrasound (P.A.U.S) for assessment kidney injury and perinephric collection, hematoma and renal morphological change.

Ethical consent:

An approval of the study was obtained from Zagazig University Academic and Ethical Committee. Every patient signed an informed written consent for acceptance of participation in the study. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Statistical analysis

The Statistical Package for the Social Sciences, version 20, was used to execute analyses of the data collected (SPSS). The mean and standard deviation were used to represent the quantitative data, which were compared by one-way ANOVA test or Kruskal-Wallis test if data were parametric or nonparametric respectively. Qualitative data were represented as frequency and proportions, and were compared by Pearson Chi-Square test (X^2). Significant results were defined as those with a p value of 0.05 or lower.

RESULTS

Study groups did not differ significantly as regard the demographic data **(Table 1).**

Table (1): Demographic data

			Group 1	Group 2	Group 3	F/ X^2	P
Age (years) mean ± SD			46.33±9.11	43.08±4.92	45.0±11.72	0.392*	0.679
BMI mean ± SD			28.29±2.05	29.93±2.98	28.79±2.99	1.154*	0.328
Residence	**Rural**	**N**	7	3	4		
		%	58.3%	25.0%	33.3%		
	Urban	**N**	5	9	8	3.03***	0.21
		%	41.7%	75.0%	66.7%		
Sex	**Female**	**N**	3	6	8		
		%	25.0%	50.0%	66.7%		
	Male	**N**	9	6	4	4.23***	0.12
		%	75.0%	50.0%	33.3%		
Total		**N**	12	12	12		
		%	100.0%	100.0%	100.0%		

(*F: ANOVA, ***X^2: Chi square test)

Regarding the stone characters there was no significant difference among groups **(Table 2).**

Table (2): Stone characters

			Group 1	Group 2	Group 3	F/ X^2	P
Stone (longest diameter by mm) mean ± SD			149.31±56.3	123.89±41.23	139.58±47.1	0.841*	0.411
Hu mean ± SD			943.08±171.4	1055.5±259.7	1143.66±306.5	1.907**	0.165
Side	**LT**	**N**	9	10	6		
		%	75.0%	83.3%	50.0%		
	RT	**N**	3	2	6	3.40***	0.18
		%	25.0%	16.7%	50.0%		
Site	**Lower calyceal**	**N**	3	4	2		
		%	25.0%	33.3%	16.6%		
	Multiple	**N**	2	2	2		
		%	16.7%	16.7%	16.7%		
	Pelvic stone	**N**	4	5	4	3.89***	3.89
		%	33.3%	41.7%	33.3%		
	Upper calyceal	**N**	3	1	4		
		%	25..0%	8.3%	33.3%		
Total		**N**	12	12	12		
		%	100.0%	100.0%	100.0%		

(*F: ANOVA, **: Kruskal-Wallis, ***X^2: Chi square test)

After the second session level of microalbuminuria was significantly higher in group 1 with no significant difference between groups 2 and 3. Microalbuminuria increased in all the groups after 2nd session then decreased after one month **(Table 3)**.

Table (3): Microalbuminuria distribution among studied groups at different times

	Group 1	Group 2	Group 3	F	P
M- albuminuria pre ESWL (mg/24 hr)	25.07±2.33	25.63±2.89	26.26±2.09	0.703*	0.502
M- albuminuria after 1st ESWL (mg/24 hr)	76.50±18.81	82.14±6.82	97.26±14.68	2.923*	0.067
M- albuminuria after 2nd ESWL (mg/24 hr)	229.02±69.86	151.94±16.71	142.88±9.27	15.490*	<0.01
M –albuminuria after one month (mg/24 hr)	35.98±8.05	36.20±7.33	30.53±3.43	2.852*	0.072

F: ANOVA:*

After the second session level of B2 microglobulinuria was significantly higher in group 1 with no significant difference between groups 2 and 3. Microalbuminuria increased in all the groups after 2nd session then decreased after one month **(Table 4).**

Table (4): B2 Microglobulinuria distribution among studied groups at different times

	Group 1	Group 2	Group 3	F	P
B2 M-globulin pre ESWL (mcg/Liter**)**	265.0±9.77	261.66±8.87	262.33±9.19	0.433	0.652
B2 M-globulin after 1st session (mcg/Liter**)**	392.66±22.6	372.58±26.32	380.33±20.06	2.294	0.117
B2 M-globulin after 2nd session (mcg/Liter**)**	586.0±101.61	406.08±33.57	404.66±11.26	33.808	<0.01
B2 M-globulin after month (mcg/Liter**)**	284.16±7.91	282.83±13.12	279.99±19.3	2.834	0.074

F: ANOVA test

Difference in stone free rate (SFR) was not significant among studied groups **(Table 5).**

Table (5): Stone free rate distribution among studied groups

			Group			X^2	P
			Group 1	Group 2	Group 3		
Residual stone size After one month	**< 4 mm**	**N**	10	9	11		
		%	83.3%	75.0%	91.7%		
	> 4 mm	**N**	2	3	1	1.2	0.54
		%	16.7%	25.0%	8.3%		
Total		**N**	12	12	12		
		%	100.0%	100.0%	100.0%		

X^2: Chi square test

Table 6 shows distribution of complications among studied groups. No case reported for perinephric collections in all groups. Regarding to gross hematuria follow up after 2nd session it was significantly associated with Group 1 up to 48 hours with no significant difference between other two groups. Steinstrasse was insignificantly associated with Group 3 with two cases reported.

Table (6): Distribution of complications among studied groups

			Group			X^2	P
			Group 1	Group 2	Group 3		
Perinephric collections follow up	**- VE**	**N**	12	12	12		
		%	100.0%	100.0%	100.0%		
	+VE	**N**	0	0	0	0.0	1.0
		%	0.0%	0.0%	0.0%		
Gross hematuria follow up after 2nd session	**< 24hr**	**N**	0	8	12		
		%	0.0%	66.7%	100.0%		
	> 24hr	**N**	3	4	0	32.91	<0.01**
		%	25.0%	33.3%	0.0%		
	> 48hr	**N**	9	0	0		
		%	75.0%	0.0%	0.0%		
Steinstrasse	**-VE**	**N**	12	12	10		
		%	100.0%	100.0%	83.3%		
	+VE	**N**	0	0	2	4.235	0.12
		%	0.0%	0.0%	16.7%		
Blood loss (Needing for blood transfusion)	**-VE**	**N**	12	12	12		
		%	100.0%	100.0%	100.0%		
	+VE	**N**	0	0	0	0.0	1.0
		%	0.0%	0.0%	0.0%		
Pyuria	**-VE**	**N**	11	12	10		
		%	91.7%	100.0%	83.3%	2.18	0.33
	+VE	**N**	1	0	2		
		%	8.3%	0.0%	16.7%		
Fever	**-VE**	**N**	11	11	10		
		%	91.7%	91.7%	83.3%	0.56	0.75
	+VE	**N**	1	1	2		
		%	8.3%	8.3%	16.7%		
Total		**N**	12	12	12		
		%	100.0%	100.0%	100.0%		

X^2: Chi square test

Regarding pain assessment by visual analogue scale (VAS) after 1st and 2nd session there was no significant differences among studied groups **(Table 7)**.

Table (7): Distribution of renal colic among studied groups

	Group 1	Group 2	Group 3	F	P
VAS 1st session	4.31±1.21	4.28±0.96	4.12±1.11	0.285	0.812
VAS 2nd session	4.42±1.08	4.25±1.22	4.27±1.07	0.458	0.598
P	0.15	0.385	0.12		

VAS: Visual analogue scale, F: ANOVA test

DISCUSSION

Urolithiasis is one of the most common urological conditions, accounting for between 1% and 13% of the world's population. Factors including economic growth, obesity rates, food, climate change, and other health problems might affect the incidence and prevalence of urolithiasis [(5)].

More intrusive treatments like pyelolithotomy and nephrolithotomy have a greater impact on kidney function than the use of minimally invasive techniques like SWL and PNL in the treatment of individuals with renal stones [(6)]. Treatment for kidney stones smaller than 2 cm in diameter prior to surgery was limited until 1980 when non-invasive extracorporeal shock wave lithotripsy (ESWL) became available. This treatment revolutionized the treatment of kidney stones due to its low cost, shorter hospital stays, reduced anesthesia exposure, fewer complications and higher efficacy [(7)].

There were 36 patients in our study who had renal stones ranging in density from 500 to 1200 Hu, and they were separated into three groups, each with a 1:1:1 randomization. All groups received two sessions of ESWL at a 3-day, 7-day, and 14-day interval.

In our investigation, all patients were treated with SWL using the same procedure by the same technician and had identical clinical characteristics. There was no evidence that patients who had previously undergone JJ stents prior to SWL were any less likely to be successful. Multiple blood and urine tests were used by numerous research centres to examine the impact of SWL and percutaneous nephrolithotomy (PCN) on renal function [(8,9)].

Our study showed significant difference in laboratory data of the three groups with significant difference was noted for pre- and post-procedure B2 Microglobulinuria and Microalbuminuria after 2nd session, Group 1 was significantly higher than other two groups and after one month there was no significant difference among groups. In general all groups significantly increased after 2nd session then significantly decreased after one month which goes in line with study done to investigate the effects of extracorporeal shock wave lithotripsy (ESWL) and percutaneous nephrolithotomy (PCN) on renal function and urinary prostaglandin excretion, performed on 40 patients (20 ESWL patients, 20 PCN patients). The study concluded a rise in urinary prostaglandin excretion after ESWL and PCN, and all results had returned to normal by two weeks [(10)].

Another study in 2013 was performed on 50 patients. The study concerned about urinary expression after SWL session represented by kidney injury molecule 1 (KIM-1) and N-acetyl-β-D-glucosaminidase (NAG), the study concluded that KIM-1 and NAG levels significantly increased post-SWL and returned to baseline within 2 weeks post-SWL [(11)].

Regarding complications in our study there was no case reported in all groups with a perinephric collection hematoma, and this result is supported by retrospective study done in Spain between the years 1992-2007 on 4815 subjects, where only seven patients treated by ESWL had perinephric hematoma, a rare complication that is handled conservatively [(12)].

Regarding gross hematuria follow up, nearly 100 percent of renal stones treated by ESWL resulted in gross hematuria, and in our study most patients in group 1 complained of gross hematuria up to 48 hours after the 2nd session. All patients were treated conservatively and gross hematuria subsided gradually without intervention or blood transfusion.

Steinstrasse was insignificantly associated with Group 3 (8.33%) with two cases reported; one case was treated conservatively by medical expulsive therapy (MET) and the other case was treated endoscopically. In a 2015 study, 80 patients with upper ureteric stones were divided into two groups according on the frequency of SWL sessions (group one 40 patients underwent SWL session with short intervals 1 day and group two 40 patients underwnt SWL session within 7 days intervals). It was found that there was no statistically significant increase in the probability of steinstrasse following lithotripsy with a short interval (3 cases 7.5%). Medical expulsive therapy (MET) may lessen the need for endoscopic treatments in patients who are asymptomatic following steinstrasse [(13)].

Regarding stone free rate in our study, it was 83.3% in group 1, 75.0% in group 2, and 91.7% in group 3, which goes in line with eight-year period study performed on 461 patients to determine the efficacy of ESWL. Study results showed a 69% success rate after

the first ESWL surgery, with a 93% success after additional sessions [(14)].

The fever, pyuria, and renal colic, after SWL groups did not differ significantly, and these results reflect the good preparation of patients before start session of SWL represented by -ve urine culture and sensitivity, course of antibiotics to +ve urine culture until become sterile, prophylactic dose of antibiotics after each session, and finally good analgesia after SWL.

CONCLUSION

It is safe and effective to use short-interval SWL sessions to treat renal stones. The study also concluded and supported the transient effect of SWL through measurement and follow up of the laboratory parameters (microalbuminuria and B2 microglobulinuria) and we found that the kidney can reverse and overcome the effect of SWL, even when repeated within a short intervals.

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