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ORIGINAL PAPER

Shock wave lithotripsy for distal ureteric stones: supin or prone

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Abstract Shock Wave Lithotripsy (SWL) has become the preferred first-line approach to most patients with symptomatic urolithiasis. The purpose of this study is to assess the ideal patient position during SWL for the treatment of distal ureter stones. A total of 342 patients included in this retrospective study. 148 (108 men, 40 women) patients were included in the first group and were treated in supine position. The remaining 194 (143 men, 51 women) patients were included to second group and were treated in prone position. This study designed retrospectively. The procedure was accepted as a success if the patient was stone free or had only clinically insignificant fragments ($\leq$3 mm) for 3 months or more after the last SWL session. Before SWL, the mean is one area in the first group was 61.32 mm^2 while the mean stone area in the second group was 59.04 mm^2 ($p = 0.208$). Mean energy, Mean energy maximum and mean number of applied shock waves of the first group was 4.65, 3.19 and 3,960, respectively. The same parameters in second group were 4.26, 3.03 and 2,953, respectively. These results show that there are statistically significant differences between two groups with respect to mean energy, mean energy maximum and mean number of applied shock waves ($p = 0.003$, $p = 0.010$, $p = 0.000$, respectively). Success rate was 85.1% in group 1 and 72.7% in group 2 ($p = 0.006$). Our results suggest that supine position is effective and better than prone position for SWL in patients with distal ureteric stones.

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Introduction

Shock Wave Lithotripsy (SWL) is an important step in the treatment of urinary calculi and after first use in 1980 [1] has become the first-line approach to most patients with symptomatic urolithiasis. The indications for the use of SWL have rapidly extended from stones in the kidney to stones in ureters. SWL is the least invasive and most widely accepted form of treatment for ureteric stones [2–6]. It is frequently used in treatment of distal ureteral stones, but the position of the treatment is still a matter of debate because of the pelvic fat tissues in especially obese patients and also because of the interaction of pelvic bones with shock waves in such patients. It has been reported that SWL applied in prone position is a safe and effective form in treatment for calculi in the distal part of ureter [7]. The purpose of this study is to assess the ideal patient position during SWL for the treatment of distal ureter stones.

Materials and methods

Between July 2003 and March 2009, 391 patients underwent SWL for distal ureter stones. All patients were evaluated by routine blood tests including coagulation tests, urinalysis, urine culture, renal sonography and intravenous urography (IVU) prior to SWL. Patients with urinary infection were treated with antibiotics prior to SWL. Those without infection did not receive prophylactic antibiotics. Patients with multiple stones, pretreatment procedures such as percutaneous nephrolithotripsy, pyelolithotomy, double-J stent, or a

percutaneous nephrostomy tube and patients who received adjuvant medical treatment for uric acid or cystine stones were excluded from the study. After excluding those patients, 342 patients were included in the retrospective study.

Stones were targeted with fluoroscopy. Patients were divided into two groups. 148 (108 men, 40 women) patients were included in the first group and were treated in supine position. The remaining 194 (143 men, 51 women) patients were included to second group and were treated in prone position. Patients are divided into groups based on the preference of surgeons.

A lithostar Modularis Uro-Plus (Siemens Medical Systems) SWL system was used under sedo-analgesia in all patients. Sedo-analgesia was performed with 0.1 mg/kg midazolam and 1.5 mg/kg fentanyl. This machine is a third-generation electromagnetic lithotripter with an endoscopic treatment table, in which the shockwave parameters have been improved. In the lithostar Modularis Uro-Plus, the penetration depth has been increased to 14 cm, and a new shockwave head has been inserted.

Stone disintegration during the procedure was evaluated by fluoroscopy, ultrasonography, or both. The stone size, maximum and average energy used, number of shockwaves delivered for each stone were reviewed. Stones were treated at a power setting of 6.0–8.0. The power settings of the machine and the energy to which they correspond are shown in Table 1.

After SWL, a plain (KUB) film was obtained on the first-day to assess the extent of stone fragmentation. If fragmentation was encountered, the patients were controlled after 2 weeks. If no fragmentation was seen, a second session was planned. The number of sessions and shockwaves were determined by the response to SWL. Maximum four sessions were applied in both groups. All patients were assessed by IVU or non-contrast computed tomography (CT) for 3 months after the last SWL session. The procedure was accepted as a success if the patient was stone free or had only clinically insignificant fragments ($\leq$3 mm) for 3 months or more after the last SWL session. The procedure was accepted as unsuccessful when the patients needed additional interventions such as ureteroscopy.

The data were processed using the Statistical Package for Social Sciences, version 11.0, for Windows (SPSS, Chicago, IL, USA). Mann–Whitney U and χ^2 tests were used for statistical analysis. $P < 0.05$ is considered to indicate significance.

Table 1 Energies corresponding to power units of lithostar modularis uro-plus

Power unit	kV	Energy (mJ)
0.1 (minimum)	9.506	4.76
0.5	11.025	10.76
1.0	12.270	18.13
1.5	12.887	22.67
2.0	13.495	27.73
2.5	14.225	34.57
3.0	14.837	40.93
3.5	15.432	47.65
4.0	15.798	52.03
4.5	16.260	57.80
5.0	16.611	62.36
5.5	17.094	68.86
6.0	17.575	75.56
6.5	17.921	80.51
7.0	18.382	87.23
7.5	18.832	93.90
8.0 (maximum)	19.305	101.00

Results

Before SWL, the mean stone area in the first group was 61.32 mm^2 while the mean stone area in the second group was 59.04 mm^2 ($p = 0.208$). Mean energy, Mean energy maximum and mean number of applied shock waves of the first group was 4.65, 3.19 and 3,960, respectively. The same parameters in second group were 4.26, 3.03 and 2,953, respectively. These results show that there are statistically significant differences between two groups with respect to mean energy, mean energy maximum and mean number of applied shock waves ($p = 0.003$, $p = 0.010$, and $p = 0.000$, respectively). Success rate was 85.1% in group 1 and 72.7% in group 2 ($p = 0.006$). There was no statistically significant difference between groups with respect to total fluoroscopy time and mean number of sessions ($p = 0.220$ and $p = 0.491$, respectively). Characteristics of treatment are summarized in Table 2.

The minor complications encountered were petechiae at the site of shockwave entry, which was seen to various degrees in nearly all of the patients and early hematuria. The major complications were not encountered in any of the patients.

Discussion

The optimal treatment of stones at the distal part of the ureter is still a matter of debate, because ureteroscopy and SWL are established methods and also are associated with high success and low complication rates [8–10]. Ureteroscopy has a higher success rate and carries low risk of multiple treatments and the least risk of the need for an additional

Table 2 Characteristics of treatment

	Supine	Prone	*P* value
No. patients (men/women)	148 (108/40)	194 (143/51)	
Mean age (years)	50.16 (10–84)	41.12 (2–81)	0.075
Left (%)	79 (53.4)	102 (52.6)	0.913
Right (%)	69 (46.6)	92 (47.4)	
Mean stone area (mm^2)	61.32 (16–204)	59.04 (10–238)	0.208
Mean applied shock waves	3,960 (1,940–7,000)	2,953 (1,250–5,500)	**0.000**
Mean energy (units)	4.65 (2.10–7.00)	4.26 (2.00–7.00)	**0.003**
Mean energy maximum (units)	3.19 (1.00–5.10)	3.03 (1.40–5.30)	**0.010**
Total fluoroscopy time (min)	5.69 (1.60–18.40)	5.60 (1.00–17.00)	0.220
Mean number of sessions	1.34 (1–4)	1.39 (1–4)	0.491
Success (%)	85.1 (126/148)	72.7 (141/194)	**0.006**

$P < 0.05$ is considered to indicate significance

intervention. The minimally invasive nature of SWL, the lack of severe undesirable effects, and the avoidance of general anesthesia make it an attractive alternative for most of the patients [8]. According to the guidelines of the European Association of Urology and the American Urology Association, both SWL and ureteroscopic stone removal are established, acceptable and efficient methods for treatment of distal ureteric stones of ≤10 mm diameter [9, 10].

At the present time, the primary treatment modality for management of symptomatic urolithiasis is SWL. However, there is no consensus about the position of patients during SWL. There are limited published articles about position during SWL treatment in the current literature. Current guidelines also do not provide enough information about the patient position during SWL. Some of the authors reported that supine position during SWL is cost-effective [11], has lower rates of morbidity [12] while others reported that prone position carries the risk of small intestinal perforation [13]. On the contrary, some authors support prone position in SWL [7, 14–18].

Various positions have been attempted to improve efficacy during SWL. Ackaert et al. [19] reported that the 'straddle' (horse-riding) position was successful in 89% of 110 patients with urinary stones at the distal part of the ureter. Jenkins and Gillenwater [7] reported that SWL applied with the patient prone position for being a safe and effective method for management of distal ureteral stones. In a study by Becht et al. [20] 39 cases of distal ureteric stones were treated using SWL with the patient at supine position and the pelvis nearly horizontal, which enabled X-rays and shock waves to enter through the foramen obturatum or the greater sciatic notch. The results of that study showed a success rate of 95% [20]. Kose and Demirbas [21] used the novel modified-prone approach in which the treatment table is rotated externally and shock waves transmitted to distal stones in the ureter on the side opposite to the lithotripter. They reported that success with SWL was 4.56 times more likely if the patient was in the modified-prone position than prone.

In our study, mean energy, mean energy maximum and mean number of applied shock waves was significantly higher in supine group. This condition led to much more effective treatment of distal ureteric stones with SWL. Patients in supine position felt less pain at same energy levels with respect to patients in prone position. Therefore, this lead to perform SWL at higher energy levels in supine position. We think that the reason for that is bonny pelvis absorbs minimally shock waves in supine position.

Conclusions

In conclusion, our results suggest that supine position is effective and better than prone position for SWL in patients with distal ureteric stones. As there is no consensus about the position of patients during SWL and current guidelines also do not provide enough information about the patient position during SWL further studies evaluating the possible role of position for the efficacy of SWL are necessary.

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