RESEARCH ARTICLES

THE OUTCOME OF EXTRACORPOREAL SHOCK WAVE LITHOTRIPSY MONOTHERAPY IN THE TREATMENT OF LARGE STONES

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SUMMARY

Purpose: *The aim of the study was to determine the effectiveness and use of extracorporeal shock wave lithotripsy (SWL) in patients who had large renal calculi (≥3 cm).* ***Patients and Methods:*** *468 patients with large renal stones who underwent SWL monotherapy between 1990-1996 were evaluated retrospectively. Stones were classified as solitary, multiple or staghorn. Staghorn stones were also subclassified as borderline, partial or complete staghorn. The outcome of SWL was evaluated 3 months after last treatment with plain abdominal x-ray and/or excretory urography.* ***Results:*** *There were 171(36.53%) solitary, 202(43.16%) multiple and 95(20.29%) staghorn stones. Mean shock wave number and power applied were 3666 and 18.4 kV, respectively. Average stone size was 5.0 cm. A total of 2253 sessions were applied to the patients (for solitary stones 703, for multiple stones 1035, for staghorn stones 515) and the average number of SWL sessions per patient was 4.70. Overall stone-free rate was 42.74% (200 patients). Stone-free rates for solitary , multiple and staghorn stone groups were 56.14% (96 patients), 37.13% (75 patients) and 30.53% (29 patients), respectively. There was no statistically significant difference for success or complication rates for the double-J stented and unstented group(p>0.05). The major complications were noted as acute pyelonephritis (5.12%), stone street (20.95%) and colic pain (23.93%). 43 (9.1%) patients required invasive endoscopic procedures such as ureterorenoscopic lithotripsy or percutaneous nephrostomy.* ***Conclusion:*** *Our experience suggests that SWL is not an appropriate primary treatment option for many patients with large stones. SWL may be considered as a first-line therapy for large solitary calculi only which were located at pelvis, superior calyx or middle calyx in patients without any upper tract abnormalities.*

Key Words: *Kidney Calculi, Extracorporeal Shock Wave Lithotripsy, Large Stones.*

INTRODUCTION

Extacorporeal shock wave lithotripsy (SWL) is generally accepted as the first-line of treatment for renal calculi which are smaller than 2 cm (1). However, the treatment of large (≥3 cm) renal calculi is a dilemma in urological practice. Although different treatment modalities such as, SWL monotherapy, percutaneous nephrolitholitotripsy (PNL) with or without the addition of SWL and open surgery are available for these stones, all methods have advantages and disadvantages (2,3). Since SWL monotherapy needs multiple treatment sessions, requires many additional procedures and has relatively lower stone-free outcome (4). Currently, most of the large stones are removed by PNL or combined PNL and SWL (5). On the other hand, its minimally invasive nature and cost-effectiveness seem to be the main advantages of SWL treatment.

This report presents our experience with extracorporeal SWL monotherapy in 468 patients with large renal calculi.

PATIENTS AND METHODS

We retrospectively evaluated 486 patients with large renal stone(s) who underwent SWL monotherapy between 1990-1996 on an outpatient basis. The male-to-female ratio was 1.57 (286 male and 182 female patients), with an age range of 17-84 years (mean age 53.1 years). All patients were treated with a second generation Siemens Lithostar plus lithotriptor without anaesthesia. Fluoroscopic localisation was used in all patients. The stones were on the right side in 204 (43.58%) patients and on the left side in 264 (56.42%). Eighty-seven (18.58%) patients had undergone a previous renal operation on the affected side and in 17 (3.63%) the stones were solitary kidneys.

Stone size was measured on a plain abdominal x-ray in largest diameter. If there was more than one stone, total burden was calculated as the sum of the largest diameters of the stones. Stones were classified as solitary, multiple or staghorn. Solitary and multiple calculi were subclassified according to stone localisation. Staghorn stones were also subclassified as borderline, partial and complete staghorn according to Griffith's classification.

Pre-treatment evaluation included urinalysis, urine culture, electrocardiogram, complete blood count, blood chemistry studies, bleeding time and coagulation time. Plain abdominal x-ray and excretory urograms were routinely performed prior to and after SWL treatment. Also, additional imaging modalities such as ultrasonography and computerized tomography were performed when indicated.

Specific antibiotic therapy was begun 3 days before SWL according to urine culture and sensitivity testing in patients who had urinary tract infection. A double-J (DJ) stent was inserted in 385 (82.26%) patients before SWL treatment.

To avoid accumulation of stone fragments within the ureter because of the large stone burden, stones were treated in stages. Initially, the pelvic component was disintegrated and then the upper, middle and lower caliceal components were treated. Patients were evaluated 1 and 15 days after treatment with abdominal x-ray and /or ultrasonography. If there was no sufficient fragmentation additional session was performed 3 weeks after the last treatment.

The outcome of SWL was evaluated 3 months after the last treatment with plain abdominal x-ray and/or excretory urography. Patients were categorised as stone free, clinically insignificant fragmentation (0-4 mm residual calculi) or insufficient fragmentation.

Student t test and chi-square test were used for statistical analysis.

RESULTS

Table 1 illustrates the stone classification and stone free rate for each localisation. There were 171 (36.53%) solitary, 202 (43.16%) multiple, and 95 (20.29%) staghorn calculi. The stone-free rate of lower calyx stones were significantly lower than other localisations in solitary stone group ($p<0.05$). The average stone size, shock wave, power and sessions are outlined in table 2. Mean shock wave number and power applied were 3666 and 18.4 kV, respectively. Average stone size was 5.0 cm. Stone-free rates according to the number of treatment sessions for each group are summarised in table 3. A total of 253 sessions was applied to patients (for solitary stones 703, for multiple stones 1035, for staghorn stones 515) and average number of SWL sessions per patient was 4.70. Examination of stone-free cases revealed that 59% (118 patients) became stone-free after three sessions (82.29% in solitary calculi, 41.33% in multiple calculi, 27.58% in staghorn calculi). We did not observe any stone-free patient after the first session in the multiple calculi group and after two sessions in the staghorn calculi group.

The results of extracorporeal SWL treatments are shown in table 4. Overall stone-

Table 1: Stone classiffication, localisation and stone-free rates.

Stone Classiffication	Localisation	Number of Patients n (%)	Stone-Free Rate n (%)
Solitary*	Superior calyx	21 (4.48)	16 (76.19)
	Middle calyx	15 (3.20)	10 (66.66)
	Lower calyx	54 (11.54)	17 (31.48)*
	Pelvis	81 (17.30)	53 (65.43)
Multiple†	Multiple calyx	39 (8.34)	14 (35.89)
	Pelvis	12 (2.57)	5 (41.66)
	Pelvis+solitary calyx	96 (20.52)	38 (39.58)
	Pelvis+multiple calyx	55 (11.76)	18 (32.72)
Staghorn‡	Borderline	16 (3.42)	6 (37.6)
	Partial	48 (10.25)	15 (31.37)
	Complete	31 (6.62)	8 (25.80)
Total		468 (100)	200 (42.74)

* χ^2 = 17.76, $p<0.05$ (chi-square test)
† χ^2 = 0.84, $p>0.05$ (chi-square test)
‡ χ^2 = 0.70, $p>0.05$ (chi-square test)

Table 2: Details of SWL application.

	Solitary	Multiple	Staghorn	Total
No. of patients (%)	171 (36.53)	202 (43.16)	95 (20.29)	468 (100)
Average stone size (cm)	3.8 (3.0-4.7)	5.4 (3.2-11.4)	6.8 (3.8-13.3)	5.0 (3.0-13.3)
Average # of shock waves	3550 (1445-4000)	3657 (1370-4000)	3860 (1520-4000)	3666 (1370-4000)
Average power (kV)	18.1 (17.5-19.0)	18.7 (16.4-19.0)	18.4 (17.5-19.0)	18.4 (16.4-19.0)
Average # of sessions	4.11 (1-5)	5.12 (2-6)	5.42 (2-6)	4.7 (1-6)

Table 3: Stone-free rates according to number of SWL sessions.

	1	2	3	4	5	6	Stone-Free n(%)
Solitary	13	29	37	14	3	-	96 (56.14)
Multiple	-	11	20	33	7	4	75 (37.12)
Staghorn	-	-	8	13	5	3	29 (30.52)
Stone-Free n (%)	13 (6.50)	40 (20.0)	65 (32.50)	60 (30.0)	15 (7.50)	7 (3.50)	200(42.74)

Table 4: Results of extracorporeal SWL.

	Stone-Free	Residual stone size (?0.4 cm)	Insufficient fragmentation
Solitary n (%)	96 (56.14)	27 (15.79)	48 (28.07)
Multiple n (%)	75 (37.13)	37 (18.32)	90 (44.55)
Staghorn n (%)	29 (30.53)	10 (10.52)	56 (58.95)
Total n (%)	200 (42.74)	74 (15.81)	194 (41.45)

χ^2 = 29.34 , $p<0.05$ (chi-square test)

Table 5: Stone street, stone-free rate and invasive auxiliary procedure rates in regard to use of DJ stent .

	With DJ Stent n(%)	Without DJ Stent n(%)
Number of patients	385	83
Stone size (cm)	5.04±1.2*	4.81±1.3*
Stone Street	76 (19.74)**	19 (22.89)**
Stone-Free	163 (42.33)**	37 (44.57)**
Invasive Auxiliary procedures	34 (8.8%)**	9 (10.8%)**

free rate was 42.74% (200 patients). Clinically insignificant fragmentations were achieved in another 74 (15.81%) patients and insufficient fragmentations were found in 194 (41.45%) patients. Stone-free rates of the solitary group, multiple group and staghorn group were 56.14% (96 patients), 37.13% (75 patients) and 30.53 (29 patients), respectively ($p<0.005$).

Complications encountered were colic pain in 112 patients (23.93%), fever (>38 C) in 32 patients (6.83%), acute pyelonephritis in 24 patients (5.12%), and stone street in 95 patients (20.29%). Complications except stone streets were managed conservatively.

Stone-free rate, stone street and auxiliary procedure rate in patients with and without DJ stent are shown in table 5. There was no statistically significant difference between two groups ($p>0.05$).

Stone streets cleared spontaneously in 33 patients (34.73%), while others needed to be treated with additional SWL, ureterorenoscopic lithotripsy or percutaneous nephrostomy. Only 19 (20%) patients became stone-free by SWL. Ureterorenoscopic lithotripsy and percutaneous nephrostomy were applied in 41(43.15%) and 2 (2.10%) patients respectively in whom primary SWL therapy was unsuccessful. When we reviewed all cases, it was found that 43 (9.1%) patients required invasive endoscopic procedures such as ureterorenoscopic lithotripsy or percutaneous nephrostomy.

DISCUSSION

In the last decade, the main question in the management of any kind of stone is usually whether the situation is amenable to SWL because of the ease of use and noninvasive nature of this technology. The real issue is whether the excellent results obtained with SWL in small stones translate into successful treatment when the target is a large stone. Stone-free rates range widely in this patient group, varying from 26-74% (2,3,6). However, the need for multiple treatment sessions, the high incidence of auxiliary procedures and lower stone-free outcome, restrict its use as standard therapy (4).

Recently, PNL or a combination of PNL and SWL were recommended for large stones. The stone-free rates were reported as 75% with PNL and 68-91% with combined PNL and SWL (2,3). However, PNL is an invasive procedure. It requires expertise and even in experienced hands it is accompanied by a significant incidence of perforation of the renal collecting system. Also the need for multiple nephrostomy tracts for complete stone clearance is another problem. Additionally, the possibility of sepsis, haemorrhage requiring transfusion, venous emboli and occasionally, the need for nephrectomy, are the other disadvantages of this treatment modality (7,8).

Considering the stones with similar composition, stone-free rates following SWL are not solely dependent on the size of the calculi, but rather on size together with stone location. Stone-free rates are generally the highest for upper or middle calyceal calculi or pelvic calculi and significantly lower for lower calyceal stones (9).

Similar results were obtained in our study and regarding large solitary calculi, only those in renal pelvis, upper pole or middle pole had stone-free rates following SWL that approach results achieved with PNL. Another finding supporting this phenomenon was the fact that 82.28% of patients were stone-free after three sessions among stone-free patients of solitary group. On the other hand, the presence of residual fragments following SWL is more commonly found in association with lower calyceal calculi (10). Part of the reason for poor SWL results in lower calyx, may be due to impedance of gravity assisted drainage. Sampaio and associates found 75% of patients with a pelvi-calyceal angle of greater than 90 degrees were stone-free at 3 months, whereas only 23% of patients with an angle less than 90 degrees were stone-free (11). In a prospective randomised study comparing SWL and PNL for the treatment of lower pole stone(s) the third month stone-free rate was 75% (2). It was also reported that PNL for large lower pole calculi was more cost-effective than SWL and clearly the optimal therapy (12). In our study, we found 31.48% stone-free rate in lower calyx calculi and we are in aggreement with this option.

A kidney occupied by multiple calculi in the pelvis or calyces, although technically not a staghorn, present the same challenges as a staghorn calculus. The proposed theoretical advantage of SWL for multiple calculi was that PNL would require multiple percutaneous punctures of the kidney. Although a single tract has been shown to have no effect on renal function, multiple tracts may damage nephrons and reduce renal reserve (13). In addition, second and third tracts need more experience. Many urologists are wary of attempting PNL access to the superior calyces because of the increased risk of violating the pleural space with subsequent pneumothorax, hydrothorax or hemothorax formation. These complications can occur in up to 3% patients (14). SWL monotherapy even with multiple sessions, proved to be less morbid than PNL. Moreover, a giant stone burden of greater than 3 cm in the greatest linear dimensions can be fragmented successfully by SWL monotherapy. In such cases, need for multiple sessions of SWL and ancillary measures can increase up to 46% (2).

Primary PNL for stones greater than 3 cm carries a much greater chance of stone-free (75%) and lower rate of ancillary procedures (8%) (2). PNL therefore generally is preferred in patients with large stones, unless the calculi are thought to be soft enough (calcium oxalatedihydrate, struvite or uric acid) and are in the renal pelvis or upper pole of a nondilated collecting system (15). In our study, stone-free rate was 37.13% with an average of 5.12 sessions in multiple large stones. This result is significantly less that can be achieved with PNL.

In the staghorn calculi guideline panel, it was reported that a 50% stone-free rate could be achieved with SWL alone in staghorn stones (3). However, it was also underlined that multiple sessions of SWL could be required. The stone-free rates for such larger stones depend on the function of the kidney and the dilatation of the collecting system. Those patients whose collecting systems are normal or minimally dilated are more likely to be stone-free than those whose renal collecting systems are dilated grossly (16). The results of combined PNL and SWL for staghorn calculi are more promising than than the SWL results (81%, 50%) (3). The AUA panel recommended PNL to be the first line of therapy for staghorn calculi, followed by SWL or repeated PNL if needed (3). Primary SWL or open surgery was not recommended for most patients. In our study, the stone-free rate was 30.53% with 5.42 sessions of SWL and we believe that PNL should be the first treatment choice for staghorn calculi, too. The lower stone-free rates in spite of multiple sessions prevent the use of SWL as a first-line treatment option. On the other hand, although the staghorn could be cleared with SWL alone, most of these stones are associated with infection, and multiple shock wave sessions and multiple fragments might be the cause of recurrent pyelonephritis and even disseminated disease (17).

Complications following SWL appears directly correlated with increasing stone burden (18). The incidence of stone street and uretral obstruction secondary to stone fragments within the ureter, are high after the treatment of large stones. The need for intervention due to obstruction has been reported to be 6% and 12% depending on stone size (19). In our study, we found a 56.19% complication rate (5.12% acute pyelonephritis, 20.29% stone street). Invasive interventions were also required in 9.1% patients.

The use of preoperative uretral stenting for large calculi remains controversial. Some authors believe that stents only increase patient symptoms and do not reduce stone-related complications (20), and we believe that stenting is not an indication for all stones. However, it may be indicated in patients with solitary kidneys, unusual renal anatomy and as an aid in stone visualisation. Although we inserted double J stents in 82.26% of patients, we did not find any correlation in terms of complications and stone-free rates between two groups ($p>0.05$).

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