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Outcome of Extracorporeal Shockwave Lithotripsy in Congenital Malformed Kidneys

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ABSTRACT

Background: urolithiasis has an important role in the structure of the urological pathology, due to its high incidence, frequency of recurrence and complications it may cause, it reduces the medium life span from 5 to 20% of the patients. The management of kidney stones with congenital kidney anomalies and abnormal variations continue to pose challenges to urologists.

Objective: to evaluate the stone free rate and complication rate of renal Extracorporeal Shockwave Lithotripsy (SWL) in patients with congenitally malformed kidney and the predictors of SWL outcome will be determined.

Patients and Methods: this is a retrospective study that has been conducted in Al-Hussein and Bab El-Shaarya University hospitals in Cairo, Egypt. It includes 50 patients with renal calculi in congenitally malformed kidney, all patients underwent SWL treatment in Al-Hussein and Bab El-Shaarya University hospitals using Dornier compact sigma lithotripser and Dornier lithotripser SII from January 2013 to January 2019.

Results: of the total SWL procedures performed to 50 patients with average age 46.3 year and average size of the stone was 15.38 mm, the stone free rate was 74 %, The complication rate was 6%, 1 patient complicated by acute pyelonephritis, 1 patient complicated by perinephric hematoma and 1 patient complicated by steinstrasse.

Conclusion: SWL has become the favored treatment for management of kidney stones with congenital renal malformations due to high stone free rate and low incidence of complication.

Keywords: Extracorporeal Shockwave Lithotripsy, Lithiasis, renal malformations, Stone-free.

INTRODUCTION

Urolithiasis has an important role in the structure of the urological pathology, due to its high incidence, frequency and complications, it reduces the average life expectancy of 5 to 20% of patients, where recurrence is detected in 50-67% of cases[(1)].

Congenital anomalies occur more often in the kidney than in any other organ. Horseshoe, malrotated and ectopic kidneys, as well as duplex systems, are the most encountered in this respect [(2)].

The association of both renal abnormalities and stones is of clinical relevance [(3)]. Conditions such as the abnormal position of the ureteropelvic junction, aberrant vascularization or the presence of an isthmus might determine urinary stasis and stone disease, especially if urinary infection and consecutive stone disease, especially if urinary infection and metabolic abnormalities are present [(4)].

The management of kidney stones with congenital kidney anomalies and abnormal variations continue to pose challenges to urologists. The treatment options include open surgery, extracorporeal shock wave lithotripsy (SWL), percutaneous nephrolithotomy (PCNL), laparoscopy and ureterorenoscopy (rigid or flexible) [(5)].

SWL is considered the first-line treatment for the majority of patients with urolithiasis especially because stone recurrence is estimated to be about 50% over the next 10 years and patient with congenitally malformed kidneys may associated with other congenital anomaly and abnormal blood vessels that make us to think in SWL firstly before any invasive management[(6)].

SWL has become the favored treatment for most urinary tract stones, variable success rates in the management of stones in anomalous kidney have been reported for SWL, ranging from 31% to 100% [(7)].

Despite SWL has been considered the first line treatment for stone in a mal-formed kidney, the associated urinary stasis which leads to the diminution of the ureteric peristalsis, could interfere with clearance of stone fragments after SWL [(8)].

In the case of patients which present urolithiasis associated with a malformed kidney the positioning on the treatment table is of great importance, Patients which have a horseshoe or malrotated kidney are placed in a ventral decubitus position because of the anterior orientation of the renal pelvis. The same position is used for patients with ectopic kidneys to avoid the bone structures of the pelvis [(9)].

We searched in this object to evaluate the stone free rate and complication rate of renal SWL in patients with congenitally malformed kidneys and predictors of SWL outcome, due to little of searches in this object especially in our community, one of the studies in this object stone free rate was 71.77 % [(10)].

AIM OF THE WORK

To evaluate the stone free rate and complication rate of renal SWL in patients with congenitally malformed kidney and the predictors of SWL outcome will be determined.

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PATIENTS AND METHODS

We performed a retrospective review of 50 patients with congenital malformed kidneys, 25 patients with malrotated kidney (50%), 11 patients with ectopic kidney (22%), 8 patients with horseshoe kidney (16%), 3 patients with polycystic kidney (6%), 2 patients with duplex system (4%), 1 patients with Pelvi-ureteric junction obstruction (2%), in Urology Department, Al-Hussein and Sayed Galal University Hospitals in Cairo, Egypt. All patients underwent SWL treatment by Dornier compact sigma lithotripser and Dornier lithotripser SII from January 2013 to December 2018.

Patients with renal mal-formations, were defined by non-contrast Computed Tomography, Intravenous Urography and/or Ultrasonography were included in the study.

Ethical approval and written informed consent:

An approval of the study was obtained from Al-Azhar University academic and ethical committee. Every patient signed an informed written consent for acceptance of the operation.

Data collection:

The patients' medical records were reviewed for:

- Pre-SWL data: Age; gender; weight; height; clinical presentation; associated medical co-morbidities; serum creatinine level, side, size, site, number, density, radio-opacity of stones and type renal mal-formation.
- SWL data: Patient position, method of localization, the number of SWL sessions, number of shockwaves, energy used, operative time and analgesia/anesthesia used, SWL by Dornier compact sigma lithotripser and Dornier SII.
- Post-SWL: Stone free status and complications.
- SWL success means complete fragmentation and clearance of stone as defined by post-SWL imaging after 3 months.

Data Analysis:

Data analysis was performed using Statistical Package for Social Sciences (SPSS) version 24. According to the type of study variables, the data was presented as number (%) or mean±SD (or median "range").

Data were explored for normality using Kolmogrov-Smirnov test and Shapiro-Wilk test. Categorical data were summarized as percentages, Comparisons between the 2 groups with respect to normally distributed numeric variables were done using the independent t-test. Non normally distributed numeric variables were compared by Mann-Whitney test. For categorical variables, differences were analyzed with (chi square) test and Fisher's exact test when appropriate. Stone free rate and complication rate was identified. Univariate and multivariate analysis was performed and factors affecting SWL outcome was determined. All p-values are two-sided. P-values ≤0.05 were considered significant.

RESULTS

This study was a retrospective study of 50 patients with renal calculi in congenitally malformed kidney, all patients underwent SWL treatment in Al-Hussein and Bab El-Shaarya University hospitals using Dornier compact sigma lithotripser and Dornier lithotripser SII since January 2013 to December 2018.

The study included 38 males and 12 females with renal calculi in congenitally malformed kidneys, 25 patients with malrotated kidney (50%), 11 patients with ectopic kidney (22%),8 patients with horseshoe kidney (16%), 3 patients with polycystic kidney (6%), 2 patients with duplex system (4%), 1 patients with Pelvi-ureteric junction obstruction (2%),the mean age was 46.3 with a range from 5 to 70 years (Fig-1), the mean BMI 29.8, the mean stone size was 15.38 mm with a range from 6 to 31 mm and the mean stone density was 912.58 HU with a range from 310 to 1500 HU, 8 patients was with fixed DJ stent and 42 patients without DJ stent.

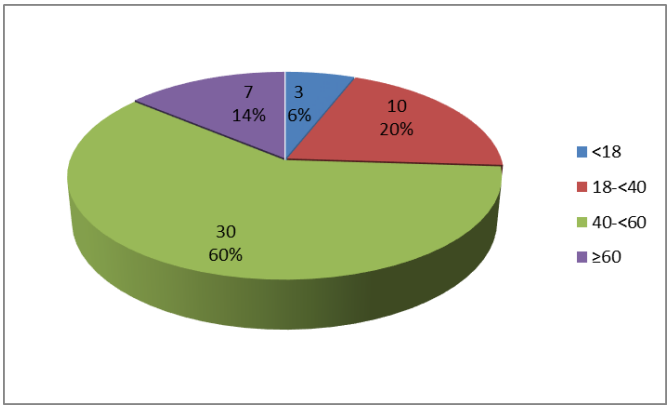

Figure (1): Age distribution among the studied population.

Table (1): Renal anomaly distribution among the studied population

		Frequency	Percent
Renal anomaly	Malrotated kidney	25	50%
	Hourseshoe kidney	8	16%
	polycystic kidney	3	6%
	Duplex kidney	2	4%
	UPJO	1	2%
	Ectopic pelvic kidney	3	6%
	Ectopic lumbar kidney	4	8%
	Ectopic abdominal kidney	4	8%
	Total	50	100%

All patients underwent SWL treatment, X-ray guided in 42 patients and US guided in 8 patients, the mean number of shock waves was 5538 shock wave, and the mean number of SWL session was 2.2, and the mean operative time of SWL session was 34.9 minute.

The stone free rate was 74%, in patients with stone size below 1cm, the stone free rate rose up to 91.6% demonstrating the importance of stone size for

a successful SWL treatment. the stone free rate was 88% in malrotated kidney, 62.5% in horseshoe kidney, 100 % in polycystic kidney, 63.6% in ectopic kidney, 0% in duplex renal system and 0% in pelvi-ureteric junction obstruction.

Table (2): Stone free status among different types of renal anomalies.

		Stone free status			
		Stone free		Failed	
		Count	%	Count	%
Type of renal anomaly	Malrotated kidney	22	88%	3	12%
	Hourse-shoe kidney	5	62.5%	3	37.5%
	Poly cystic kidney	3	100%	0	0%
	Duplex system	0	0%	2	100%
	PUJO	0	0%	1	100%
	Ectopic pelvic kidney	0	0%	3	100%
	Ectopic lumbar kidney	3	75%	1	25%
	Ectopic abdominal kidney	4	100%	0	0%

The complication rate in our study is 6%, one patient complicated by acute pyelonephritis (2%) that managed by medical treatment, one patient complicated by perinephric hematoma (2%) that managed conservatively and one patient complicated by steinstrasse (2%) that managed by URS.

Table (3): Complication rate among the studied population.

	Type of complication	No.	Percent
Complication	No complication	47	94%
	Steinstrasse	1	2%
	Perinephric hematoma	1	2%
	Acute pyelonephritis	1	2%

DISCUSSION

The stone free rate was 74%, in patients with stone size below 1cm, the stone free rate rose up to 91.6% demonstrating the importance of stone size for a successful SWL treatment.

The stone free rate within patients without DJ stent was 81.8% and within patients with fixed DJ was 16.7%, the p value <0.05 so there was a statistically difference between 2 groups. This means that patients with fixed DJ stent had lower stone free rate in comparison with patients without DJ stent, as DJ stent interfere with stone clearance because the presence of stent is significantly hinder the passage of fragments after SWL and this agrees with the study performed by **Argyropoulos and Tolley**[11] that found a difference of >22% in the stone-free rate in favour of the non stented patients this was statistically significant (p=0.016).

Regarding the stone free rate in the other studies, variable success rates in the management of stones in anomalous kidneys have been reported for ESWL, ranging from 31% to 100% [7]; **Singh *et al.***[12] found the stone free rate was 50%; 13 patients with anomalous kidneys underwent SWL treatment, 2 patients ectopic kidney, 2 patients malrotated kidney, 6 patients horseshoe kidney, 3 patients ADPCK. In this study the stone free rate is low most probably due to very small sample size. Also, **Brad *et al.***[10] found that stone free rate was 71.77%, this study included 118 patients; 35 patients were horseshoe kidneys, 48 patients duplex kidneys, 15 patients malrotated kidneys, 13 patients ectopic kidneys and 7 patients hypoplastic kidneys. The average size of the stone was 10.228 mm. This study is convergent to our study in stone free rate.

Al-Tawheed *et al.*[13] the stone free rate was 83.9%. This study included 25 patients, (9 had different types of ectopic Kidney, three had malrotated kidneys, 2 patients had duplex renal systems, 1 patient had polycystic and 1 patient hypoplastic kidney), the mean size of stone was 1.5 (range 0.8– 2.1) cm. in this study the stone free rate is higher than in our study may be due to the difference in the type of renal anomaly that predominant in each study, ectopic kidney and horseshoe kidney (patients) in Al-tawheed et al 2006 And maltotated kidney (25 patients) in our study. Also, **Sheir *et al.***[14] published a large series of 198 patients who were treated for urolithiasis in anomalous kidneys using ESWL (The kidneys were horseshoe in 49, malrotated in 120, and duplex in 29), the stone-free rates were 71.4%, 69.2% and 86.2%, respectively. The overall stone free rate was 72.2%, the univariate analysis showed a significant correlation between the overall stone-free rate and both stone size and number (P=0.000 and P=0.006, respectively), this study is convergent to our study in stone free rate.

Kupeli *et al.*[15] on 120 patients with congenital renal anomaly underwent SWL treatment, found that the stone free rate was 70% this study is convergent to our study in stone free rate.

Regarding the type of renal anomaly 25 patients with malrotated kidney (50%), the stone free rate was 88% in our study, regarding the stone free rate in malrotated kidneys in the other studies, Variable success rates in the management of stones in malrotated kidneys have been reported for ESWL, For example:-

Singh *et al.*[12], report stone free rate 50%, 2 patients malrotated kidney underwented SWL treatment, In this study the stone free rate is low most probably due to very small sample size.

Al-Tawheed *et al.*[13] reported their experience with ESWL infour patients with stones in malrotated kidneys. Two renalunits outof fourwererendered stone-free (50%) and significant residual stones were encountered in the other two patients. Out of these latter two patients one required open surgery, while the other was treated successfully using PCNL. In this study the stone free rate is low,

most probably due to very small sample size as previous study.

Sheir *et al.*[14] published a largeseries of198 patients who were treated for urolithiasis in anomalous kidneys using ESWL (The kidneys were horseshoe in 49, malrotated in 120, and duplex in 29), the stone-free rates were:(71.4%), (69.2%) & (86.2%), respectively. The univariate analysis showed a significant correlation between the overall stone-free rate and both stone length and number (P=0.000 and P=0.006, respectively). However, when both were analyzed according to the type of anomaly, their impact on the stone-free rate was significant in malrotated kidneys only. the stone free rate in this study is slightly low than our study because the percent of stone multiplicity is higher than our study 32.3%, 16% respectively.

In our study 8 patients with horseshoe kidney (16%), the stone free rate was 62.5% in our study. Stone-free rates after SWL for horseshoe kidneys vary widely, ranging from 28% up to% 80[14] For example:-
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Brad *et al.*[10], reported SWL for 81 horseshoe kidneys, the stone-free rate was 70.3%, with average size of the stone was 10.3 mm (12.1 mm in our study) and the most common stone site was renal pelvis, this explain the higher stone free rate of this study than our study..

Singh *et al.*[12], report stone free rate 50%, 6 patients with horseshoe kidney underwented SWL treatment, in this study the stone free rate is low, most probably due to small mean stone size (12.1mm) in our study that this study (14.4mm). **Al-Tawheed *et al.*[13]** published a study on ESWL for treatment of 9 patients with stones in horseshoe kidneys, the stone-free rate was 76.9%, better clearance was achievedfor calculi in the renal pelvis or upper pole, the stone site was renal pelvis in 50% of patients in this study, while was lower calyx 50% of patients in our study.

Tunc *et al.*[4] reported ESWL for 45 horseshoe kidneys, the stone-free rate was 66% and with an additional 22% sufficient fragmentation rate and overall success of 88%. Mean stone burden was 2.24 ± 0.6 cm and 51% of stones were located in the pelvis alone without coinciding calyx stone, this explain higher stone free rate than our study in addition to small sample size of our study.

In our study 3 patients with polycystic kidney (6%), the stone free rate was 100 %. regarding the results of SWL for treatment of calculi in ADPKD insome previous studies.

Singh *et al.*[12] reported ESWL for treatment of 3 patients with stones in ADPKD, all cases failed SWL treatment.

Al-Tawheed *et al.*[13] reported SWL for treatment of 1 patient with stones in ADPKD, the stone free rate 100%, this study is convergent to our study in stone free rate.

Deliveliotis *et al.*[16] reported SWL for treatment of 4 patients with stones in ADPKD. The mean stone diameter was 1.05cm. In all cases the stones were located in the calices mainly lower calyx. Although stone fragmentation was successful in all patients (100%), showing that the cysts do not impede the shock waves in reaching the stones, but only one patient (25%) became stone-free. In our study 66.6% of cases (2 patients) the stone located in middle calyx and 33.3% (1 patient) of cases the stone located in lower calyx. That may mad the difference in stone free rate in 2 studies.

Ng *et al.*[17] published a study on 5 patients who were treated for urolithiasis in ADPKD using SWL. Stone-free result was achieved in 2 patients (40%) and the remaining 3 (60%) had only residual "dust," that is indiscrete particles assuming the shape of the involved calix and multiple treatments were required in only 1 patient, this study is convergent to our study in stone free rate.

The modest outcome could be a result of the obstructiveeffect of the cysts and the resultanturinary stasis, which impedes passage of the stone fragments.

Grampsas *et al.*[18] demonstrated a proportional relationship between the number and size of the cysts and the resultant urinary stasis and intrarenal anatomic obstruction.

In our study 2 patients with duplex renal system (4%), the stone free rate was 0%. Very small sample size (2 patients) may be the cause of this very low stone free rate in our study in relation of previous study as, **Tunc *et al.*[4]** evaluated ESWL for treatment of 57 patients with urolithiasis in duplex systems and reported 80% stone-free rate suggesting ESWL should be the preferred therapeutic option forduplex kidneys.

Sheir *et al.*[14] published a study on 29 patients who were treated for urolithiasis in duplex kidneys using ESWL. Stone-free result was achieved in (86.2%) of patients.

Gallucci *et al.*[19] observed 55% stone-free rate at 3-monthof follow up of 34 cases treated with ESWL in duplex kidneys.

In our study 11patients with ectopic kidney (22%), the stone free rate was 63.6%, the percent of Stone multiplicity was 27%, the average stone size was 17.7 mm.

Singh *et al.*[12], reported stone free rate was 50%, 2 patients with ectopic kidney underwent SWL treatment. In this study the stone free rate is low, most probably due to very small sample size.

Al-Twheed *et al.*[13] published a study on ESWL for treatment of10 patients with stones in ectopic kidneys. The stone-free rate was 100%. The average stone size was 14 mm smaller than our study 17.7 mm.

Tunc *et al.*[4] had published a study on a large series of 150 patients with stones in anomalous kidneys, which were treated by ESWL (14 pelvic and four crossed ectopic kidneys). The minimum success

rate was obtained in patients with lower calyceal stones (50%), followed by middle-calyceal (60%) calculi. Success was size dependent, in patients with stones larger than 3 cm, only 34% became stone free, compared with 92% for calculi smaller than 1 cm. The stone-free rates in pelvic and crossed ectopic kidneys were found to be 57% and 25%, respectively.

In our study, one patient with Pelvi-ureteric junction obstruction (2%), the stone free rate was 0%.

There is a strong association in our study between stone free rate and the following factors (gender, stone size, stone density, application of DJ stent, type of renal anomaly, number of SWL session, number of shock waves and mean energy used) all these factors had a significant influence on the stone free rate as P value below 0.05 (statistically significant), other factors that have association with stone free rate as stone site appear to not affect stone free rate due to small sample size.

The complication rate in our study is 6%, one patient complicated by acute pyelonephritis (2%) that managed by medical treatment, one patient complicated by perinephric hematoma (2%) that managed conservatively and one patient complicated by steinstrasse (2%) that managed by URS.

Regarding the complication rate in the other studies:

Singh *et al.*[12], the complication rate was 30% (fever 20% and haematuria 10%).

Brad *et al.*[10], the complication rate was 13.56%, Complications were subcapsular renal hematoma in two (1.69%) cases, acute pyelonephritis in two (1.69%) pacients, hematuria with vesical globe in another two (1.69%) cases and stone-street formation in 10 (8.47%)cases.

Sheir *et al.*[14], no complications were recorded except steinstrasse that occurred on 7 patients (3.53%).

STUDY LIMITATION

Limitations of our study include small sample size, in addition to very small number in patients with certain renal anomaly as duplex renal system.

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