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Extracorporeal Shock Wave Lithotripsy: Experience of the Urology Department at the Oued Eddahab Agadir Military Hospital

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Abstract **Original Research Article**

Introduction: Since its invention, extracorporeal lithotripsy has been the reference treatment for all stone locations and sizes. ***Materials and methods***: In this retrospective study, we present our experience of 116 patients treated for urinary calculi by extracorporeal lithotripsy (DORNIER Sigma 3 MedTech) performed in the urology department of the oued eddahab Agadir military hospital between June 2020 and July 2022. ***Results***: The average age of our patients was 51, with extremes ranging from 23 to 79, with males the most frequently affected. The number of sessions per patient varied from one to four, with an average of 2.5 sessions. There is no particular anatomical site for renal lithiasis. A single stone is enough to reveal the symptomatology of urinary lithiasis. ***Conclusion***: Despite the relative simplicity of the technique and its low morbidity, the indication must be carefully considered, taking into account factors predictive of success and failure.

Keywords: ESWL- indications - success rate – complications.

INTRODUCTION

EXTRACORPOREAL SHOCK WAVE LITHOTRIPSY (ESWL) has been one of the most frequently used therapeutic procedures in the treatment of urinary tract lithiasis since the mid-1980s [1]. After some initial reluctance regarding its use in children, the technique is now considered the treatment of first choice for 80% of upper urinary tract stones, and indications for ESWL can be extended to include 90% of all stones, including those in the iliac or pelvic ureter [4, 5]. The main aim of our study was to evaluate the efficacy of ESWL in the treatment of renal calculi, and to outline some critical issues raised by the fragmentation of large calculi and the removal of residual fragments; in the Urology Department of the Oued Eddahab Military Hospital, Agadir.

MATERIALS AND METHODS

We conducted a prospective study in the urology department of the oued eddahab military hospital in Agadir over a 2-year period from June 2020 to June 2022, involving 116 patients with urinary tract calculi who had not previously undergone ESWL and for whom LEC was indicated. The ESWL sessions took place in the urology department of the Agadir military hospital, equipped with a Dornier Sigma MedTech electromagnetic lithotripter. The shockwave power level was progressively increased from level 1 to level 4, with a firing frequency set at 90 strokes per minute. The parameters (frequency and power) were adjustable on the lithotripter and recorded in the study report. Data were collected from the patients' clinical records, preoperative workups, AUSP data and CT scans, enabling us to specify the characteristics of the calculus. At the time of treatment, all our patients had: an unprepared urinary tract X-ray (UPTRA), a uro-scanner to determine the size and density of the stone, and to ensure that there was no underlying obstruction in the urinary excretory tract. A bacteriological cutaneous urine examein to rule out urinary tract infection. ESWL was performed on an outpatient basis, and patients were admitted to hospital on the day of the extracorporeal lithotripsy appointment. Treatment was performed using an electromagnetic source lithotripter and a dual radiological/ultrasound tracking system (Dornier Sigma MedTech). All sessions were performed without anesthesia. The total number of shocks to be delivered to the lithiasis was left to the operator's discretion, but never exceeded 3,500 shocks.

Treatment time averaged 40 minutes. Post-ESWL evaluation consisted of a follow-up X-ray (AUSP) 15 days after the session to ensure stone fragmentation, and to decide whether or not a second session was required. The technique is considered successful <<successful>> in the event of complete fragmentation of the calculus, or with persistence of lithiasis fragments less than or equal to 5 mm in major axis. The persistence of fragments even smaller than 5 mm in diameter after three months is considered a failure.

Results

The mean age of our patients was 51 years, with extremes ranging from 23 to 79 years. The 49-74 age group was the most represented. Men represented 71% (82 cases) of our series, compared with 39% (34 cases) for women. Medical history was distributed as follows : 19 cases of hypertension, 14 cases of diabetes, 1 case of pyelourethral junction syndrome. There were 36 patients with antecedents related to lithiasis prior to ESWL: 22 cases of open surgery for renal lithiasis, 11 cases of NLPC and 5 cases of ureteroscopy. Among our 116 patients, 36 cases (31%) required placement of a JJ catheter prior to ESWL. Symptoms expressed by patients prior to LEC included low back pain (92 cases), renal colic (51 cases), micturition disorders (43 cases), hematuria (13 cases) or urinary tract infection (4 cases). 110 of our patients had unilateral calculi, i.e. 95%, of whom 62% had right-sided calculi, while 38% had left-sided calculi. 6 patients had bilateral calculi, i.e. 5%. Renal localization was most frequent in 76% of our patients, with 11% in the superior calyx, 21% in the middle calyx, 20% in the inferior calyx and 24% in the pyloric calyx. Ureteral location accounted for 24% of cases, with lumbar ureter calculi predominating (12%), pelvic ureter (9%) and iliac ureter (3%) Table 1. 88% of our patients had a single stone, compared with 12% with multiple stones. The mean stone size at the time of treatment was 18.5mm, with extremes ranging from 9mm to 28mm. In our series, 80% of patients had stones between 10-20mm in size, 11% of cases less than 10mm and 9% greater than 20mm Table 2. The average density of ESWL-treated stones was 1035 HU, with extremes ranging from 610 HU to 1460 HU. There was a slight predominance of stones with a density greater than 1000 HU, with a percentage of 55% (Table 3). The average number of treated calculations was 3,000, with shockwave power levels progressively increasing from 1 to 4. The average duration was 35 minutes. The success rate was 65.43% (no residual fragments or one residual fragment < 5mm) versus 34.57% failure. The overall success rate for renal calculi was 62%, with a SF rate of 79% for pyelic calculi, 75% for the upper calyx, 71% for the middle calyx, 23% for the lower calyx Table 4. The overall success rate for ureteral calculi was 61%, with a SF rate of 67% for the lumbar ureter, 52% for the iliac ureter and 42% for the pelvic ureter Table 5. As shown in Table 6 below, the success rate was 72% for stones smaller than 10mm, 63% for stones between 10 and 20mm and only 54% for stones larger than 20mm. Among 116 of our patients, 87% were successful for stones with a density of less than 1000UH, while the figure was 43% for stones with a density greater than 1000UH (Table 7). As shown in Table 8 below, the success rate was 73% for single lithiasis, and 39% for multiple lithiasis. 36% of our patients had moderate pain, 24% had hematuria that resolved with copious drinks after 24 to 48 hours, and 5 patients had a renal colic attack that was relieved by NSAIDs without the need for hospitalization. Spectrophotometric analysis of the calculus is routinely proposed when lithiasis fragments are removed. Unfortunately, we were only able to recover 32 analyses, 26 of which were calcium stones, 4 calcium oxalate dihydrate stones and 2 calcium oxalate monohydrate stones.

Table 1: Distribution of urinary lithiasis according to topography

TOPOGRAPHY	NUMBER	%
Renal		
Upper calyx	13	11
Medium calyx	25	21
Lower calyx	23	20
Pyelic	29	24
Ureteral		
Lumbar	14	12
Iliac	5	3
Pelvic	7	9
TOTAL	116	100

Table 2: Distribution of lithiasis according to size

Calculation size in millimetres	Number	Percentage
< 10mm	13	11%
10-20mm	93	80%
> 20mm	10	9%
TOTAL	116	100%
Medium size		18.5mm

Table 3: Distribution of lithiasis according to density

Density in UH	Number	Percentage
< 1000UH	52	45%
> 1000UH	64	55%
TOTAL	116	100%

Table 4: Success and failure rates by site of kidney stone

TOPOGRAPHY	Success		Failure	
	Number	rate	Number	rate
Upper calyx	10	75%	3	25%
Medium calyx	18	71%	7	29%
Lower calyx	5	23%	18	77%
Pyelic	23	79%	6	21%
TOTAL	47	62%	30	38%

Table 5: Success and failure rates according to ureteral calculus location

TOPOGRAPHY	Success		Failure	
	Number	rate	Number	Rate
Lumbar	11	67%	6	32%
Iliac	1	52%	1	48%
Pelvic	5	42%	6	53%
TOTAL	17	57%	13	43%

Table 6: Success and failure rates by size

Calculation size in millimetres	Success		Failure	
	Number	rate	Number	rate
< 10mm	10	72%	3	30%
10-20mm	50	63%	43	38%
> 20mm	6	54%	4	44%
TOTAL	66	62%	50	38%

Table 7: Success and failure rates as a function of calculation density

Density	Success		Failure	
	Number	rate	Number	rate
< 1000UH	45	87%	7	13%
> 1000UH	28	43%	36	57%
TOTAL	73	65%	43	35%

Table 8: Success rate as a function of the number of calculations

Number of stones	Success		Failure	
	Number	rate	Number	rate
Single	75	73%	27	27%
Multiple	6	39%	8	61%
Total	58	65%	32	36%

DISCUSSION

In our series, the preferred location was on the right, with 62% of all patients having unilateral calculi. The same finding as ours was made by TRAORE [2], who found 84.60% right-sided localization. Whereas in the series by DEMBLE and COFFI [3], left-sided localization was classiq, SHEKARRIZ drew attention to the possible link between the laterality of the stones and the side on which patients habitually slept [4]. Moreover, stones were bilateral in 5% of cases, in line with the rate observed in the literature, as reported by C. Zendo *et al*., [5] with a rate of 5.3%. Pyloric localization was most frequent in 24% of patients, with 20% of cases in the lower calyx, 21% in the middle calyx and 11% in the upper calyx. This result differs from that reported by DIAKITE [6], who found 11 cases of lithiasis in the lower calyx, 1 case in the upper calyx and 2 cases in the middle calyx. Lumbar ureter involvement was most predominant in our series (66%), with 11 cases (38%) in the pelvic ureter and 8% in the iliac. In contrast to our series, those of COFFI [3] and TRAORE [2] found 62% and 77% pelvic involvement respectively. On the other hand, DIAKITE [6] found an equivalence between lumbar and pelvic involvement, with 50% for each. 80% of our patients had stones between 10 and 20 mm in size, 11% less than 10 mm and 9% greater than 20 mm, irrespective of stone location. Our data are almost identical with those published in the literature, since C. ZeOndo *et al*., [5] reported that 65.5% were smaller than 10mm and 34.5% between 10 and 20mm. In our series, 88% of our patients had a single calculus, compared with 12% with multiple calculi. Our study showed a success rate of 65.43% after 1 to 4 ESWL sessions at 6 months, irrespective of stone location, size or other parameters. This rate is lower than that of Traxer *et al*., with a success rate of 90% after 1 to 4 sessions [7]. ESWL results depend on the calculus (size, density, nature, location), the patient (BMI, malformations), but also on other parameters. The anatomy of the renal cavities is a highly controversial parameter. The lithotripter and the technique of the LEC session are also important factors. In order to achieve good fragmentation, the lithotripter must enable real-time tracking, have a wide focal spot and adjustable energy parameters. LEC results also depend on the operator's experience, power, frequency, number of shockwaves and number of sessions [7]. For optimum fragmentation, low frequencies should be used, ideally 1 Hz or even 1.5 Hz. Using low frequencies results in better fragmentation and less analgesia, because at this frequency the cavitation bubble clusters do not interfere with the shock waves. What's more, at 1 Hz, the negative pressure wave is deeper, without affecting the positive pressure peak [8]. Poor results in lower calcific calculi may be explained by their sloping position and the particular anatomical layout of the lower pole of the kidney, with a long and/or narrow calcific stem [9]. However, the negative influence of stone location in the inferior calyx is debated, and was not demonstrated in Danuser's study of 96 patients treated with ESWL for a single calcific stone. The quality of stone disintegration would seem to depend more on the characteristics of the stone itself than on the anatomical features of the inferior calyx [9]. For ureteral calculi, the overall success rate was 57% in our series. The SF rate was 65% for lumbar ureter stones, followed by 50% for iliac ureter stones and 45% for pelvic ureter stones. Nakumara [10] reported better results, with SF rates of 89.4% and 94.4% for lumbar and pelvic ureter stones respectively. The number of stones also influences the results of extracorporeal lithotripsy. While the complete success rate after extracorporeal lithotripsy for single kidney or ureteral lithiasis reaches 70%, this rate drops to 31% after treatment of 2 or more lithiases. This is in line with the rates observed in the literature, as reported by Vallancien [11], where the FS rate was 64% for single lithiasis versus 43% for patients with multiple lithiasis. In Perks' study, the three-month SF rate was 46% for stones below 1000 HU and 17% for stones above 1000 HU. In addition, after ESWL, dense calculi are fragmented into larger fragments [12]. In a prospective study on the identification of factors predictive of stone fragmentation by non-injected CT, the fragmentation failure factors for electromagnetic ESWL were high BMI and stone density greater than 1000 HU. The only factor predictive of residual fragments was stone density greater than 1000 HU [13]. ESWL is currently in competition with holmium laser USR, and the latter is increasingly preferred by many authors [14]. Open surgery remains indicated in two particular situations: complex renal calculi such as certain coralliform calculi, and the unavailability of other therapeutic means, as is often the case in developing countries. ESWL and ureteroscopy (URS) are equally effective in treating stones in the proximal ureter [15]. However, for stones larger than 1.5 cm with upstream dilatation, URS is significantly more effective. Similarly, SF results are achieved more rapidly with URS than with ESWL [16]. SF rates at 3 weeks and 3 months were 58 and 88% for ESWL and 78 and 89% for URS [16]. Finally, in an economic study, it was reported that URS was less expensive than ESWL in proximal ureteral calculi. However, ESWL is perceived as more comfortable and is preferred by patients. For the pelvic ureter, controversy persists between the use of in situ pelvic ESWL as a first-line procedure or semi-rigid or flexible ureteroscopy. The advantage of ureteral ESWL is its use as an outpatient procedure [17]. Obesity remains a limitation of ESWL treatment in all stone topographies, especially for pelvic stones, due to the depth of firing which may require full bladder location techniques using angles in the coronal and sagittal planes [18]. If ESWL complications such as ureteral impaction occur, URS may be proposed, and if this fails, laparoscopic or open ureterolithotomy may be the ultimate solution. The most frequent complications of ESWL are related to the presence of residual lithiasis fragments, potentially responsible for urinary tract obstruction in the event of secondary migration. Complications unrelated to the presence of residual fragments are rare (< 1%) and often poorly understood. After ESWL, the risk of renal colic is 20-25%, and of infection 5%. After ESWL, skin bruising or hematoma may occur. There is little risk of damage to the inner ear. Iliac artery stenosis has been reported [19]. ESWL of distal ureteral calculi may impair spermogram quality (density, motility), but this is reversible within three months [20]. Long-term effects on sperm quality are unknown [20]. The risk of impaction after ESWL is 2-8%, 80% of which occurs in the distal ureter. The risk increases with size (< 1 cm: 4%; 1-2 cm. 16%; > 2 cm : 24%), location (calyces: < 10%; renal pelvis: 19%) and stone density (650 HU). An asymptomatic, uncomplicated stone impaction should be monitored every two to four weeks, otherwise an ESWL can be performed on the head of the stone impaction, before indicating ureteroscopy. The renal damage caused by ESWL is essentially due to the pressure and energy density created by the cavitation of the shock wave [21]. In a matched cohort study of lithiasis patients who had or had not had ESWL from 1985 to 2004, an increased risk of hypertension and diabetes mellitus was demonstrated at 19 years in patients who had had ESWL. ESWL was performed for kidney stones or proximal ureter stones. The risk factor for hypertension was bilateral ESWL, and for diabetes the number of sessions and intensity of ESWL [22].

Conclusion

ESWL is an effective treatment for the management of lithiasis of the upper urinary tract. Despite the relative simplicity of the technique and its low morbidity, the indication must be carefully considered, taking into account the factors predictive of success and failure, namely the size, location, density and number of calculi, not forgetting the complications it may cause.

Conflicts of Interest: The authors declare no conflicts of interest.

Authors' Contributions

The authors participated equally. All authors read and approved the final version of the manuscript.manuscrit.

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