Extracorporeal Shock Wave Lithotripsy vs Flexible Ureteroscopy for Small and Intermediate Size Urinary Calculi: A Retrospective, Single Center Comparison

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ABSTRACT

Introduction and Objectives. When it comes to the best treatment option for small (<10 mm) and intermediate (10-20 mm) kidney stones, the EAU offers the possibility to choose between ESWL and f-URS. Given the fact that the management of kidney stones smaller than 2 cm in diameter is still controversial, we aimed to retrospectively compare the efficacy of these two techniques in our clinical department.

Materials and Methods. A retrospective evaluation between January and December 2022 was conducted at our clinic including 231 patients with a single renal opaque stone ≤2 cm who underwent ESWL or f-URS. In order to assess the efficacy of each treatment, we set the stone-free rate as our main objective and complications, operating time and hospital stay as our secondary outcomes. As a way to a more precise comparison, we divided the patients in two subgroups regarding the stone size: One subgroup with small renal stone (<10 mm) and one with intermediate renal stone (10-20 mm).

Results. Overall, a better stone free rate was found in f-URS group (f-URS 87.5% vs. 70.58% ESWL), although both the operative (63.2 min vs. 44.5 min) and hospitalization (3.65 days vs. 1.43 days) time were longer for f-URS than ESWL. Regarding small sized stones (Subgroup 1), the stone-free rate was similar between each procedure (ESWL 87.5 % vs. 94.2% f-URS). When it comes to intermediate sized stones (Subgroup 2), more f-URS patients achieved a stone-free status (81.6% vs. 44.6%). In both subgroups, the ESWL procedure achieved a better operative time, as well as a shorter hospital stay. Less complications were encountered when ESWL was the treatment option.

Conclusions. We advocate for using ESWL as primary treatment option for kidney stones smaller than 10 mm and to strongly consider it regarding intermediate renal stones.

Key-words: f-URS, ESWL, urinary calculi,

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INTRODUCTION AND OBJECTIVES

Urolithiasis remains one of the most painful diseases in urology since mankind [1]. What has changed over time are the treatment options that surgeons have. Now that endourologic technology has advanced, only 1% to 2% of kidney stones require open surgery to be removed [2]. Despite the fact that urolithiasis can be successfully treated, the high rate of recurrence makes it a serious health concern that necessitates additional methods, emphasizing the value of endoscopic and minimally invasive therapies [3].

Since 1980, when the first patient was treated for kidney stones using the HM1 extracorporeal lithotripter, the idea of a noninvasive and anesthesia-free procedure for kidney stones intrigued the scientific world which led to major improvements of shockwave lithotripsy. However, even with today's technology, some drawbacks such as kidney injury and high retreatment rate prove that it's not a flawless technique [4]. The effectiveness of extracorporeal shockwave lithotripsy (ESWL), according to the European Association of Urology's (EAU) recommendations, depends on the size, location and composition of the stone as well as individual patient variables [5].

The ability of flexible ureteroscopy (f-URS) to examine the upper urinary tract has significantly increased as a result of the advances in endoscopic technology. Based on past experiences, f-URS may have a higher stone-free rate (SFR) and a reduced risk of kidney damage and bleeding. However, its limitations as a first treatment option comes with greater risk of ureteral injury, a more challenging surgical technique and higher medical costs [6,7].

When it comes to the best treatment option for small (<10 mm) and intermediate (10-20 mm) kidney stones, regardless of their location (upper/middle/lower calyx), the EAU offers the surgeon and the patient the possibility to choose between ESWL and f-URS [5]. Given the fact that the management of kidney stones smaller than 2 cm in diameter is still controversial, we aimed to retrospectively compare the efficacy of these two techniques for this kind of calculi in our clinical department.

MATERIALS AND METHODS

A retrospective evaluation between January and December 2022 was made at our clinic including 231 patients. The main inclusion criteria were represented by patients with a single renal opaque stone with a diameter ≤2 cm who underwent SWL or f-URS. The preferred course of treatment was determined by the surgeon who also took into consideration patient's preference. Patients were excluded if any of the following were present: congenital anomalies (e.g. horseshoe kidney, duplicity), pregnancy, solitary kidney, stone in calyceal diverticulum, ureteropelvic junction obstruction. In order to assess the efficacy of treatment we set the stone-free rate as our main objective and complications, operating time and hospital stay as our secondary outcomes.

Regardless the procedure, every patient was evaluated with a complete clinical and paraclinical examination including a urine culture. Stone size and location were assessed using intravenous urography (IVU) or a contrast-enhanced computed tomography (CECT). Although CECT is superior in estimation of stone size, it was not available in all patients, thus creating a range of biases. In case of positive urine cultures, antibiotic treatment was started prior to surgery.

For all patients included in this study, the stone-free rate was assessed with a kidney-ureter-bladder X-ray (KUB) 1 month following the procedure. The Clavien-Dindo classification was used to evaluate the complications [8]. As a way to a more precise comparison between ESWL and f-URS, we divided the patients in two subgroups regarding the stone size: One subgroup with small renal stone (<10 mm) and one with intermediate renal stone (10-20 mm).

Total operative time was measured by the respective devices and entered into the surgical protocol notes.

ESWL technique

A MODULITH SLX-F2 Stationary lithotripter with electromagnetic shock wave from Storz Medical™ was used for ESWL treatment as an outpatient procedure. According to the patient's preference, an oral non-steroidal anti-inflammatory drug was administered 1 hour prior the procedure. There was no need for any sedation or general anesthesia. Real-time ultrasound localization of the stone was used for every patient. The coupling for this device was done by a membrane and a water cushion. The procedure consisted of a maximum of 3000 shocks for each session. If insufficient fragmentation was found, the patient underwent another session. A ESWL failure was declared after two sessions if the breakage of the stone didn't occur.

f-URS techinque

Two weeks prior the surgery, a JJ stent was inserted on all patients that underwent f-URS. On the day of he surgery, a spinal anesthesia was used, then the patient was placed in the lithotomy position. The entire surgery was assisted with fluoroscopic imaging. Before performing a flexible ureteroscopy, a semirigid retrograde ureteroscopy was regularly tcarried out to dilate and inspect the ureter. Then, using a guidewire, an ureteral access sheath (11/13 Fr) was passed. The flexible ureteroscope LithoVue™ (Boston Scientific) was inserted through the ureteral access sheath. For lithotripsy, a Holmium Laser (Litho 150W from Quanta System™) in combination with an optical fiber 272- m was used. A JJ stent was mounted after the surgery and removed 7-14 days postoperatively.

RESULTS

A total of 231 patients were retrospectively assessed for this study, including 119 patients that underwent ESWL and 112 patients who benefited from f-URS. As the demographic table (Table 1) shows, the baseline parameters - age, sex, stone localization (right vs. left kidney), stone size - were similar. The average stone size was slightly higher in the f-URS Group (11.48 mm vs 9.28 mm). After the division of the two stone size subgroups, we observe that in ESWL group there are more patients treated for small-sized kidney stones (60.5%) than medium-sized stones (39.5%). As of f-URS group, the distribution between the two subgroups is similar (46.4% vs 53.6%). When it comes to stone localization, regarding the procedure, almost half of the patients (ESWL - 56.4%; f-URS – 47.4%) were treated for lower calyx stones.

	ESWL Group	f-URS Group
Number of patients	119	112
Age (years)	51.3	52.94
Sex - n (%)	Male-64 (53.7) Female-55 (46.3)	Male-46 (41.1) Female-66 (58.9)
Stone localization	Right Kidney (n=59) Left Kidney (n=60)	Right Kidney (n=54) Left Kidney (n=58)
Upper Calyx - n (%)	12 (10)	18 (16)
Middle Calyx - n (%)	40 (33.6)	41 (36.6)
Lower Calyx - n (%)	67 (56.4)	53 (47.4)
Stone Size Avg. mm (Range)	9.28 (5-18)	11.48 (7-20)
Subgroup 1 (<10 mm) n patients (%)	72 (60.5)	52 (46.4)
Subgroup 2 (10 -20 mm) n patients (%)	47 (39.5)	60 (53.6)

Table 1 – Patient demographics

Table 2 reveals the primary and secondary outcomes. Overall, 52 patients from ESWL group underwent two sessions, meaning an overall mean of 1.43 sessions. A better stone free rate was found in f-URS group (f-URS 87.5% vs. 70.58% ESWL), although both the operative (63.2 min vs. 44.5 min) and hospitalization (3.65 days vs. 1.43 days) time were longer for f-URS than ESWL.

	Subgroup 1 (<10 mm)		Subgroup 2 (10-20 mm)		Overall	
	ESWL	**f-URS**	**ESWL**	**f-URS**	**ESWL**	**f-URS**
Stone-free Rate - n (%)	63 (87.5%)	49 (94.2%)	21 (44.6%)	49 (81.6%)	84 (70.58%)	98 (87.50%)
Total Complications - n (%)	2 (2.77%)	4 (7.69%)	2 (4.25%)	6 (10%)	4 (3.36%)	10 (8.92 %)
Grade I	2	3	1	3	3	6
Grade II	0	0	0	1	0	1
Grade III	0	1	1	2	1	3
Grade IV	0	0	0	0	0	0
Grade V	0	0	0	0	0	0
Operative Time Avg. (min.)	42.37	50.4	51.6	71.5	44.5	63.2
Hospitalization Time Avg. (days)	1.32	3.46	1.74	3.81	1.43	3.65

Table 2. Primary and Secondary Outcomes

Comparing the two procedures for small sized stones (Subgroup 1), we noticed that results are similar regarding stone-free rate between them (ESWL 87.5% vs. f-URS 94.2%). Twenty patients required two sessions of ESWL resulting in a mean of 1.27 sessions, yet the operative time was shorter in ESWL group (42.37 min. vs. 50.4 min). Two patients in ESWL group presented renal colic, including one patient that was admitted for 3 days for medical treatment. However, the hospitalization time was significantly shorter for ESWL group (1.32 d. vs. 3.46 d.). During one flexible ureteroscopy, there was a ureteric injury from a large fragment retrieval, which needed prolonged stenting for 7 weeks.

When it comes to intermediate sized stones (Subgroup 2), more f-URS patients achieved a stone-free status (81.6% vs. 44.6%). A bigger stone meant that 32 patients needed two sessions of ESWL resulting in an average of 1.68 sessions, yet only about half of the patients reached stone-free success. Although they are a slightly higher, both operative (44.5 min. vs. 63.2 min) and hospitalization (1.43 d. vs. 3.65 d.) time favored the ESWL procedure. Two patients from the ESWL subgroup needed admission. One patient presented steinstrasse, which meant he had to undergo an ureteroscopy, and another patient presented a perirenal hematoma which was treated conservatively. Even though every patient presented a negative urine culture at the time of the procedure, one session of flexible ureteroscopy had to be temporized because the patient shivered. Ureteric injury was a complication in 3 of f-URS group that needed a prolonged JJ stenting.

DISCUSSIONS

Given the rising incidence of urolithiasis worldwide, enhancement and improvement of the current treatment options are crucial [9]. Both the ESWL and f-URS evolved over the years, yet the fray remains tight regarding the best treatment option for renal calculi smaller than 20 mm. For this type of stones, EAU suggests that both procedures remain valid treatment options [5].

Herout et al. conducted a retrospective analysis in Germany that included a period of the last 14 years,

regarding the management of upper urinary tract stones. Although the prevalence of urolithiasis has risen steadily over time, as have the surgeries performed to treat it. The total number of SWL has decreased, being replaced by the number of f-URS, which has considerably increased [10].

At first sight, f-URS had better results regarding the stone-free rate in our study, but when we compare the two stone size subgroups, the odds change. F-URS had a better stone-free rate when we consider intermediate size stones, but also a prolonged hospital stay, longer operative time and more complications. It is also worth to note that f-URS group faced three Grade III complications, which reminds us that it has greater risks than non-invasive ESWL. When it comes to small sized stones, ESWL achieved a similar stone-free rate with f-URS, but also it had better operative time, hospitalization time and a lower complication rate. In our opinion, ESWL is the preferred treatment option for kidney stones smaller than 10 mm.

In a recent meta-analysis, Guangda Lv and colleagues compared ESWL and f-URS regarding kidney stones smaller than 20 mm. In comparison to SWL, f-URS can obtain a higher SFR for urinary stones that are 1-2 cm in size while having lower rates of retreatment, sessions, and auxiliary procedures. There is no observable change in SFR between ESWL and f-URS for urinary stones under 1 cm. While f-URS primarily necessitates longer hospitalization, ESWL is typically done as an outpatient procedure with a shorter operative time and hospitalization [11].

In a large single center study conducted by Luke H. Chan, ESWL was assessed as a primary treatment option for 10-20 mm lower pole kidney stones. In their study, ESWL, as an outpatient procedure, obtained similar efficacy with f-URS and concluded that shock-wave procedure is more cost-efficient than f-URS [12].

Our study shows similar results with previous articles. However, some limitations of this study include the stone-free assessment with KUB Radiography, a lack of information about patients' body mass index and information about the Hounsfield Units of the calculi.

CONCLUSIONS

ESWL showed similar results to f-URS in the subgroup of small sized stones (<10 mm), with better operative times and shorter hospital stay. For the treatment of intermediate sized stones (10-20 mm), f-URS appeared to have a better stone-free rate, but more complications were encountered and a longer operative and hospitalization time were needed. We advocate for using ESWL as primary treatment option for kidney stones smaller than 10 mm, and to strongly consider it regarding intermediate renal stones.

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