Original Article

Shock wave lithotripsy in the era of COVID-19

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Abstract

Objective: The objective of the study y was to evaluate factors which can improve shock wave lithotripsy (SWL) results to keep up with COVID-19 pandemic.

Methods: Between June 2020 and June 2021, patients with radio-opaque or faint radio-opaque upper urinary tract stones, stone attenuation value ≤1200 HU, and stones size <2.5 cm were treated by electrohydraulic SWL. Patients with respiratory tract symptoms elevated temperature, contact with COVID-19 patients, or positive COVID-19 swab 2 weeks preoperatively, skin-to-stone distance >11 cm, and body mass index >30 kg/m^2 were excluded from the study. Patients were prospectively enrolled in SWL done at a rate of 40–50 SWs/min under combined ultrasound and fluoroscopy-guided, ramped into high power in the 1st 300 shocks. Success rate and complications were recorded.

Results: Five hundred and ninety patients completed the study. The success rate after 1st session was 408/590 patients (69.15%) which was augmented by 2nd session to reach 527/590 patients 89.3%. The success rate was 96.2% at 3 months postoperatively. Most complications were mild (Grade 1 or 2).

Conclusions: SWL results improved using slow rate high power from the start of the session under combined fluoroscopy and ultrasound guidance. SWL may be a preferred option during a pandemic.

Keywords: COVID-19, renal stones, shock wave lithotripsy, upper urinary tract stones

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INTRODUCTION

The development of minimally invasive techniques, such as retrograde intrarenal surgery, mini percutaneous nephrolithotomy (PNL), and ultra-mini PNL, have made urologists hardly prescribe shock wave lithotripsy (SWL) as a treatment option for patients with upper urinary tract stones (UUTSs).[1] On February 14, 2020 the first case of COVID-19 was reported in EGYPT, after that COVID-19 has been declared as a pandemic by the World Health Organization on March 11, 2020.[2] Many members of the anesthetic team were redeployed to intensive care units or COVID-19-specific resuscitation teams, which led to fewer available medical and paramedical staff. The patient's candidate for surgical operations may be at increased risk of contracting COVID-19 due to the mobilization of pathogens by aerosol generated during anesthesia and the procedure itself.[3] This encouraged the local authorities in our country to direct surgeons toward outpatient procedures, which can be done without hospital admission, general or regional anesthesia. Hence, in the era of COVID-19, the use of SWL in the treatment of UUTS has been outweighed by urologists in our center, especially after the development of new SWL protocols, providing

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nearly the same stone-free rate (SFR) and complications as compared to laser ureteroscopy (URS).[4] Moreover, SWL is available, noninvasive, and of lower cost, which favors its use during a pandemic, although improving its SFR and safety are still mandatory.[5] This study aimed to evaluate factors that can improve SWL results to keep up with COVID-19 pandemic. We assessed SWL under the combined use of ultrasound and fluoroscopy guide, using a high power slow rate from the beginning of SWL session.

METHODS

Between June 2020 and July 2021, 590 patients with radio-opaque or faint radio-opaque UUTS, stone attenuation value (SAV) (≤1200 HU), and stones size <2.5 cm were enrolled in a prospective study in our center. All patients with respiratory tract symptoms, elevated temperature, contact with COVID-19 patients or positive COVID-19 swab 2 weeks preoperatively, renal insufficiency, skin-to-stone distance (SSD) >11 cm, and body mass index (BMI) >30 kg/m^2 were excluded. On arrival, all patients were screened for respiratory tract symptoms and temperature. Personal protective equipment was used for all patients and our staff, including surgical masks, gloves, and eye-protecting devices. Written informed consent and approval by our ethical committee at the Faculty of Medicine, Beni-Suef University, were taken. Preoperative evaluation included serum creatinine, complete blood count, coagulation profile, BMI, urine analysis, and culture when needed. Ultrasonography (US), kidney-ureter-bladder (KUB) film, and noncontrast computed tomography (NCCT with measuring stone size, SSD, and SAV) were done. Patients underwent SWL at a rate of 40–50 SWs/min. SWL sessions were carried out by the same urologist and technician, using an electrohydraulic lithotripter (EMD E-1000, focal area [2.40 cm × 0.6 cm], focal depth [13.5 cm], and focal pressure [55–110 MPa]). At the beginning of the session, intravenous midazolam, subhypnotic dose of propofol, and nalbuphine were administered to all patients for procedural sedation and analgesia. Power ramping was carried out from 6 to 20 kV during the 1st 300 shock waves (SWs). Tapering the tip of electrodes and readjusting the distance between them after each session were done. The session was accomplished at 2500 SWs/session, except if a significant stone fragmentation was achieved earlier. After that, we recommended alpha-blockers and drink plenty of fluids and analgesics for all patients. Patient follow-up was done with US and KUB after 2 weeks to assess stone fragmentation and the requirement for an additional session. If sizable fragments (≥4 mm) were found, the SWL session was carried out on the same day of follow-up. In patients who showed residual fragments ≥4 and ≤9 m after the 3rd session, then a 4th session was considered an auxiliary procedure. For all patients, an NCCT was carried out 3 months later, from the last session. Success was defined as complete clearance of stones or clinically insignificant residual fragments ≤3 mm (obtaining nonsymptomatic residual fragments).

Statistical analysis

Data analysis was performed using (SPSS Inc., Chicago, IL, USA) The description of quantitative variables was in the form of mean and standard. The description of qualitative variables was in numbers and percentages.[6]

RESULTS

Patients and stone demographic data were summarized in Tables 1 and 2. There was a higher success rate in all patients after 1st session 408/590 patients (69.15%) which was augmented by 2nd session to reach 527/590 patients (89.3%). The success rate at 3 months reached 568/590 patients, 96.2%. Concerning the number of sessions, number of SWs, duration of each session, and auxiliary maneuvers are summarized in Table 3. Fifteen patients, only 15 patients showed a complete failure of stone disintegration so PNL and URS were done for all failed patients. Patients showed that residual fragments ≥4 and ≤9 m were seven patients whom a 4th session completed the mission. The success rate reached 97.45%, which was considered an auxiliary procedure. There was no impairment of blood pressure or serum creatinine in up to 3 months of follow-up. Post-SWL complications are summarized in Table 4.

Table 1: Patients and stone data

Items	Mean±SD
Age	42.1±11.7
Sex (male/female)	328/262
BMI	27.3±3.2
Stone size	18±4
SAV	966.5±199.5
SSD	8.3±1.7

BMI: Body mass index, SSD: Skin-to-stone distance, SAV: Stone attenuation value, SD: Standard deviation

Table 2: Stone and JJ data

	n (%)
Site	
Lower calyx	85 (14.4)
Middle calyx	44 (7.47)
Pelvic	334 (56.6)
Upper calyx	63 (10.67)
Upper ureter	29 (4.9)
Laterality	
Left	292 (47.61)
Right	298 (50.43)
JJ stent	51 (8.64)

Most complications were mild (grade 1 or 2). Six patients required URS to manage steinstrasse to relieve pain and/or obstruction as shown in Table 4.

DISCUSSION

Despite the remarkable improvement in the safety and efficacy of flexible URS, we gradually shifted toward SWL to treat UUTS during COVID-19 pandemic. This was influenced by the local authority's instructions to limit hospital admission of cold cases to reduce disease spread and reallocate resources to target the disease.[7] We preferred SWL as it has many merits as its shorter hospital stay decreases the risk of disease transmission. In addition, it needs fewer staff members are needed during the procedure, and less personal protective equipment is required. Moreover, it does not need intubation, general anesthesia, or regional anesthesia, which may be unsafe during COVID-19 pandemic.[3] The higher number of hospital attendances per patient for URS and the higher number of procedures per patient for URS are important factors that favor SWL for ureteric stone treatment in a pandemic.[8] As a result, the combined ultrasound and fluoroscopy targeting of the stone has motivated our staff and patients to SWL using during patient counseling. Despite that, the main drawbacks were the increased number of sessions needed to clear the stone and the longer postoperative follow-up. It was proved that high power and slow rate SWL are safe and effective in previous studies and decreased the number of sessions.[8] Unfortunately, it was found to prolong the duration of each session,[8] so in our study, we waived the safety pause and ramped to reach the maximum power in the 1st 300 SWs using combined ultrasound and fluoroscopy targeting system, aiming at decreasing the time of each session because continuous ultrasound targeting of the stone decreased the number of shocks to 2053.7 ± 243 SWs compared to 3900 SWs in Al-Dessoukey *et al.* 2020.[9] It was found that slowing the rate of SWL from 120 to 30 SWs/min has significantly improved safety and SFR in the porcine model[10] and human studies[11] so we used the slow rate of 40 to 50 SWs/min. Our study found that the overall success rate of all patients was 69.15% after 1st session that was augmented by 2nd session to reach 89.3%. The 3 months' success rate reached 96.2%. Al-Dessoukey *et al.* 2020 concluded that the rate of 30 SWs/min had a better SFR than 60 SWs/min which may be attributed to the use of high power in the group of 30 SWs/min versus ramping power in group 60 SWs/min. Hence, we fixed the high power and omitted the ramping power from our study. The use of intravenous sedative analgesics that kept the stone in the target of SWs during the session may also explain the high success rate. These results were consistent with a study conducted by Chang and associates in 2020. They had conducted a comparison between the ultrasound-assisted and pure fluoroscopy-guided SWL.[12] However, in contrast to their study, we believe that an ultrasound targeting of stones is safe if available. Still, it can give additional benefits without added harm whenever it could be combined with fluoroscopy.

Table 3: The success rate and number of shock waves and sessions

Items	Mean, *n* (%)
Success rate 1st session	408 (69.15)
Success rate 2nd session	527 (89.3)
Success rate 3 months	568 (96.2)
Number of SWs, mean±SD	2053.7±243
Number of sessions, mean±SD	1.35±0.6
Duration of session (min)	45.26±20
Auxiliary procedure	
URS	6 (1.47)
PNL	10 (2.94)
4th session	6 (2.94)

SWs: Shock waves, SD: Standard deviation, URS: Ureteroscopy, PNL: Percutaneous nephrolithotomy

Table 4: Distribution of postoperative complications

Complications	*n* (%)
Overall complications	69 (11.69)
Grade I	
Subcapsular hematoma	3 (0.50)
Skin ecchymosis	50 (8.47)
Grade II	
Fever	10 (1.69)
Grade IIIb	
Steinstrasse needing URS	6 (1)

URS: Ureteroscopy

There were no complicated gross perinephric or subcapsular hematomas, perinephric collections, and parenchymal lesions during the follow-up. This confirmed the safety of omitting the safety pause. Hence, our recommendation for future studies is to increase the number of included patients and prolong the follow-up period.

CONCLUSION

SWL results could be improved using high power, slow rate, combined fluoroscopy, ultrasound, and SWL may be a preferred option during a pandemic.

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Conflicts of interest
There are no conflicts of interest.

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