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Comparison of outcomes between USG-guided ESWL and fluoroscopy-guided ESWL – Our institutional experience

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ABSTRACT

Background: Extracorporeal shockwave lithotripsy (ESWL) is a commonly used non-invasive treatment modality for urolithiasis. While fluoroscopy (FS)-guided ESWL has been the traditional approach, the use of ultrasound (USG) guidance has gained traction due to its potential benefits in terms of reduced radiation exposure and improved stone targeting. **Aims and Objectives:** The aims and objectives are to study the safety and efficacy of extracorporeal shock wave lithotripsy in the management of renal stones, outcomes of overall stone-free rate (SFR), pain intensity, urinary biochemical variables, mean hospital stay, quality of life, and adverse events. **Materials and Methods**: Patient data from the period of May 2022 to April 2023 were reviewed, including 20 patients who underwent USG-guided ESWL and 20 patients who underwent FS-guided ESWL. **Results**: Our analysis revealed that the USG-guided ESWL group demonstrated comparable stone fragmentation rates and SFR (P-value) when compared to the FS-guided group. Moreover, radiation exposure was significantly reduced in the USG-guided ESWL group, with a mean total FS time of [55] s compared to [3005] s in the FS-guided group. No significant differences were observed in terms of complications between the two groups. **Conclusion:** This study highlights the successful implementation of USG-guided ESWL in our institution's experience, showing comparable outcomes in terms of stone fragmentation rates and SFR, while significantly reducing radiation exposure, also can be considered an effective and safe alternative for the treatment of urolithiasis.

Key words: Renal stone; Extracorporeal shock wave lithotripsy; Ultrasound; Fluoroscopy; Radiation; Stone-free rate

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INTRODUCTION

Extracorporeal shock wave lithotripsy (SWL) is a well-known technique that has been used since the early eighties for the treatment of renal stones.[1] At present, there is a trend toward the preferred use of minimally invasive endoscopic procedures such as (flexible) ureteroscopy or (mini-) percutaneous nephrolithotomy for the treatment of renal stones. Despite this evolution, extracorporeal shockwave lithotripsy (ESWL) remains one of the preferred treatment options for renal stones <15 mm.[2] ESWL has a low complication rate and does not require general anesthesia.[3]

The success rates for ESWL vary strongly, as stone-free rates for renal and ureteric stones of 32–90% and 43–98%, respectively, have been reported.[4] The success rate depends on the type of stone and several patient-related factors, as well as treatment protocol and operator experience.[1,5-8] It is crucial for the success of ESWL to correctly visualize the stone to focus the shock waves as precisely as possible, which is done by radiological imaging such as ultrasonography (US) (B-scan ultrasound [USG]) or fluoroscopy (FS) (X-rays). Radiopaque stones located in the kidney calices, the renal pelvis, or the ureteropelvic junction can often be visualized by both US and FS whereas radiolucent stones better visualized by the US.

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Aims and objectives

The aims and objectives are to study the safety and efficacy of ESWL in the management of renal stones, outcomes of overall stone-free rate (SFR), pain intensity, urinary biochemical variables, mean hospital stay, quality of life, and adverse events.

MATERIALS AND METHODS

Study design

It is a hospital-based retrospective study conducted from May 2022 to April 2023. A total of 40 patients were enrolled in the study.

Study place

The study was conducted in the Department of Urology, Government Mohan Kumaramangalam Medical College and Hospital, Salem.

Data analysis

Statistical data analysis was done using Microsoft Excel (2019) software.

Ethics approval and consent to appropriate

The study protocol was approved by the institutional ethics committee, and all patients provided written informed consent before enrolment. IEC NO: GMKMC&H/114/IEC/2023.

Inclusion criteria

Inclusion criteria were as follows: Adults of age group 20–60 years with renal stones of size up to 1.5 cm, post-procedural residual renal stones, high-risk patients with renal stones, and comorbidities such as hypertension, diabetes mellitus, and ischemic heart disease admitted in GMKMCH, Salem, were included in the study.

Exclusion criteria

Exclusion criteria were as follows: Patients of age group <20–>60 years, renal stones of size >1.5 cm, and patients with ureteric calculus and bladder calculus were excluded from the study.

RESULTS

In Table 1, USG-guided SWL group included (n=20) patients out of which mean stone size (9 mm) and FS-guided SWL included (n=20) out of which mean stone size (8.5 mm) in various calyces in the kidney. Table 2 shows body mass index (BMI) of average 27 (US group) and 28 (FS group) with P<0.001 in both the groups. Table 3 includes shock wave frequency (90–110) and number of shocks (3000) given were same in both the groups with P<0.01 although mean energy was different (US group=64J and FS group=68J). Table 4 shows radiation exposure in both groups, and mean number of SWL sessions/patients is 2.6 in US group and 2.7 in FS group with P<0.031. Mean dose area product (DAP) (mGy/cm^2)/SWL session was 55 in US group and 3005 in FS group with P<0.001. Figure 1 shows (a) stone focused using USG guidance, (b) stone focused using FS guidance, and (c) stone fragmentation seen in USG-guided ESWL. Table 5 shows post-operative complications, i.e., mild pain intensity seen in 18 patients (US group) and 16 patients (FS group) with P<0.03. Hematuria is seen in 16 (US group) and 18 (FS group) with P<0.04. Urinary infection is seen in 7 patients in both the groups with P<0.03. SFR was achieved in 17 patients (US group) and 18 patients (FS group) with P<0.05. Outcomes in the study are shown in Table 6, and asymptomatic residual stone fragments are seen in 2 (US group) and 3 (FS group) of P<0.03. One patient in each group underwent an auxiliary procedure (Table 6).

DISCUSSION

Radiopaque stones in the upper urinary tract can often be visualized both by US and FS during ESWL treatment. Not all urologists have an USG system that can be coupled to their ESWL machine or they are not familiar or experienced with this USG-guided SWL technique. The use of FS is easier and may save some time. In our study, during 12-month period from May 2022 to April 2023, 40 patients with renal calculi of size <1.5 cm were treated by ESWL: 20 (USG guided) and 20 patients (FS guided). The study found that both techniques were effective in treating renal calculi. However, USG-guided ESWL technique exhibited

Table 1: Stone-related factors

Stone size and position	US group (n=20)	FS group (n=20)	Statistics and analysis
Stone size			
Mean stone size	9 mm	8.5 mm	P<0.09
Number of stones (0–0.9 mm)	9	8	P<0.001
Number of stones (0.9–1.5 mm)	11	12	P<0.001
Stone position			
Number of upper pole stones	6	7	P<0.37
Number of midpole stones	7	8	P<0.01
Number of lower pole stones	4	3	P<0.01
Number of pelvic stones	3	2	P<0.014

US: Ultrasonography, FS: Fluoroscopy

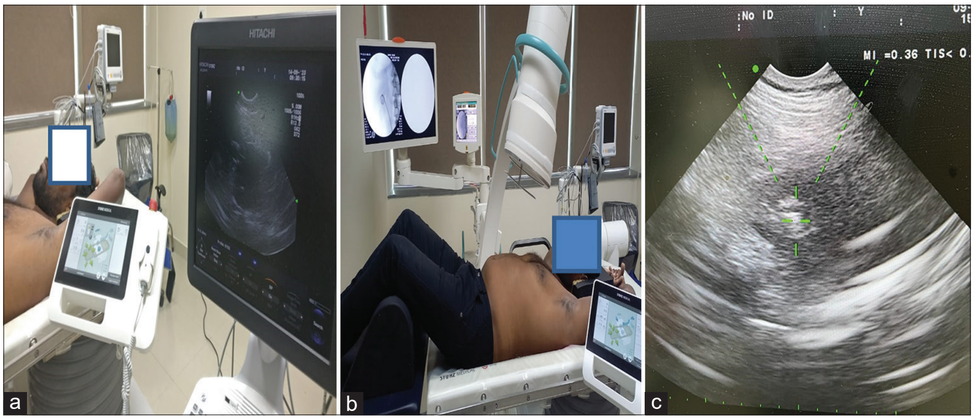

Figure 1: (a) ultrasound (USG)-guided extracorporeal shockwave lithotripsy (ESWL) renal stone; (b) fluoroscopy-guided ESWL; (c) real-time monitoring of renal stone in USG-guided ESWL

Table 2: Patient-related factors

Patient characteristics	US-group	FS-group	Statistics and analysis
Mean BMI (kg/m^2)	27	28	P<0.001
Mean skin-to-stone distance (mm)	90	105	P<0.001

BMI: Body mass index

Table 3: Technique-related factors

ESWL	US group	FS group	statistics and analysis
Shock frequency (bpm)	90–110	90–110	P<0.01
Number of shocks	3000	3000	P<0.01
Mean energy (Joule)	64	68	P<0.001

Table 4: Radiation exposure

No of sessions and amount of radiation	US-group	FS-group	Statistics and analysis
Mean number of SWL sessions/patient	2.6	2.7	P<0.031
Mean DAP (mGy/cm^2)/SWL session	55	3005	P<0.001

SWL: Shock wave lithotripsy, DAP: Dose area product

Table 5: Post-operative complications

Post op complaints	US group (n=20)	FS group (n=20)	Statistics and analysis
Pain intensity - mild (VAS)	18	16	P<0.03
Hematuria	16	18	P<0.04
Infection (UTI)	7	7	P<0.03

US: Ultrasonography, FS: Fluoroscopy, VAS: Visual analog scale, UTI: Urinary tract infection

superior outcomes with higher stone clearance rates in radiolucent calculi (P<0.001), also less radiation exposure (P<0.05), and less number of cycles (P<0.003) compared to FS-guided ESWL. The mean time to position a patient

Table 6: Outcomes

End result	US group	FS group	Statistics and analysis
Number of stone-free patients	17	16	P<0.05
Number of patients with asymptomatic residual fragments	2	3	P<0.03
Number of patients with a positive outcome (7)	19	18	P<0.001
Number of patients needing additional therapy	1	1	P<0.011

in the US group was almost double the time to position a patient in the FS group.[9]

The mean difference however was only 4 min which is very limited, especially when the complete duration of an ESWL procedure (up to 1 h) is taken into account. The study was limited to renal calculi since calculi in lower positions may be difficult to visualize in the US. The clinical results after ESWL in our study showed that the chance of having a stone-free status after US-guided ESWL treatment was slightly higher than after FS-guided SWL treatment. A possible explanation for this difference might be the real-time monitoring which led to a significantly higher number of repositioning in the US group.[10]

In our study, the mean FS time was 101 s and the mean DAP was 3005 mGy/cm^2/SWL session. Patients may undergo more than one SWL session for the same stone. Although this is not a worrisome dose compared to other interventional procedures, we need to bear in mind the cumulative effect of ionizing radiation. Another important advantage of USG is that it does not use ionizing radiation.[11] Furthermore, the operator's exposure to ionizing radiation should be taken into account.[12] Based on these results, we can only conclude that the US is not inferior to FS. Interestingly, however, Ordon et al. demonstrated that a small but significant increase in FS time correlated with an increase in ESWL success rates.[13]

Limitations of the study

1. It is not a randomized controlled trial
2. Long-term follow-up is required
3. More number of patients need to be included in the study
4. The major limitation of our study is the relatively small number of patients
5. A second limitation is the significant difference in BMI, skin-to-stone distances, and energy used during an SWL procedure between both groups
6. It is known that a higher BMI and skin-to-stone distance may have a negative effect on SWL success.

CONCLUSION

Renal calculus of size <1.5 cm (<1000HU) can be better treated with the help of USG-guided ESWL compared to FS-guided ESWL. Our study demonstrates that US-guided ESWL is not inferior to FS-guided ESWL, with the additional advantage of avoiding ionizing radiation to the patient as well as urologist. Patients with high risk for surgery can be easily treated with ESWL. Although more patients are needed to substantiate our findings, we would suggest to perform USG-guided ESWL whenever possible.

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PP- Interpreted the results; reviewed the literature and manuscript preparation; **JN-** Concept, coordination, interpretation, and publication work; **RM-** Concept and design of the study, prepared the first draft of manuscript; **KV-** Data collection, statistical analysis, preparation of manuscript.

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