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Original Research Article

EFFICACY OF EXTRACORPOREAL LITHOTRIPSY FOR UPPER URETERIC CALCULI: A SINGLE TERTIARY CENTER STUDY

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ABSTRACT

Background: Urolithiasis represents a prevalent urological condition that necessitates prompt intervention. Upper ureteric calculi are usually treated by either ureteroscopic lithotripsy (URSL), percutaneous nephrolithotomy or extracorporeal shock wave lithotripsy (ESWL). This study was conducted to analyze the efficacy of ESWL for upper ureteric calculi at a tertiary care hospital.

Material and Methods: From January 2023 to June 2023, a total of 57 adult patients with single upper ureteric calculus <2 cms in size and <1500 Hounsfield units were included in the study and underwent primary ESWL at our hospital. The primary objective of the study was the stone-free status, as assessed by plain radiography and non-contrast enhanced computed tomography within three months following the final treatment session. Patients who did not respond after two sessions of ESWL were classified as treatment failures. Descriptive analysis, independent t-test and Chi-square test were used for data analysis.

Results: 46 out of 57 (80.7%) patients achieved stone free status. On analysis, stone size ($p<0.001$) and stone density ($p<0.001$) were found to be significantly higher in patients with ESWL failure. However, patient age ($p=0.129$), gender ($p=0.603$), body mass index ($p=0.208$), stone laterality ($p=0.285$), nature of disease ($p=0.573$) and duration of symptoms ($p=0.936$) showed no statistically significant difference between the groups. Steinstrasse was a complication in 5 (8.77%) patients among whom 2 patients required URSL.

Conclusion: ESWL offers an effective, safe, non-invasive method for treating upper ureteric stones less than 2 cms in size with a satisfactory stone-free rate. Stone size and stone density are important predictors of a successful ESWL.

Key Words: Extracorporeal shockwave lithotripsy, Hounsfield unit, steinstrasse, upper ureteric calculus.

INTRODUCTION

Urolithiasis represents a prevalent urological condition that has widespread occurrence, significant rates of recurrence, and potential complications necessitating prompt intervention. Various therapeutic strategies exist for the effective management of ureteric stones, aiming for complete stone removal while minimizing patient morbidity. The predominant methods employed include ureteroscopic lithotripsy (URSL), extracorporeal shock wave lithotripsy (ESWL), percutaneous nephrolithotripsy, laparoscopic ureterolithotomy, and open ureterolithotomy.[1,2] Nevertheless, there remains a deficiency in definitive evidence based guidelines for the treatment of large proximal ureteral stones.

Furthermore, the selection of the most appropriate treatment modality is influenced by multiple factors, such as the size, composition, and location of the stone, as well as clinical considerations, the availability of equipment, and the surgeon's

expertise.[3] The guidelines established by the European Association of Urology advocate for ESWL or URSL as the preferred initial treatment options for proximal ureteral stones.[4]

ESWL was introduced as a treatment for renal stones in 1980 and has since become a widely accepted method for the minimally invasive management of urolithiasis. Initially, the application of ESWL was limited to upper ureteric and renal stones. Over time, it has evolved to include distal ureteric stones in its treatment repertoire, primarily due to its favorable characteristics, which include the absence of significant side effects or complications, no requirement of anesthesia, cost-effectiveness, and a high degree of safety.[5-7] This study was conducted to analyze the efficacy of extracorporeal shock wave lithotripsy for upper ureteric calculi at a tertiary care hospital.

MATERIALS AND METHODS

A total of 57 patients diagnosed with radiopaque single upper ureteric calculus and treated with primary ESWL at our hospital from January 2023 to June 2023 were included in the study. Patients with age <18 years or >60 years, multiple stones, bilateral calculi, stone size >2 cms, stone density >1500 Hounsfield units (HU), preexisting coagulopathy, solitary functioning kidney, congenital abnormality were excluded from the study. The upper ureter was defined as the segment extending from the ureteropelvic junction to the superior margin of the sacroiliac joint. Detailed patient history was recorded, and a comprehensive clinical examination was performed. Diagnostic investigations included routine blood investigations, plain radiography, ultrasonography, intravenous urography and non-contrast enhanced computed tomography (NCCT). The treatment protocol was thoroughly explained to the patients. All procedures were conducted as in-patient basis without the use of anesthesia. The Storz Medical Modulith SLX—F2, an electromagnetic shock wave lithotripter, was employed to deliver shock waves, with low-energy waves administered initially and gradually increased based on patient tolerability. The primary objective of the study was the stone-free status, defined as the absence of visible fragments or the presence of fragments smaller than 3 mm, which were classified as clinically insignificant residual fragments, as assessed by plain radiography and NCCT within three months following the final treatment session. Patients who did not respond after two sessions of ESWL were classified as treatment failures, and alternative treatment options were discussed with them. Descriptive analysis, independent t-test and Chi-square test were used for data analysis.

RESULTS

Table 1 shows various patient characteristics. Mean age was 43.47 ± 9.07 years with a male to female ratio of 1.59:1. In 34 patients calculus was on left side while 23 patients had right sided calculus. In 12 patients the stone was recurrent, whereas 45 patients were first time stone formers. In 15 patients duration of symptom was less than 7 days. The mean stone size was 14.0 ± 3.7 millimeters and mean stone density was 877.44 ± 169.77 HU. [Table 1]

46 out of 57 (80.7%) patients achieved stone free status. On analysis, stone size ($p<0.001$) and stone density ($p<0.001$) were found to be significantly higher in patients with ESWL failure. However, patient age ($p=0.129$), gender ($p=0.603$), body mass index ($p=0.208$), stone laterality ($p=0.285$), nature of disease ($p=0.573$) and duration of symptoms ($p=0.936$) showed no statistically significant difference between the groups. [Table 2]

Ureteric colic was seen in 19 (33.33%) patients. 4 (7.02%) patients had post procedure gross hematuria. 2 (3.51%) patients developed febrile episodes and were managed conservatively with antibiotics and supportive treatment. However, steinstrasse was a complication in 5 (8.77%) patients among whom 2 patients required URSL while others were managed conservatively. [Table 3]

Table 1: Patient characteristics

Variable	Mean (± SD) or Number (n)
Total number of patients (n)	57
Mean age (years)	43.47 ± 9.07
Gender (n)	
Male	35
Female	22
BMI (kg/m^2)	24.33 ± 1.55
Laterality of stone (n)	
Right	23
Left	34
Nature of Disease (n)	
De novo	45
Recurrent	12
Stone size (mm)	14.0 ± 3.7
Stone density (HU)	877.44 ± 169.77
Duration of symptoms (n)	
≤7 days	15
>7days	42

BMI body mass index, HU Hounsfield Unit, SD Standard deviation

Table 2: Analysis of factors predicting successful extracorporeal shock wave lithotripsy

Variable	Patients with Successful ESWL	Patients with ESWL Failure	p-value
Total number of patients (n)	46	11	
Mean age (years)	42.80 ± 9.26	46.27 ± 8.03	0.129
Gender (n) **Male** **Female**	 29 17	 6 5	 0.603
BMI (kg/m^2)	24.42 ± 1.48	23.99 ± 1.85	0.208
Laterality of stone (n) **Right** **Left**	 17 29	 6 5	 0.285
Nature of Disease (n) **De novo** **Recurrent**	 37 9	 8 3	 0.573
Stone size (mm)	13.2 ± 3.5	17.5 ± 1.6	<0.001
Stone density (HU)	834.63 ± 157.64	1056.46 ± 76.75	<0.001
Duration of symptoms (n) **≤7 days** **>7days**	 12 34	 3 8	 0.936

BMI body mass index, HU Hounsfield Unit

Table 3: Complications of extracorporeal shock wave lithotripsy

Complication	Number of patients (%)
Hematuria	4 (7.02%)
Ureteric colic	19 (33.33%)
Febrile episodes	2 (3.51%)
Steinstrasse	5 (8.77%)

DISCUSSION

The initial discoveries regarding the ability of acoustic shockwaves to break apart brittle materials occurred during the 1950s. The first documented instance of utilizing ESWL for the treatment of renal calculi in humans was in 1980. Dornier HM-3, the first commercially available lithotriptor, was introduced in 1983. ESWL transformed the approach to managing urolithiasis, shifting from a predominantly surgical method to one that is now primarily minimally invasive. While the stone fragmentation rates achieved with the HM-3 were notable, the procedure necessitated general anaesthesia. The introduction of second-generation lithotriptors enabled treatment under local anaesthesia, albeit with a reduction in the efficiency of stone fragmentation. Current fourth-generation lithotriptors yield treatment outcomes comparable to those of the HM-3, but they can be administered as outpatient procedures with the option of oral or intravenous analgesia.[8-10]

Treatment methods used for proximal ureteric stones include URSL, ESWL, percutaneous nephrolithotripsy, laparoscopic ureterolithotomy, and open ureterolithotomy. European Association of Urology guidelines recommend both URSL and ESWL equally for proximal ureteric stones less than 1 cm. However, it recommends URSL as first choice followed by ESWL in the management of stones larger than 1 cm in non-obese patients.[4] This study was conducted to analyze the efficacy of extracorporeal shock wave lithotripsy for upper ureteric calculi at a tertiary care hospital.

Stone free rates (SFR) for ESWL in upper ureteric calculus has varied from 72% to 94% in various studies.[11] Al-Marhoon et al. reported SFR of 88% for ureteric stones.[12] Recently, Singh et al. showed a total clearance rate of 81.81% for upper ureteric stones.[10] In our study, an average SFR of 80.7% was achieved. Logarakis et al. showed higher SFR for stones less than 10 mm in size as compared to stones more than 10 mm (79.6% vs 63.6%).[13] Various studies have shown similar results.[11,14] Yazici et al. showed that higher stone density independently predicted ESWL failure in proximal ureteric calculi.[15] Our study also found higher stone size ($p<0.001$) and stone density ($p<0.001$) to be significantly associated with ESWL failure.

Ureteric colic was the most common complication occurring in 33.33% patients in our study. 3.51% patients developed febrile episodes and were managed conservatively with antibiotics and supportive treatment. Steinstrasse was seen in 8.77% patients among whom 40% (2 out of 5) required URSL while others were managed conservatively. In a study by Batra et al. including 76 patients of upper ureteric calculus, 5.2% patients had ureteric colic, 2.6% patients had gross hematuria, 3.9% patients developed fever and 3.9% patients had steinstrasse while 2.6% patients suffered from severe nausea or vomiting.[11]

ESWL offers several benefits however it has a few important disadvantages such as success of the treatment can be affected by various factors like stone size, stone density, stone composition, stone location, and the patient's anatomy. Also, frequent complications such as pain, hematuria, and steinstrasse are major drawbacks. Our study has few limitations including a smaller patient cohort. Also it is a single center study where all cases were done

on a single machine (Storz Medical Modulith SLX—F2).

CONCLUSION

This study highlights that ESWL offers an effective, safe, non-invasive method for treating upper ureteric stones less than 2 cms in size with a satisfactory SFR. Stone size and stone density are important parameters while recommending ESWL for such patients.

REFERENCES

1. Papadoukakis S, Stolzenburg J-U, Truss MC. Treatment strategies of ureteral stones. EAU-EBU Update Ser. 2006;4(5):184–90.
2. Ahn SH, Oh TH, Seo Y. III Can a dual-energy computed tomography predict unsuitable stone components for extracorporeal shock wave lithotripsy? Korean J Urol. 2015;56(9):644–9.
3. Rabani SM, Moosavizadeh A. Management of large proximal ureteral stones: A comparative clinical trial between transureteral lithotripsy (TUL) and shock wave lithotripsy (SWL). Nephrourol Mon. 2012 Summer;4(3):556–9.
4. Skolarikos A, Jung H, Neisius A, Petřík A, Somani B, Tailly T, et al. EAU Guidelines on Urolithiasis. Eur Assoc Urol 2021. 2023;(March):1–87.
5. Bierkens, Hendrikx, Rosette DL, Stultiens, Beerlage, Arends, et al. Treatment of mid- and lower ureteric calculi: extracorporeal shock-wave lithotripsy vs laser ureteroscopy. A comparison of costs, morbidity and effectiveness. Br J Urol. 1998;81(1):31–5.
6. Yang SW, Hyon YK, Na HS, Jin L, Lee JG, Park JM, et al. Machine learning prediction of stone-free success in patients with urinary stone after treatment of shock wave lithotripsy. BMC Urol. 2020;20(1):88.
7. Zhao J, Xing SL. Observation of clinical efficacy of extracorporeal shock wave lithotripsy in treating urinary stones. Shaanxi Med J. 2017; 46:633–4.
8. Nabi G, Downey P, Keeley F, Watson G, McClinton S. Extra-corporeal shock wave lithotripsy (ESWL) versus ureteroscopic management for ureteric calculi. Cochrane Database Syst Rev. 2007;(1):CD006029.
9. Harmon WJ, Sershon PD, Blute ML, Patterson DE, Segura JW. Ureteroscopy: current practice and long-term complications. J Urol. 1997;157(1):28–32.
10. Singh N, Agarwal S, Sarpal R. Prospective evaluation of extracorporeal shockwave lithotripsy in renal and upper ureteric stone treatment: Clinical assessment and results. Cureus. 2024;16(5): e61102.
11. Batra R, Batra P, Bokariya P, Kothari R. Role of extracorporeal shock wave lithotripsy in management of upper ureteric stones. Afr J Urol. 2018;24(3):186–90.
12. Al-Marhoon MS, Shareef O, Al-Habsi IS, Al Balushi AS, Mathew J, Venkiteswaran KP. Extracorporeal shock-wave lithotripsy success rate and complications: Initial experience at Sultan Qaboos University Hospital. Oman Med J. 2013;28(4):255–9.
13. Logarakis NF, Jewett MA, Luymes J, Honey RJ. Variation in clinicaloutcome following shock wave lithotripsy. J Urol. 2000; 163:721–5.
14. Akal HR. The role of Extracorporeal shock wave lithotripsy ESWLin the treatment of upper ureteral stone disease. Thi-Qar Med. 2011;5(3):16–27.
15. Yazici O, Tuncer M, Sahin C, Demirkol MK, Kafkasli A, Sarica K. Shock wave lithotripsy in ureteral stones: Evaluation of patient and stone related predictive factors. Int Braz J Urol. 2015;41(4):676–82.