Original Article

Efficacy of extracorporeal shockwave lithotripsy, with modified position of the machine head in the treatment of lower calyceal stones in obese patients

Mohamed Abou-Farha, Ahmed El-Abd, Tarek Gameel, Hassan Eltatawy, Salah Nagla

Department of Urology, Tanta University, Tanta, Egypt

Abstract

Context: Extracorporeal shock wave lithotripsy (ESWL) has inferior results in the lower calyceal stones, especially in obese patients.

Aims: This study aimed at evaluating of the efficacy of extracorporeal shockwave lithotripsy, with modified position of the machine head in the treatment of single lower calyceal stones in obese patients.

Settings and Design: This was a prospective study (phase IV trial).

Subjects and Methods: We studied the anterior rotation of the shock wave machine head in obese patients for the treatment of lower calyx stones. From February 2015 to June 2019, 105 obese patients (body mass index [BMI] ≥35) having lower calyx stones (≤20 mm) underwent ESWL at our institute. The procedure was done in a supine position, and the head of the shock-wave machine was tilted anteriorly. ESWL was considered successful if the kidney was completely cleared of stones.

Statistical Analysis Used: The statistical methods used were descriptive statistics, mean, standard deviation frequency analysis, Chi-square test, unpaired *t*-test test, and Pearson correlations (r).

Results: The mean BMI of these patients was 39.71 ± 2.8 kg/m^2, the mean stone size was 17.4 ± 2.1 mm, the mean stone density was 767.1 ± 193.4 Hounsfield unit, and the mean of skin to stone distance (SSD) was 145.4 ± 4.5 mm. ESWL was successful in 86 (81.9%) patients; 13 patients (12.4%) showed complete success after the first session, while 37 (35.2%), 25 (23.8%), and 11 (10.5%) patients showed success after the second, third, and fourth sessions, respectively. ESWL failed in 19 (19.1%) cases. The success rate decreased significantly with higher stone density and SSD ($P < 0.001$), with negative correlations (*r* values) of −0.871 and −0.811, respectively.

Conclusions: Anterior rotation of the head of the shock wave machine is a suitable option for the treatment of lower calyceal stones in obese patients.

Keywords: Extracorporeal shock wave lithotripsy, obesity, stones

Address for correspondence: Dr. Salah Nagla, Department of Urology, Tanta University, Tanta, Egypt. E-mail: salahnaglah@yahoo.com
Received: 18.11.2020, **Accepted:** 12-03-2021, **Published:** 20.01.2022.

INTRODUCTION

Extracorporeal shock wave lithotripsy (ESWL) is an available option for the treatment of renal stones.[1] ESWL is a minimally invasive procedure, with minimal side effects, and it does not necessitate general anesthesia.[2,3] The World

Access this article online	
Quick Response Code:	Website: www.urologyannals.com
	DOI: 10.4103/UA.UA_176_20

How to cite this article: Abou-Farha M, El-Abd A, Gameel T, Eltatawy H, Nagla S. Efficacy of extracorporeal shockwave lithotripsy, with modified position of the machine head in the treatment of lower calyceal stones in obese patients. Urol Ann 2022;14:81-4.

Health Organization defines obesity according to the body mass index (BMI). Patients are considered obese if their BMI is > 30 kg/m^2 and morbidly obese if 40 or more,[4,5] and recent studies have shown that larger body size is linked to a higher risk of urinary stones.[6] ESWL success rate is affected by the site, size, composition, and the density of the stone, in addition to other factors, for example, BMI, lower calyx stones, and presence of hydronephrosis.[7,8] Several problems are associated with the use of ESWL in obese patients for the management of renal stones. The main problem is the extreme difficulty of focusing on the stone. Sometimes, the skin-to-stone distance (SSD) is far behind the focal length of the lithotripter, so the success rates decrease while increasing the risk to the adjacent organs.[9] The lower calyx stones have a low success rate with ESWL, and studies have reported that there is an inverse relationship between ESWL success rate and BMI.[9,10] Here, we attempted to study the effect of changing the position of the head of the shock wave machine anteriorly to facilitate the stone positioning in obese patients in lower calyceal stones.

SUBJECTS AND METHODS

This was a prospective study of 105 obese patients with lower calyceal stones. All patients were treated by ESWL in our urology department from February 2015 to June 2019.

Inclusion and exclusion criteria

- The inclusion criteria were BMI of 35 or more and single lower calyceal stone <20 mm in diameter
- The exclusion criteria were patients <18 years old; pregnant women; solitary kidney; closed neck of the lower calyx or narrow infundibulum; inclining infundibulum-renal pelvic angle; radiolucent stones; patients with a distal ureteric obstruction or lower ureteric dilatation; patients with severe hydronephrosis; patients with stones larger than 20 mm (maximum diameter); previous history of failed ESWL, cysteine stone, calcium oxalate monohydrate, or brushite stones; and bleeding disorders.

Ethical consideration

Ethical approval was obtained from the local ethical committee before the start of this study. The study has been performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments, or comparable ethical standards. The procedures and their possible complications were discussed with all patients, and informed consent was obtained from the subjects of this study before the beginning of the procedures. Patients' confidentiality was respected and maintained throughout this study.

Procedures

All patients were subjected to routine pre-ESWL investigations, including complete blood count, renal function tests, and coagulopathy profile. Computed tomography (CT) (with and without contrast) was done in all patients to measure the stone sizes, SSD, and density of the stone (Hounsfield Unit [HU]).

Extracorporeal shock wave lithotripsy

Routine pre-ESWL preparation was done. ESWL was performed using Dornier compact delta 2 under local anesthesia (local xylocaine gel 4%) and parenteral analgesia for pain control. Patients were placed in a supine position. All ESWL procedures were done by a single urologist (first author). The adjustment of the stone position was made using the C-arm. The head of the machine was rotated anteriorly to localize the stone. The localization of the stone was done in two planes: anteroposterior and 30°. The shock wave power and rate were applied according to the recommended table of the machine. All patients received post-ESWL medication in the form of antibiotic prophylaxis (ciprofloxacin 500 mg tablets) twice daily for 3 days, once daily alpha-blocker (Tamsulosin 0.4 mg), and an analgesic (intramuscular sodium diclophenate 75 mg), when needed. All patients were instructed to receive plenty of oral fluids and increase physical activity after the session. Follow-up of the patients was done after 3 weeks using a nonenhanced CT scan to assess the success of the ESWL.

Treatment outcomes

ESWL was considered successful if the kidney was completely cleared of stones. The maximum number of allowed ESWL sessions was four.

Statistical analysis

We used the Statistical Package for the Social Sciences (SPSS; version 21, SPSS Inc., IBM, USA) for the analysis. The statistical methods used were descriptive statistics, frequency analysis, Chi-square test, unpaired *t*-test test, and Pearson correlations (r). The results were expressed as the number of patients (n), mean, standard deviation, and range (max-min). $P < 0.05$ was considered statistically significant.

RESULTS

The study was completed on 105 patients: 54 males (51.4%) and 51 females (48.6%). Their mean age was 43 (27–60 years) years. The mean BMI was 39.7 kg/m (35–46). The mean stone size was 17.4 mm (12–20). The mean stone density was 767.1 HU (500–1250). The mean SSD was 145.4 mm (140–155) [Table 1]. The success rate was 81.9% (n = 86). The success rate was higher among

females (88.2%) than males (75.9%), with no statistically significant difference ($P = 0.102$). After the first session, 13 (12.4%) patients showed complete success, while 37 (35.2%), 25 (23.8%), and 11 (10.5%) patients showed success after the second, third, and fourth sessions, respectively. Failed cases ($n = 19$) were treated by percutaneous nephrolithotomy (three cases) and flexible ureteroscopy (16 cases) [Table 2]. The success rate decreased significantly with increasing density of the stone and SSD ($P < 0.001$, $r = -0.871$ and -0.811, respectively). There was no correlation between the stone size and the success rate ($r = -0.076$) [Tables 3 and 4]. Complications occurred in 16 (15.2%) patients; renal colic occurred in 8 of 16 (50%) patients who responded well to antispasmodic and strong analgesia, fever occurred in three of 16 (18.7%) patients, prolonged hematuria (≥4 days) occurred in four of 16 (25%) patients, and steinstrasse in one patient.

Table 1: Descriptive statistics for age, sex, stone size, body mass index, density, and skin-to-stone distance

	Mean±SD	Range
Age	43.7±8.3	27-60
Height (cm)	169.1±11.2	148-190
Weight (kg)	113.9±13.4	86-141
BMI (kg/m^2)	39.7±2.8	35-46
Stone size (mm)	17.4±2.1	12-20
Density (HU)	767.1±193.4	500-1250
SSD (mm)	145.4±4.5	140-155

SD: Standard deviation, BMI: Body mass index, SSD: Skin-to-stone distance, HU: Hounsfield unit

Table 2: Success rate among gender and sessions

	Success (%)	Failed (%)	Total (%)	*P*
Gender				
Male	41 (75.9)	13 (24.1)	54 (100)	0.102
Female	45 (88.2)	6 (11.8)	51 (100)	
Sessions				
First session	13 (15.1)	0	13 (12.4)	<0.001
Second session	37 (43)	0	37 (35.2)	
Third session	25 (29.1)	0	25 (23.8)	
Fourth session	11 (12.8)	0	11 (10.5)	
PNL	0	3 (15.8)	3 (2.9)	
Flexible URS	0	16 (84.2)	16 (15.2)	

PNL: Percutaneous nephrolithotomy, URS: Ureteroscopy

Table 3: Success among age, stone size, density, and skin-to-stone distance

	Success		Failed		*P*
	Mean±SD	Range	Mean±SD	Range	
Age	43.3±8.4	27-60	45.7±8.1	30-59	0.264
Stone size (mm)	17.4±2.1	12-20	17.8±2.1	14-20	0.438
Density (HU)	688.4±98.7	500-950	1123.7±78.8	1000-1250	<0.001
SSD (mm)	144.2±2.4	140-153	149.1±2.1	146-155	<0.001

SD: Standard deviation, SSD: Skin-to-stone distance, HU: Hounsfield unit

DISCUSSION

The European Association of Urology guidelines recommend ESWL for the treatment of lower calyceal stones when conditions are favorable.[11] Multiple studies have reported that patients' age, stone size and density, SSD, and BMI affect ESWL outcomes.[8-10] However, here, we report that there was no correlation between the success rate of this technique and stone size in stones <2 cm ($r = -0.076$). In addition, there were weak correlations between the success rate and age and gender ($r = -0.110$ and 0.160, respectively). Several studies have reported the effect of the stone density on the success rate of ESWL. Pareek *et al*.[8] and Wang *et al*.[12] have reported that a renal stone density >900 HU highly predicts ESWL failure. Gupta *et al*.[13] concluded that 77% of patients with a stone density >750 HU and a stone diameter >1.1 cm needed more than three sessions of ESWL. Although we had a different category – obese patients – the success rate of ESWL by the anterior head rotation technique in our study was 81.9%, and failure occurred with 19.1%, which is in line with the results of Massoud *et al*.,[14] and the previous studies report a failure rate of 5%–20%. Moreover, our study proves that the success rate decreased significantly with the density of the stone ($P < 0.001$), with a strong negative correlation between stone density and the success rate ($r = -0.871$). In high stone density patients (500–1000 HU), ESWL is expected to be an ideal treatment; however, this does not apply in obese patients (BMI > 30). El-Nahas *et al*.[15] and Massoud *et al*.[14] concluded that patients with a BMI >30 have a lower success rate of ESWL, especially if the stone density was >500 HU. However, other studies concluded that the effect of BMI is linked to SSD, which correlates with the shock wave path in the body.[8] Moreover, Cho *et al*.[16] have reported that a 10 cm SSD is a positive predictor of success following ESWL. For that reason, we attempted to overcome this limitation by decreasing the SSD through the anterior rotation technique. We could adjust the stone position using the C-arm and locate the stone in two planes anteroposterior and 30° by rotating the head of the machine during the ESWL procedure for all patients. Our success rate decreased significantly

Table 4: Pearson correlation (*r*) between success rate and age, sex, stone size, density, and skin-to-stone distance

Correlation	Age	Gender	Stone size/mm	Density/HU	SSD/mm
Pearson correlation (*r*)	−0.110	0.160	−0.076	−0.871	−0.811
Coefficient	Weak negative	Weak positive	Zero	Strong negative	Strong negative
Significance (two tailed)	0.264	0.103	0.438	<0.001	<0.001

SSD: Skin-to-stone distance, HU: Hounsfield unit

with SSD ($P < 0.001$), and there was a strong negative correlation between SSD and the success rate ($r = -0.811$). ESWL is considered to be a noninvasive approach.[7] At the same time, other authors have concluded that, when using flexible ureteroscopy, the stone-free rates were similar among obese and nonobese patients without referral to the morbidly obese patients.[5,17] However, these studies provided little information about the intra- and postsurgical anesthesia complications rates in obese patients. Martov *et al*.[18] concluded that ESWL, flexible ureteroscopy, and Percutaneous Nephro-Lithotomy (PNL) have equal outcomes for the treatment of single lower calyceal stone without referral to obese patients. Moreover, Mezentsev[19] reported that in obese patients, ESWL shock wave using the ordinary method had a success rate of just 60%. In our study of 105 patients, the success rate was similar among obese and morbidly obese patients, achieving success in 86 (81.9%) cases. In the current study, we proved that ESWL is a good treatment option for obese and morbidly obese patients with lower calyceal stones in the supine position. In addition, adjustment of the stone position using the C-arm and localization of the stone by rotating the head of the machine anteriorly could be made. The high success rate (81.9%) in our study might be related to the experience of the operator (grade 4 level of evidence).[11] Moreover, this outcome is directly related to the patients' selection criteria. The only drawback of the inclusion criteria was the long SSD, so we used the head rotation technique to decrease this distance.

Limitations of this study

Although previous studies have reported inferior results with ESWL in obese patients, our study was a noncomparative study. Moreover, only 105 patients completed the study, and a larger number should be included in further studies to eliminate type II statistical error.

CONCLUSIONS

Anterior rotation of the head of the shock wave machine is a suitable and safe option for the treatment of single lower calyceal stones in obese patients when conditions allow. With this technique, ESWL treatment outcomes are independent of the stone size in stones <2 cm, while it is inversely dependent on SSD and stone density.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. El Taher M, Reda A, Abdel Latif A, El Gammal M. Comparison of diferent shock wave frequencies on stone disintegration in extracorporeal shock wave lithotripsy; 60, 80 and 100/min. Afr J Urol 2021;27:22.
2. Gadelmoula M, Elderwy AA, Abdelkawi IF, Moeen AM, Althamthami G, Abdel-Moneim AM. Percutaneous nephrolithotomy versus shock wave lithotripsy for high-density moderate-sized renal stones: A prospective randomized study. Urol Ann 2019;11:426-31.
3. Ouyang W, Sun G, Long G, Liu M, Xu H, Chen Z, *et al*. Adjunctive medical expulsive therapy with tamsulosin for repeated extracorporeal shock wave lithotripsy: A systematic review and meta-analysis. Int Braz J Urol 2021;47:23-35.
4. Tiselius HG. How efficient is extracorporeal shockwave lithotripsy with modern lithotripters for removal of ureteral stones? J Endourol 2008;22:249-55.
5. Natalin R, Xavier K, Okeke Z, Gupta M. Impact of obesity on ureteroscopic laser lithotripsy of urinary tract calculi. Int Braz J Urol 2009;35:36-41.
6. Asplin JR. Obesity and urolithiasis. Adv Chronic Kidney Dis 2009;16:11-20.
7. Dede O, Şener NC, Baş O, Dede G, Bağbancı MŞ. Does morbid obesity influence the success and complication rates of extracorporeal shockwave lithotripsy for upper ureteral stones? Turk J Urol 2015;41:20-3.
8. Pareek G, Armenakas NA, Panagopoulos G, Bruno JJ, Fracchia JA. Extracorporeal shock wave lithotripsy success based on body mass index and Hounsfield units. Urology 2005;65:33-6.
9. Pareek G, Hedican SP, Lee FT Jr, Nakada SY. Shock wave lithotripsy success determined by skin-to-stone distance on computed tomography. Urology 2005;66:941-4.
10. Bultitude MF, Tiptaft RC, Dasgupta P, Glass JM. Treatment of urolithiasis in the morbidly obese. Obes Surg 2004;14:300-4.
11. Türk C, Skolarikos A, Neisius A, Petrik A, Seitz C, Thomas K. Guidelines on Urolithiasis; 2019. Available from: http://www.uroweb.org/publications/eau-guidelines. [Last Updated on 2019 March].
12. Wang LJ, Wong YC, Chuang CK, Chu SH, Chen CS, See LC, *et al*. Prediction of outcomes of renal stones after extracorporeal shock wave lithotripsy from stone characteristics determined by unenhanced helical computed tomography: A multivariate analysis. Eur Radiol 2005;15:2238-43.
13. Gupta NP, Ansari MS, Kesarvani P, Kapoor A, Mukhopadhyay S. Role of computed tomography with no contrast medium enhancement in predicting the outcome of extracorporeal shock wave lithotripsy for urinary calculi. BJU Int 2005;95:1285-8.
14. Massoud AM, Abdelbary AM, Al-Dessoukey AA, Moussa AS, Zayed AS, Mahmmoud O. The success of extracorporeal shock-wave lithotripsy based on the stone-attenuation value from non-contrast computed tomography. Arab J Urol 2014;12:155-61.
15. El-Nahas AR, El-Assmy AM, Mansour O, Sheir KZ. A prospective multivariate analysis of factors predicting stone disintegration by extracorporeal shock wave lithotripsy: The value of high-resolution noncontrast computed tomography. Eur Urol 2007;51:1688-93.
16. Cho KS, Jung HD, Ham WS, Chung DY, Kang YJ, Jang WS, *et al*. Optimal skin-to-stone distance is a positive predictor for successful outcomes in upper ureter calculi following extracorporeal shock wave lithotripsy: A bayesian model averaging approach. PLoS One 2015;10:e0144912.
17. Best SL, Nakada SY. Flexible ureteroscopy is effective for proximal ureteral stones in both obese and non obese patients: A two-year, single-surgeon experience. Urology 2011;77:36-9.
18. Martov AG, Ergakov DV, Andronov AS, Dutov SV, Takhaev RA, Kil'chukov ZI, *et al*. Solitary stones of the lower renal calyx: How to treat? Urologiia 2017;(2):28-35.
19. Mezentsev VA. Extracorporeal shock wave lithotripsy in the treatment of renal pelvicalyceal stones in morbidly obese patients. Int Braz J Urol 2005;31:105-10.