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ORIGINAL RESEARCH

Comparative Efficacy of Digital Flexible Ureteroscopy in Management of Renal Stones in Normal-Weight and Overweight/Obese Patients

Nguyen Huu Thanh[1,2], Nguyen Minh Tuan[2], Hoang Long[1], Tran Quoc Khanh[2], Ngo Xuan Cuong[2], Nguyen Truong Giang[2], Nguyen Thanh Vinh[3], Dong Ngoc Minh[4], Duc Anh Dinh[5]

[1]Department of Surgery, Hanoi Medical University, Hanoi, Vietnam; [2]Urological Surgery Department, Bach Mai Hospital, Hanoi, Vietnam; [3]Department of Surgery, Ha Dong General Hospital, Hanoi, Vietnam; [4]Department of Neurology and Neuro Intensive Care, Viet Duc Hospital, Hanoi, Vietnam; [5]Department of Surgery, Viet Nam National Children's Hospital, Hanoi, Vietnam

Correspondence: Nguyen Thanh Vinh, Ha Dong General Hospital, Hanoi, Vietnam, Tel +84 395 875 002, Email Drvinh1982@gmail.com

Purpose: Overweight and obesity are increasingly prevalent and may influence the outcomes of surgical interventions for kidney stones. This study aimed to compare primary and secondary outcomes between normal-weight and overweight/obese patients undergoing flexible ureteroscopy lithotripsy of kidney stones.

Patients and Methods: A study was conducted on 114 patients (73 normal-weight, 41 overweight/obese) who underwent flexible ureteroscopy lithotripsy for kidney stones. Primary outcomes included lithotripsy durations, hospital stay, and median stone size. Secondary outcomes included the stone-free rate, quality of life (QoL) scores, and complications.

Results: No significant differences were observed between the two groups in surgery duration, lithotripsy duration, or hospital stay. While the median stone size at 1-month and 3-month postoperative was comparable between both groups, the stone size exhibited a significantly smaller size at 3 months (all p-values < 0.001). The stone-free rate at 3 months trended significance, with a lower rate in the overweight/obese group (93.2% vs 70.4%, p = 0.035). QoL significantly improved over time (p < 0.001), with most patients reporting no disruption to daily activities after 1 month in all patients.

Conclusion: Overweight/obesity might influencing stone-free rate in patients undergoing flexible ureteroscopy lithotripsy for kidney stones, despite similar perioperative outcomes. The flexible ureteroscopy lithotripsy is shown to be effective over time in reducing kidney stone size as well as postoperative QoL regardless of BMI. Further research is warranted to elucidate the underlying mechanisms and optimize outcomes in this patient population.

Keywords: flexible ureteroscopy lithotripsy, kidney stones, overweight/obese, stone-free rate, quality of life

Introduction

Kidney stones are among the most common disorders encountered in urology. Their occurrence differs according to factors such as region, climate, ethnicity, nutritional patterns, and inherited susceptibility. Worldwide prevalence remains substantial, with estimates of 7–13% in North America, 5–9% across Europe, and about 1–5% in Asia.[1] The prevalence of urinary stones in Vietnam ranges from 2% to 12%, and approximately 40% of cases are renal calculi.[2] The increased incidence may be linked to dehydration caused by elevated ambient temperatures in the summer, which subsequently leads to lower urine volume.[3] As global temperatures continue to rise due to climate change, it is predicted that the number of people suffering from urinary stones may increase from 1.6 million to 2.2 million by 2050.[4] Inadequate management of renal calculi may result in a spectrum of severe consequences, including infections like pyelonephritis and interstitial nephritis, obstructive conditions such as hydronephrosis or pyonephrosis, diminished urine output, and ultimately acute or chronic kidney failure.[5]

Currently, many methods of treating upper urinary tract stones are being applied in Vietnam and around the world, such as extracorporeal shock wave lithotripsy, percutaneous nephrolithotomy, and retrograde endoscopic ureteral

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lithotripsy with semi-rigid endoscopes, reusable flexible endoscopes, and single-use flexible endoscopes, which are increasingly being applied due to their effectiveness and safety.[6] There have been many remarkable improvements in the technology and clinical application of many minimally invasive procedures in the field of urology over the past decades, and in parallel, the continuous development of flexible endoscopy has increased its clinical applicability and made it the first choice for urinary stone disease.[7] Recently, many studies have shown that overweight/obesity significantly increases the incidence of urinary tract stones.[8,9] Furthermore, scientists have demonstrated that 63% of stones in obese patients were composed of uric acid compared to 11% in the non-obese group.[10] However, there are not many reports on the effectiveness of flexible endoscopy lithotripsy treatment in this group of subjects. Therefore, this study was conducted to assess the safety and effectiveness of digital flexible ureteroscopy in treating urinary stones, as well as to assess patients' quality of life between the normal weight and overweight/obesity groups.

Method

Study Population

This study employed a single-center observational study. The study population included 114 patients diagnosed with renal calculi who received treatment at Bach Mai Hospital from January 2023 to December 2024. Recruitment was conducted through convenience sampling, in which all patients meeting the eligibility criteria and presenting during the study period were invited to join.

Exclusion criteria included patients with urinary tract obstruction (eg, urethral or ureteral stenosis, ureteropelvic junction obstruction, or grade 4 hydronephrosis), non-functioning kidneys, or kidney stones in pregnant women or children under 16 years of age. Patients with congenital renal anomalies (such as duplex or horseshoe kidneys) or musculoskeletal deformities (including scoliosis or spinal abnormalities) were also excluded.

The study was approved by the Institutional Review Board of Hanoi Medical University (approval number 876/GCN-HĐĐĐNCYSH-ĐHYHN, July 13, 2023) and conducted according to the ethical standards of the Declaration of Helsinki. The consent form was written by patients. Patients who do not participate voluntarily are not discriminated against in treatment.

Overview of the participants. A total of 280 patients underwent endoscopic treatment for urolithiasis at the Urological Surgery Department of Bach Mai Hospital between 2023 and 2024; we excluded 123 subjects who declined to participate in the study. We also excluded 43 patients who were lost in the follow-up period. A total of 114 patients were used for the final analysis. The flowchart of participants was described in the Figure 1.

Demographic Characteristics

Clinical variables documented included demographics (age, sex, BMI), prior renal treatment history, admission cause, and comorbidities (hypertension, diabetes, other endocrine diseases). BMI is calculated as weight in kilograms divided by the square of the height in meters (kg/m²) and is categorized into four groups according to the Asian-Pacific cutoff points: normal weight (18.5–22.9 kg/m²), overweight (23–24.9 kg/m²), and obese (≥25 kg/m²) for both genders.[11]

Ultrasound Assessment

All participants received renal ultrasonography for the evaluation of stone dimensions and location. Stone size was determined by measuring the greatest diameter, and the site was categorized as upper, middle, or lower calyx. Hydronephrosis was classified into four grades: grade 1 (mild pelvic/calyceal dilatation, PPI 2:1), grade 2 (dilated calyces/pelvis, parenchyma <15 mm, PPI 1:1), grade 3 (marked dilatation with incomplete septa, renal enlargement, PPI 1:2), and grade 4 (severe dilatation with indistinct anatomy, parenchyma <3 mm, PPI 1:3). Patients with grade 4 were excluded.[12]

Surgical Techniques

All surgical procedures were carried out under general anesthesia with patients positioned in lithotomy, following the standard retrograde ureteroscopy approach. Continuous fluoroscopic monitoring was provided using a C-arm, allowing visualization from the bladder through to the renal pelvis. In the majority of cases, passive dilation of the ureter had already

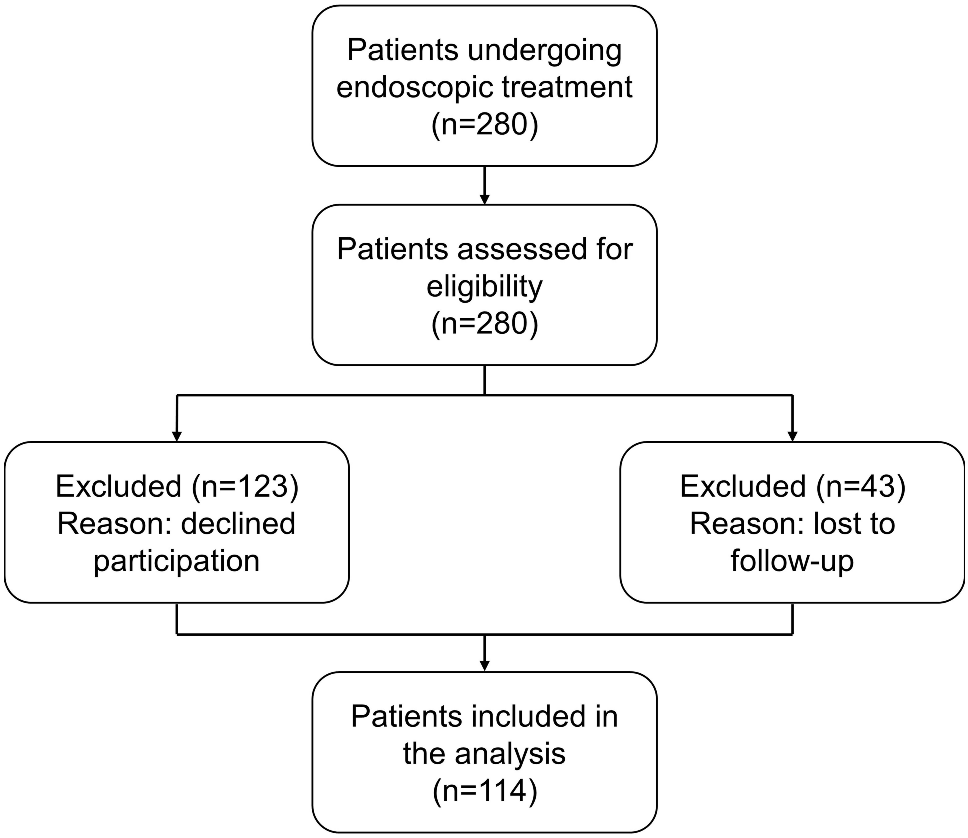

Figure 1 Flow chart of the study participants. A total of 280 patients underwent endoscopic treatment for urolithiasis at the Urological Surgery Department of Bach Mai Hospital between 2023 and 2024; we excluded 123 subjects who declined to participate in the study. We also excluded 43 patients who were lost in the follow-up period. A total of 114 patients were used for the final analysis.

been achieved by placing a 6 Fr JJ stent (Marflow, Switzerland) 7–14 days prior to surgery. For patients without prior stenting, intraoperative ureteral dilation was performed with a semi-rigid ureteroscope, after which a JJ stent was introduced.

A cystoscope was utilized to expose and retrieve the distal portion of the JJ stent, and under fluoroscopic control, a guidewire was advanced into the renal pelvis. In cases involving stones within the ureter, renal pelvis, or upper calyx, a semi-rigid ureteroscope was first introduced along the guidewire to perform initial lithotripsy. The scope was then withdrawn while leaving the guidewire in situ. Subsequently, a 12–14 Fr ureteral access sheath was advanced over the guidewire into the renal pelvis under C-arm guidance, and once in position, the guidewire and obturator were removed.

Through the access sheath, a disposable flexible ureteroscope was introduced into the collecting system, navigated with both direct endoscopic vision and fluoroscopy. Irrigation with normal saline was maintained throughout the procedure. In situations where the ureter was sufficiently dilated, the flexible ureteroscope could be advanced directly over the guidewire without the need for prior sheath placement. Stones were identified, their dimensions measured, and if required, repositioned from the lower calyx into the upper calyx or renal pelvis to minimize deflection of the flexible scope.

Lithotripsy was performed using a 230-µm Holmium:YAG laser fiber, which was passed through the working channel of the ureteroscope with a protective sheath. Stone clearance was defined either by the visualization of fragments ≤4 mm (confirmed both endoscopically and fluoroscopically) or by the complete absence of residual calculi. At the conclusion of each procedure, a JJ stent was inserted to ensure adequate urinary drainage.

Outcome Assessments

Postoperative Assessment and Follow-up

The procedure was defined as successful if only small gravel or stone fragments ≤4 mm were left behind, or if no residual calculi were detected on intraoperative C-arm fluoroscopy.[13]

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Stone-free status was evaluated at 1 and 3 months after surgery using plain abdominal X-ray or renal ultrasound. Patients were classified as stone-free if no radiopaque focus was visible at the previous stone site (for radiopaque calculi) or if any remaining fragments measured ≤4 mm in maximum diameter.

Complication Assessment

Complications that occur during the patient's hospitalization include Clavien-Dindo or Traxer. Dindo and Clavien (2004) jointly proposed a modified Clavien classification (previously, in 1994, Clavien published a surgical complication classification), based on a study that followed the treatment results of 6336 patients undergoing general surgery. Studies on flexible endoscopic lithotripsy also applied this classification, which ranged from Grade 0 to Grade 3.[14] Besides, in the study evaluating and classifying urinary injuries caused by ureteral dilator placement in flexible endoscopic lithotripsy, Traxer and Thomas (2013) proposed the new classification, including 2 levels: mild (Grade 0 and Grade 1) and severe (Grade 2 to Grade 4).[15]

Quality of Life Assessment

The EQ-5D-5L was used to assess the quality of life at admission, immediately after surgery, and postoperatively (1-month and 3-month follow-up). The EQ-5D-5L instrument comprises a descriptive system and a visual analogue scale.[16] The descriptive system classifies health on five dimensions: mobility (MO), self-care (SC), usual activities (UA), pain/discomfort (PD), and anxiety/depression (AD). Within each dimension, respondents are asked to describe their current health using either five: 1) no problems, 2) slight problems, 3) moderate problems, 4) severe problems, and 5) unable to/extreme problems levels of severity. Disutility weights were used to calculate values for all health states in the Vietnamese EQ-5D-5L value set. For example, the value of the health state 12345 is calculated as 1 - (MO1) - (SC2) - (UA3) - (PD4) - (AD5) = 1– (0) - (0.0428) - (0.0587) - (0.2700) - (0.2388) = 0.3897.

Definition of Primary and Secondary Outcomes for Analysis

The primary outcomes assessed were surgery duration, lithotripsy duration, average hospital stay, change in the median size of the largest stone and stone-free rate at 1 and 3 months postoperative. The secondary outcomes included the QoL score and complications.

Statistical Analyses

Baseline characteristics of the study population were summarized by body mass index status. Continuous data were presented as mean ± standard deviation (SD) and compared using Student's *t*-test. Categorical variables were expressed as frequencies and percentages, with group differences analyzed using the chi-square test. For paired data, mean comparisons were conducted with the paired *t*-test, while the McNemar test was applied for categorical outcomes across two follow-up points. Repeated-measures ANOVA was used to analyze continuous variables assessed at three-time intervals. Statistical analyses were performed with SPSS version 29.0 for Mac (IBM Corp., USA). All tests were two-sided, and statistical significance was set at $p < 0.05$.

Results

Characteristics of the Participants

Table 1 performed the characteristics of 114 participants, categorized into normal-weight (n=73) and overweight/obese (n=41) groups. The table included age and sex, as well as clinical parameters such as body mass index (BMI), size and number of kidney stones, presence of hematuria, and history of hypertension and type 2 diabetes. The average age of the participants was approximately 50 years, with no significant difference between the normal-weight and overweight/obese groups. However, there was a statistically significant difference in sex distribution between the two groups (p=0.028). The overweight/obese group had a higher proportion of men (70.4%). The median size of the largest kidney stone was slightly larger in the overweight/obese group (13.9 mm) compared to the normal weight group (12.8 mm), but this difference was not statistically significant. Similarly, the distribution of the number of stones did not differ significantly between the two groups. The presence of hematuria and the severity of hydronephrosis also showed no significant

Table 1 Characteristic of Participants

	Total	Normal Weight	Overweight/Obesity Patients	*p*-value
	(n=114)	(n=73)	(n=41)	
Age (year) † ¶	49.9±13.2	51.36±14.3	47.41±10.8	0.184
Sex ‡ ‡‡				**0.028**
Men	65(57.0)	36(49.3)	29(70.7)	
Women	49(43.0)	37(50.7)	12(29.3)	
Mean BMI (kg/m2) † ¶	22.4±2.8	20.8±1.5	25.3±2.0	**<0.001**
Median size of largest stone (mm) † ¶	13.2±4.6	12.8±4.3	13.9±5.1	0.193
Number of stone ‡ ‡‡				0.082
1	71(62.3)	51(70.2)	20(48.7)	
2	39(34.2)	21(27.4)	18(43.9)	
3	4(3.5)	1(1.4)	3(7.4)	
Hematuria ‡ ‡‡				0.648
Yes	7(9.5)	5(10.6)	2(7.4)	
No	67(90.5)	42(89.4)	25(92.6)	
Disease history ‡ ‡‡				
Hypertension	10(13.5)	7(14.9)	3(11.1)	0.468
Type 2 diabetes	7(9.5)	5(10.6)	2(7.4)	0.495
Treatment history ‡ ‡‡	16(14.0)	6(8.2)	10(24.3)	**0.025**

Notes: † Mean ± Standard deviation ‡ Number (%). ¶ The Student's *t*-test was used to calculate the *p* value. ‡‡ The chi-square test was used to calculate the *p* value. Bold font indicates statistical significance.

differences between the normal-weight and overweight/obese groups. Regarding disease history, there were no significant differences in the prevalence of hypertension or type 2 diabetes between the two groups.

Primary and Secondary Outcomes

Table 2 presents the primary and secondary outcomes of our study comparing patients with normal weight and those with overweight/obesity who underwent flexible endoscopic lithotripsy. First, for the primary outcomes, the average surgery duration was slightly longer in the overweight/obesity group (70.5 minutes) compared to the normal weight group (60.5 minutes), but this difference was not statistically significant (p=0.292). Similarly, lithotripsy duration was also

Table 2 Primary Outcomes

	Total	Normal-Weight Patients	Overweight/Obese Patients	*p*-value
	(n=114)	(n=73)	(n=41)	
Surgery duration (min) † ¶	65.8±22.9	60.5±33.4	70.5±22.9	0.292
Lithotripsy duration (min) † ¶	50.9±21.7	50.9±32.3	52.3±25.7	0.108
Average hospital duration (day) † ¶	4.9±4.6	4.8±1.5	5.3±2.7	0.087
Median size of largest stone (mm) † ¶				
1 month	2.0±1.8	3.8±1.8	3.7±1.7	0.901
3 month	2.2±0.9	2.0±0.5	2.5±1.2	0.195
p-value $	**0.008**	**<0.001**	**0.028**	
Stone-free rate ‡ ‡‡				
Perioperative	84(73.6)	56(76.7)	28(68.3)	0.327
1 month	95(83.3)	65(87.8)	30(77.8)	0.336
3 month	92(80.7)	69(93.2)	33(70.4)	**0.035**
p-value ††	0.09	**0.004**	0.625	

Notes: † Mean ± Standard deviation ‡ Number (%). ¶ The Student's *t*-test was used to calculate the *p* value. ‡‡ The chi-square test was used to calculate the p value. $ The paired-*t* test was used to compared mean and calculated p value. †† The Mac-nemar test was used to compared proportions and calculated p value. Bold font indicates statistical significance.

slightly longer in the overweight/obesity group (52.3 minutes vs 50.9 minutes), but the difference was not statistically significant (p=0.108). The average hospital stay was slightly shorter in the overweight/obesity group (4.8 days vs 5.3 days), but this difference was also not statistically significant (p=0.087). Besides, the median size of the largest stone was assessed at 1 month and 3 months' post-surgery; the results showed no significant difference between the two groups (p=0.901 and p=0.195, respectively). However, when comparing 1 month and 3 months in the normal-weight group, the median stone size at 3 months (2.0 mm) was significantly smaller than at 1 month (3.8 mm) after surgery, with p < 0.001. Similarly, this significant difference also occurred for the overweight/obesity group (3.7 mm at 1 month vs 2.5 mm at 3 months) with a p-value of 0.028, suggesting a reduction in stone size post-surgery. The stone-free rate at 1 month was 87.7% in the normal weight group and 77.8% in the overweight/obesity group, but this difference was not statistically significant (p=0.336). At 3 months, the stone-free rate was 89.4% in the normal weight group and 70.4% in the overweight/obesity group, with a p-value of 0.035, indicating a significance, suggesting a potentially lower stone-free rate in the overweight/obesity group at 3 months.

Table 3 presents the secondary outcomes. The mean postoperative quality of life score increased significantly over the follow-up period (p < 0.001), with a similar trend in both groups. Similarly, mobility, self-care, and usual activity scores all

Table 3 Secondary Outcomes

	Total	Normal-Weight Patients	Overweight/Obese Patients	*p*-value
	(n=114)	**(n=73)**	**(n=41)**	
QoL score † ¶				
Total				
Addmision	0.620±0.032	0.560±0.042	0.752±0.040	
Perioperative	0.869±0.018	0.853±0.024	0.897±0.026	
1 month	0.981±0.006	0.974±0.008	0.992±0.006	
3 month	0.981±0.006	0.976±0.008	0.986±0.012	
p-value $$	**<0.001**	**<0.001**	**<0.001**	
Mobility score				
Addmision	0.062±0.009	0.077±0.012	0.037±0.017	
Perioperative	0.043±0.005	0.047±0.006	0.034±0.019	
1 month	0.000±0.000	0.000±0.000	0.000±0.000	
3 month	0.000±0.000	0.000±0.000	0.000±0.000	
p-value $$	N/A	N/A	N/A	
Self-care score				
Addmision	0.036±0.006	0.043±0.009	0.022±0.022	
Perioperative	0.010±0.003	0.010±0.004	0.010±0.010	
1 month	0.000±0.000	0.000±0.000	0.000±0.000	
3 month	0.000±0.000	0.000±0.000	0.000±0.000	
p-value $$	N/A	N/A	N/A	
Usual activity score				
Addmision	0.054±0.007	0.062±0.011	0.039±0.008	
Perioperative	0.016±0.004	0.015±0.006	0.016±0.007	
1 month	0.002±0.001	0.002±0.001	0.002±0.002	
3 month	0.002±0.001	0.002±0.001	0.002±0.002	
p-value $$	**<0.001**	**<0.001**	**<0.001**	
Pain/Discomfort score				
Addmision	0.138±0.009	0.158±0.011	0.104±0.015	
Perioperative	0.047±0.007	0.058±0.009	0.027±0.009	
1 month	0.014±0.004	0.018±0.005	0.006±0.005	
3 month	0.010±0.003	0.014±0.005	0.003±0.003	
p-value $$	**<0.001**	**<0.001**	**<0.001**	

(*Continued*)

Table 3 (Continued).

	Total	Normal-Weight Patients	Overweight/Obese Patients	*p*-value
	(n=114)	(n=73)	(n=41)	
Anxiety/depression score				
Addmision	0.090±0.005	0.099±0.006	0.073±0.008	
Perioperative	0.016±0.004	0.016±0.005	0.016±0.006	
1 month	0.004±0.002	0.006±0.003	0.000±0.000	
3 month	0.006±0.003	0.005±0.003	0.009±0.007	
p-value $$	<0.001	<0.001	<0.001	
Complications ‡ ‡‡				
Traxer 1	33(28.9)	16(22.0)	17(41.4)	0.076
Traxer 2	81(71.1)	57(78.0)	24(58.6)	

Notes: † Mean ± Standard deviation ‡ Number (%). ¶ The Student's *t*-test was used to calculate the *p* value. ‡‡ The chi-square test was used to calculate the *p* value. $ Repeated measurement was used to compared mean and calculated p value. Analysis was adjusted for gender (binary), comorbidities (categorical), age (continuous), stone size (continuous). Bold font indicates statistical significance.

improved dramatically after surgery for both groups, with scores approaching 0.000 by the 3-month postoperative. The analysis for these three metrics was adjusted for various factors like age, gender, and comorbidities. In terms of pain/discomfort and anxiety/depression, both groups experienced significant reductions in their scores over the study period, with a p-value of less than 0.001 for both outcomes. The pain/discomfort score dropped from 0.138 at admission to 0.010 at 3 months. The anxiety/depression score followed a similar pattern, decreasing from 0.090 at admission to 0.006 at 3 months.

Table 3 also provides data on postoperative complications using the Traxer classification. A total of 33 patients (28.9%) experienced Traxer 1 complications, with a notable difference between groups: 16 (26.2%) in the normal weight group versus 17 (41.5%) in the overweight/obese group. Similarly, 81 patients (71.1%) had Traxer 2 complications, with 57 (93.4%) in the normal weight group and 24 (58.6%) in the overweight/obese group. The p-value of 0.076 indicates that the difference in complication rates between the two groups was not statistically significant.

In summary, there were no significant differences in surgery duration, lithotripsy duration, hospital stay, size of the largest stone, stone-free rate at 1 month and 3 months postoperative, or complications between the two groups. Interestingly, while the normal weight group showed a significant decrease over time in all secondary outcomes, the overweight/obese group only showed a significant decrease in the largest stone size and increased quality of life scores during follow-up.

Discussion

This study aimed to investigate the impact of overweight/obesity on the outcomes of flexible ureteroscopy lithotripsy, comparing a group of normal-weight patients. Our findings revealed several key differences between these groups as well as the effectiveness of the surgical method through a number of outcomes monitored over time. According to the report of Pietro Manuel Ferraro et al, the risk of kidney stones was consistently higher across categories of age (40–75 years old) among men compared to women.[17] This is consistent with our study, where the number of men having kidney stones was greater than that of women at the age of 49.9 ± 13.2 years old. Our study also reported a significant difference in sex distribution, with a higher proportion of males in the overweight/obese group. However, the recruitment of subjects into our study was completely random, so we consider this difference to be bias. In a study by Onur Dede et al, a higher proportion of males was also reported in the group with a higher BMI than the normal BMI group at the age of 45 years old.[18] Our study's results suggested that the overweight/obese group did not experience significantly longer surgery, lithotripsy durations, and hospital stays than patients in the normal-weight group. Those results suggested that the surgical procedure itself may not be significantly more challenging in overweight/obese patients. Other studies also reported the same findings about the operation time as our study results.[18,19] Moreover, Erhan Sari et al demonstrated that there was no difference in the mean hospitalization time between normal-weight and overweight/obese patients.[20]

Our present study results suggested that there was no significant difference in the median size of the largest stone at 1 month and 3 months postoperative between normal-weight and overweight/obese populations. Interestingly, the difference in stone size reduction over time, as indicated by the significant p-values for within-group changes, warrants further investigation to understand the underlying mechanisms, such as differences in metabolic profiles or anatomical factors. In addition, the flexible ureteroscopy lithotripsy also showed effectiveness in reducing kidney stone size after surgery. Other surgery outcomes: the stone-free rate at 1 month postoperative in the overweight/obesity group was lower than in the normal weight group, but this difference was not significant. However, at 3 months postoperative, the stone-free rate of overweight/obesity group was significantly lower than normal group. This result consistent with research by Amy Kramback et al,[21] the authors also reported that higher BMI was associated with lower stone-free rates, and any deviation from normal weight was associated with higher retreatment rates. This may be explained by the obese patients have higher rates of kidney stone formation than non-obese patients.[18,22,23] Hypertension and hyperlipidemia, which are frequently associated with obesity, have been shown to contribute to a higher incidence of urinary stone formation.[24–26] The development of stones in obesity seems to result from a combination of insulin resistance, poor dietary habits, and metabolic abnormalities that collectively create a more lithogenic urinary environment. Indeed, Onur Dede et al[18] also reported significantly lower FSRs in obese than normal subjects treated with extracorporeal shockwave lithotripsy (ESWL). This suggests that the surgical procedure itself may not be significantly more challenging in overweight/obese patients. However, for obese patients, early postoperative consultation and monitoring are needed to have timely intervention and treatment strategies due to the suggestion of a higher recurrence rate than in people with normal weight.

Although the postoperative complications classified by the Traxer scale showed no significant difference between normal and overweight/obesity group, the QoL score after surgery was interesting. There is a relative paucity of research examining quality-of-life outcomes following laparoscopic lithotripsy. In one study, patients treated with digital flexible ureteroscopy achieved markedly higher quality-of-life scores than those who underwent minimally invasive percutaneous nephrolithotomy.[27] In the present study, we assessed the patient-reported quality of life four times: preoperatively, postoperatively, and at 1 and 3 months postoperative. Our results showed progressive improvement in QoL scores, and at 1 month, most patients experienced only slight disruption of daily routines. Notably, the domains of mobility, self-care, and usual activities improved markedly, reaching statistical significance ($p < 0.001$). By three months post-surgery, these scores had all converged toward optimal levels (approaching 1.0 for QoL and 0.0 for the others), suggesting that the surgical intervention was highly effective in restoring patients' functional well-being. This is a crucial finding, as these metrics go beyond surgical success and reflect the tangible benefits of the procedure on patients' daily lives. Similar to the functional outcomes, pain/discomfort and anxiety/depression scores also demonstrated a dramatic and statistically significant reduction for the entire cohort. This suggests that the surgery was not only physically effective but also contributed positively to the patients' psychological state by alleviating pain and its associated mental distress. These results supported the benefits of flexible ureteroscopic lithotripsy both in terms of treatment effectiveness and in promoting better quality of life and postoperative recuperation.

This study has certain limitations. Being conducted at a single center without randomization, the design does not allow for establishing causality and may be affected by uncontrolled confounders. To mitigate potential bias, we applied strict inclusion and exclusion criteria, and all patients were treated by an experienced surgical team using a consistent technique. Additionally, the small number of participants reduces the overall generalizability of the study outcomes. Evaluating residual stones using ultrasonography/plain abdominal radiology is less sensitive compared to CT because of the limited funding might lead to an underestimation of stones in high BMI group. Finally, the analysis did not fully address risk factors associated with postoperative complications, indicating the need for further investigation to improve clinical outcomes and guide patient selection. Future studies should consider employing randomized controlled trial designs and involving multiple centers to enhance the external validity and robustness of findings. Larger sample sizes, extended follow-up durations, and comparative analyzes across various patient subgroups will also be important in identifying predictors of complications and long-term quality of life outcomes.

Conclusion

In conclusion, while the surgical outcomes were largely similar between normal-weight and overweight/obese patients, the free-stone rate was significantly higher in normal-weight patients in the 3-month follow-up. Besides, flexible ureteroscopy lithotripsy has been shown to be effective over time in reducing kidney stone size as well as postoperative pain. Further prospective studies with larger sample sizes and detailed metabolic evaluations are needed to confirm these findings and elucidate the underlying mechanisms. Additionally, tailored postoperative management strategies may be necessary to optimize outcomes in overweight/obese patients with kidney stones.

Data Sharing Statement

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Ethical Approval

The study was approved by the Institutional Review Board of Hanoi Medical University (approval number 876/GCN-HĐĐĐNCYSH-ĐHYHN, July 13, 2023) and conducted according to the ethical standards of the Declaration of Helsinki. Participants were fully informed about the purpose of the study. The consent form was written by the patients. The participants could withdraw from the interview at any time. Patients who do not participate voluntarily are not discriminated against in treatment.

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