Original Article

ISSN 2465-8243(Print) / ISSN: 2465-8510(Online)
https://doi.org/10.14777/uti.2024.19.2.31
Urogenit Tract Infect 2024;19(2):31-39

Effect of Residual Stone Fragments on Patient-Reported Quality of Life after Endoscopic Kidney Stone Surgery

Sang Hee Lee[1], Jun-Koo Kang[2,3], Jae-Wook Chung[2,3], Yun-Sok Ha[1,2], Jun Nyung Lee[1,2], Seock Hwan Choi[2,3], Hyun Tae Kim[1,2], Tae-Hwan Kim[2,3], Eun Sang Yoo[1,2], Tae Gyun Kwon[2,3], Bum Soo Kim[1,2]

[1]Department of Urology, Kyungpook National University Hospital, Daegu, [2]Department of Urology, School of Medicine, Kyungpook National University, Daegu, [3]Department of Urology, Kyungpook National University Chilgok Hospital, Daegu, Korea

Purpose: This study examined the effects of residual fragments (RF) on the patient-reported quality of life (QOL) after kidney stone surgery, such as retrograde intrarenal surgery (RIRS) and percutaneous nephrolithotomy (PCNL), using the Korean version of the Wisconsin Stone Quality of Life Questionnaire (K-WISQOL).
Materials and Methods: The medical records of 156 patients who underwent RIRS or PCNL and completed the preoperative and postoperative K-WISQOL from January 2021 to September 2023 were analyzed retrospectively. The patients were divided into RIRS and PCNL groups by the surgical method. The participants completed the K-WISQOL within four weeks before and after treatment. The patients' baseline characteristics, surgical outcomes, and K-WISQOL scores were compared according to the presence of RF in each surgical group.
Results: Of the 156 patients, 95 underwent RIRS, and 61 underwent PCNL. In the RIRS group, the patients' baseline characteristics and surgical outcomes were similar in the stone-free (SF) and RF subgroups. The changes in all K-WISQOL domain scores and total scores were similar in the two subgroups. In the PCNL group, the RF subgroup had a significantly higher proportion of staghorn stones, a significantly larger mean stone diameter and significantly longer operation time than those of the SF subgroup. But, the changes in all K-WISQOL domain scores and total scores were not significantly different between the two subgroups, as observed in the RIRS group.
Conclusions: This study showed that the presence of RFs after endoscopic kidney surgery did not affect the short-term patient-reported QOL regardless of the surgical methods.

Keywords: Kidney calculi; Nephrolithotomy, percutaneous; Ureteroscopy; Quality of life

Received: 17 June, 2024
Revised: 15 July, 2024
Accepted: 18 July, 2024

Correspondence to: Bum Soo Kim
https://orcid.org/0000-0002-4873-3049
Department of Urology, Kyungpook National University Hospital, School of Medicine, Kyungpook National University, 130 Dongdeok-ro, Jung-gu, Daegu 41944, Korea
Tel: +82-53-200-5855, Fax: +82-53-421-9618
E-mail: urokbs@knu.ac.kr

INTRODUCTION

Globally, the prevalence, incidence, and recurrence of kidney stones are increasing [1,2]. With the development of endoscopes and novel instruments, such as lasers, minimally invasive endoscopic surgery is performed to manage kidney stones [3,4]. Although the goal of these stone surgeries is complete stone removal, postoperative residual fragments (RFs) can sometimes be left. Thus, patients can have concerns regarding stone regrowth, stone-related

events, and the possible need for interventional procedures for RFs (even though those are asymptomatic and small). Hence, postoperative RFs can affect the health-related quality of life (HRQOL) of patients.

The concerns about the impact of kidney stones on patients' quality of life (QOL) have increased. Accordingly, questionnaires have been developed to assess a patient's QOL [5,6]. Penniston et al. [7] developed the Wisconsin Stone Quality of Life Questionnaire (WISQOL), which can evaluate the QOL of patients in whom kidney stones form and those who underwent stone surgery. The WISQOL is commonly used to assess the QOL of patients with kidney stones in North America.

An agreement on the definitions for several categories related to RFs is needed. Successful outcomes in kidney stone surgery emphasized the stone-free (SF) status. Nevertheless, no official consensus exists on defining the clinical SF status [8]. In addition, the choice of imaging modalities and the time of postoperative imaging are not standardized [9]. There is also no consensus regarding the schedule for a second-look intervention [10]. The RF size and location after the interventions can be the major predictors for clinically significant symptoms and stone events requiring intervention. Traditionally, inferring, a second-look intervention may be performed because of the possibility of a stone event based on RF location and size [11-13].

The impact of RFs on postoperative HRQOL can determine whether to perform the second-look intervention. Nevertheless, the influence of postoperative RFs on the patients' HRQOL is unclear. The HRQOL was assessed in some studies after extracorporeal shock wave lithotripsy (ESWL), but these studies used the general SF-36 questionnaire, which is not a stone-specific instrument [14,15]. Recent studies analyzed the patients' HRQOL after interventional treatment using WISQOL, a stone-specific instrument. On the other hand, a study performed in North America did not subdivide the group according to the surgical method [16]. According to a Japanese study, the patients' QOL can be affected by the treatment type, ureteral stent placement, and hospital stay [17]. Therefore, evaluating the patients' QOL after subdividing the group according to surgery type is necessary. Using the Korean version of the WISQOL (K-WISQOL) developed and validated in 2020 [18], this study evaluated the QOL of patients who underwent endoscopic kidney stone surgery at the authors' institution. In addition, the effects of RFs on patients' HRQOL were assessed using the K-WISQOL according to the surgical method.

MATERIALS AND METHODS

1. Research Ethics

The Ethics Committee of Kyungpook National University Hospital (approval number: KNUH 2023-04-042) approved this study. This study was performed according to the ethical standards in the 1964 Declaration of Helsinki and its later amendments. Data collection and analysis were performed after gaining approval from the institutional review board. The institutional review board of Kyungpook National University Hospital waived the need for informed consent because this study was performed retrospectively.

2. Patients and Methods

This study included patients with kidney stones who underwent retrograde intrarenal surgery (RIRS) or percutaneous nephrolithotomy (PCNL) from January 2021 to September 2023. Patients with simultaneous ureter stones, those who had other surgeries besides RIRS and PCNL at the same time, and those who did not complete the K-WISQOL were excluded. Finally, 156 patients were enrolled in this study. Of the 156 patients, 95 underwent RIRS, and 61 underwent PCNL for kidney stones. Each group was divided into RF and SF subgroups, depending on the presence of RFs. In the RIRS group, there were 73 patients with SF state and 22 with RFs. In the PCNL group, there were 31 patients with SF state and 30 with RFs. The participants completed the K-WISQOL within four weeks before and after treatment. Non-contrast computed tomography (NCCT) was performed within four weeks before and after the surgery in all patients to evaluate stones. The patient was included in the SF subgroup if the RFs were not identified on postoperative imaging because stone-free was defined as having no residual fragments at postoperative NCCT in this study. The patient was included in the RF subgroup if RFs were identified on postoperative imaging. One surgeon performed all surgeries and verbally explained the presence or absence of residual fragments based on the NCCT at the first outpatient visit after surgery. The laterality, multiplicity of stones, and location and diameter of the largest stone were checked before surgery. The surgeon chose the surgical procedure based on the size and location

of the kidney stones, as well as the patient's comorbidities. Post-surgery, the collected stone specimens were analyzed using a physical method. The characteristics of patients and stones, the hospital stay, operation time, postoperative complications, and K-WISQOL scores between SF and RF subgroups in the RIRS and PCNL groups, respectively, were analyzed retrospectively.

3. Korean Version of the Wisconsin Stone Quality of Life Questionnaire Characteristics

The questionnaire consisted of 28 questions with a score of 1-5 points for each item. The total score ranged from 28 to 140 points, with higher scores indicating a higher HRQOL. These 28 questions were grouped intuitively into the following seven domains: (D1) energy and fatigue, (D2) sleep, (D3) work and family, (D4) nutrition and pharmacological therapies, (D5) physical symptoms, (D6) concerns related to intimacy and travel, and (D7) general emotional well-being.

4. Statistical Analysis

A normality test was performed before comparing the continuous variables because the sample size was small, and normality was not found. Therefore, the continuous variables were recorded as median (interquartile range) and compared using a Mann-Whitney U-test. The categorical variables were recorded as numbers (percentage) and compared using a chi-square or Fisher's exact test. A Fisher's exact test was used to compare the categorical variables if the number in each cell was <5. All statistical analyses were performed using IBM SPSS Statistics 19.0 (IBM Co.). A p-value<0.05 indicated statistical significance.

RESULTS

The patients' baseline characteristics, such as age, gender, body mass index, stone episodes, stone laterality, stone multiplicity and largest stone location, largest stone diameter, and stone composition, were similar in the SF and RF subgroups in the RIRS group (Table 1). The surgical outcomes, such as hospital stay, operation time, duration between the first follow-up and surgery, and complication rates, were similar in the subgroups in the RIRS group. One patient in the SF subgroup underwent percutaneous nephrostomy (PCN). Migration of the ureteral stent occurred in this patient two days after surgery, which was removed earlier than intended. After ureteral stent removal, flank pain with hydronephrosis developed because of a ureteral obstruction with a blood clot; thus, a temporary PCN was placed to relieve the pain (Table 2). While the RF subgroup showed significantly higher scores in the preoperative D4 compared to the SF subgroup (14.0 vs. 12.0, p=0.049), the total scores and other domain scores were similar in the two subgroups (Table 2). On the other hand, the postoperative D2 (18.0 vs. 15.0, p=0.021), D3 (24.5 vs. 20.0, p=0.025), D4 (13.0 vs. 11.0, p=0.015), D7 (29.5 vs. 24.0, p=0.024), and total scores (123.0 vs. 108.0, p=0.036) were significantly higher in the RF subgroup (Table 2). On the other hand, the mean changes in the K-WISQOL scores, including the total and all domain scores, were similar in both subgroups (Table 2).

In the PCNL group, a higher proportion of renal pelvis stones (41.9%) was found in the SF subgroup, while more staghorn stones (46.7%) were identified in the RF subgroup (p=0.021). The mean stone size was significantly larger in the RF subgroup than in the SF subgroup (30.0 vs. 25.0, p=0.015) (Table 3). Consequently, the operation time in the RF subgroup was significantly longer than that in the SF subgroup (92.5 vs. 80.0, p=0.010). One patient in the SF subgroup underwent angioembolization because of postoperative persistent tract site bleeding, and one patient in the RF subgroup was admitted to an intensive care unit due to postoperative pulmonary embolism (Table 4). The pre- and postoperative K-WISQOL scores and mean changes in the K-WISQOL scores were similar in both subgroups (Table 4).

DISCUSSION

Kidney stone disease (KSD) can significantly affect patients. In addition to the classic symptoms of pain, nausea, and vomiting, KSD negatively impacts the HRQOL, even in the absence of stone-related events. Thus, it negatively affects physical well-being, daily life, work, relationships, and family life [19]. The outcome assessment in treating KSD is traditionally recorded using objective outcome measures, such as SF status and complication rate. On the other hand, patient-reported outcome measures have emerged as an improved tool to address HRQOL as a part of the evolution to shift healthcare to a more patient-orientated respect [6].

Table 1. Comparison of the patients' baseline characteristics between the stone-free and residual fragments subgroups in the retrograde intrarenal surgery group

Variable	SF (n=73)	RF (n=22)	p-value
Age (y)	60.0 [51.5-67.0]	58.0 [47.8-62.8]	0.363[a]
Gender			0.503[b]
Male	44 (60.3)	15 (68.2)	
Female	29 (39.7)	7 (31.8)	
BMI (kg/m^2)	24.0 [22.4-25.9]	24.0 [22.3-27.4]	0.761[a]
Stone episodes			0.315[b]
First	41 (56.2)	15 (68.2)	
Recurrent	32 (43.8)	7 (31.8)	
Ureteral stent			-
Absent	0 (0.0)	0 (0.0)	
Present	73 (100.0)	22 (100.0)	
Stone laterality			
Right	31 (42.5)	8 (36.4)	0.133[c]
Left	24 (32.8)	12 (54.5)	
Both	18 (24.7)	2 (9.1)	
Unilaterality			
Unilateral	55 (75.3)	20 (90.9)	0.145[c]
Bilateral	18 (24.7)	2 (9.1)	
Stone multiplicity			0.398[b]
Single	34 (46.6)	8 (36.4)	
Multiple	39 (53.4)	14 (63.6)	
Largest stone location			0.281[c]
Ureteropelvic junction	1 (1.3)	1 (4.5)	
Renal pelvis	17 (23.3)	4 (18.2)	
Upper calyx	14 (19.2)	2 (9.2)	
Mid calyx	3 (4.1)	3 (13.6)	
Lower calyx	38 (52.1)	12 (54.5)	
Staghorn	0 (0.0)	0 (0.0)	
Longest stone diameter (mm)	10.0 [8.0-14.0]	12.5 [10.0-15.0]	0.063[a]
Stone composition			0.851[c]
Calcium oxalate monohydrate	26 (35.6)	7 (31.8)	
Uric acid	6 (8.2)	1 (4.6)	
Struvite	1 (1.4)	0 (0.0)	
Mucin	1 (1.4)	0 (0.0)	
Mixed	39 (53.4)	14 (63.6)	

Values are presented as the median [interquartile range] or number (%).
In cases of multiple stones, the location and size of the stones were measured based on the largest stone.
Statistically significant at $p<0.05$.
BMI: body mass index, SF: stone-free, RF: residual fragments.
[a]Mann Whitney U-test.
[b]Chi-square test.
[c]Fisher's exact test.

In recent years, there has been a continuous rise in the use of patient-reported outcome measures in urology. The two most commonly used questionnaires are the 36-Item Short Form health survey (SF-36) and the Patient-Reported Outcomes Measurement Information System. Stone-disease-specific tools, such as the WISQOL, have been established and used to evaluate the QOL of patients with kidney stones [20].

Penniston and Nakada [21] conducted the first study on QOL in kidney stone formers in 2007. They analyzed 189 adults with a history of urolithiasis using a mail survey. The SF-36 was used to evaluate the patients' QOL, and the responding kidney stone formers had lower scores in the 'bodily pain' and 'general health' domains than those without kidney stones [21]. Bensalah et al. [5] also showed that patients with urolithiasis had lower scores in 5 out of 8 SF-36 domains. They compared these patients with the American general population in a physical composite summary and suggested that KSD negatively impacts the perception of physical and mental well-being [5]. The QOL of patients with kidney stones might be worse, even without kidney stone episodes, because kidney stones are a recurrent disease with serious related symptoms. Thus, the QOL of patients with kidney stones could be worse if RFs remain after interventional procedures.

Several studies have analyzed the effects of RF on the

Table 2. Comparison of the surgical outcomes and Korean version of the Wisconsin Stone Quality of Life Questionnaire scores between the stone-free and residual fragments subgroups in the retrograde intrarenal surgery group

Variable	SF (n=73)	RF (n=22)	p-value
Hospital stay (d)	3.0 [3.0-3.0]	3.0 [3.0-3.0]	0.525[a]
Operation time (min)	73.0 [60.0-85.0]	82.5 [60.0-105.0]	0.170[a]
Duration between the first follow-up and surgery (d)	19.0 [16.0-23.0]	23.0 [17.0-28.0]	0.058[a]
Complication			1.000[b]
No complication	67 (91.8)	21 (95.5)	
Postoperative febrile UTI	5 (6.8)	1 (4.5)	
Intervention	1 (1.4)	0 (0.0)	
ICU care	0 (0.0)	0 (0.0)	
Preoperative K-WISQOL scores			
Energy and fatigue (D1)	11.0 [9.0-14.0]	13.0 [10.3-15.0]	0.104[a]
Sleep (D2)	16.0 [13.0-18.0]	17.0 [15.0-18.0]	0.212[a]
Work and family (D3)	24.0 [20.0-25.0]	25.0 [20.8-25.0]	0.249[a]
Nutrition and pharmacological therapies (D4)	12.0 [10.0-14.0]	14.0 [11.5-15.0]	0.049[a]
Physical symptoms (D5)	16.0 [14.0-18.0]	17.0 [14.8-19.0]	0.340[a]
Concerns related to intimacy and travel (D6)	14.0 [11.0-15.0]	14.0 [12.8-15.0]	0.654[a]
General emotional well-being (D7)	26.0 [20.5-30.0]	29.0 [22.0-30.0]	0.158[a]
Total score	117.0 [98.0-130.0]	126.5 [112.0-132.3]	0.145[a]
Postoperative K-WISQOL scores			
Energy and fatigue (D1)	11.0 [9.0-13.0]	12.0 [7.8-15.0]	0.261[a]
Sleep (D2)	15.0 [11.0-18.0]	18.0 [14.0-20.0]	0.021[a]
Work and family (D3)	20.0 [17.0-24.5]	24.5 [20.0-25.0]	0.025[a]
Nutrition and pharmacological therapies (D4)	11.0 [9.0-13.0]	13.0 [11.8-14.0]	0.015[a]
Physical symptoms (D5)	15.0 [13.0-18.0]	17.0 [14.8-19.3]	0.107[a]
Concerns related to intimacy and travel (D6)	12.0 [9.0-15.0]	13.5 [8.8-15.0]	0.537[a]
General emotional well-being (D7)	24.0 [19.0-30.0]	29.5 [23.8-30.0]	0.024[a]
Total score	108.0 [91.0-124.5]	123.0 [105.0-132.8]	0.036[a]
Changes in the K-WISQOL scores			
Energy and fatigue (D1)	0.0 [-2.0-2.0]	0.0 [-2.8-1.0]	0.652[a]
Sleep (D2)	-1.0 [-3.5-1.0]	0.0 [-1.5-2.3]	0.085[a]
Work and family (D3)	-1.0 [-4.5-0.0]	0.0 [-2.5-0.3]	0.334[a]
Nutrition and pharmacological therapies (D4)	0.0 [-2.5-1.0]	-1.0 [-2.0-1.0]	0.989[a]
Physical symptoms (D5)	0.0 [-3.0-1.0]	0.0 [-2.0-1.0]	0.344[a]
Concerns related to intimacy and travel (D6)	0.0 [-3.0-0.0]	0.0 [-1.5-1.0]	0.617[a]
General emotional well-being (D7)	0.0 [-4.5-1.5]	0.0 [-1.0-1.3]	0.304[a]
Total score	-3.0 [-19.5-4.5]	-1.0 [-7.8-9.8]	0.349[a]

The values are presented as the median [interquartile range] or number (%).
The intervention was the percutaneous nephrostomy insertion.
Change in the K-WISQOL score=postoperative-preoperative K-WISQOL score.
Statistically significant at $p<0.05$.
UTI: urinary tract infection, ICU: Intensive care unit, K-WISQOL: Korean version of the Wisconsin Stone Quality of Life Questionnaire, SF: stone-free, RF: residual fragments.
[a]Mann Whitney U-test.
[b]Fisher's exact test.

patients' HRQOL. Sahin et al. [14,15] monitored patients who had undergone ESWL for kidney stones over one to three months post-treatment. They reported that the HRQOL can be affected by the size of the RF. Streeper et al. [16] examined patients who had undergone surgical treatments for renal stones, including Double J stent insertion, ureteroscopic lithotripsy, PCNL, shock wave lithotripsy, and nephrectomy, ranging from one to 24 months following their procedures. In this study, the HRQOL was similar in the RF and SF subgroups, and additional surgical treatment to reach the SF status worsened the HRQOL. Similarly, Okada et al. [17] examined patients who received ESWL, ureteroscopy lithotripsy, and endoscopic combined intrarenal surgery within one month after treatment. This study showed that improving patients' HRQOL after surgery was unrelated to the SF status, but the SF status was identified as a factor influencing emotional recovery.

The HRQOL can be influenced by RFs and interventional procedures. Atis et al. [22] reported that patients with renal stones managed by ESWL showed more favorable HRQOL scores than patients managed by RIRS in the short term. Di Mauro et al. [23] reported that patients who underwent RIRS reported higher anxiety and depression scores compared to patients who underwent PCNL. The social and

Table 3. Comparison of the patients' baseline characteristics between the stone-free and residual fragments subgroups in the percutaneous nephrolithotomy group

Variable	SF (n=31)	RF (n=30)	p-value
Age (y)	61.0 [50.0-64.0]	53.5 [48.3-63.3]	0.254[a]
Gender			0.488[b]
Male	18 (58.1)	20 (66.7)	
Female	13 (41.9)	10 (33.3)	
BMI (kg/m^2)	23.7 [22.6-26.8]	25.3 [22.0-27.5]	0.564[a]
Stone episodes			0.252[b]
First	19 (61.3)	14 (46.7)	
Recurrent	12 (38.7)	16 (53.3)	
Nephrostomy			0.785[b]
Absent	6 (19.4)	5 (16.7)	
Present	25 (80.6)	25 (83.3)	
Ureteral stent			0.182[c]
Absent	28 (90.3)	23 (76.7)	
Present	3 (9.7)	7 (23.3)	
Stone laterality			0.132[b]
Right	6 (19.4)	11 (36.7)	
Left	25 (80.6)	19 (63.3)	
Unilaterality			
Unilateral	31 (100.0)	30 (100.0)	
Bilateral	0 (0.0)	0 (0.0)	
Stone multiplicity			0.373[b]
Single	18 (58.1)	14 (46.7)	
Multiple	13 (41.9)	16 (53.3)	
Largest stone location			0.021[c]
Ureteropelvic junction	1 (3.2)	3 (10.0)	
Renal pelvis	13 (41.9)	3 (10.0)	
Upper calyx	1 (3.2)	3 (10.0)	
Mid calyx	9 (29.1)	7 (23.3)	
Lower calyx	0 (0.0)	0 (0.0)	
Staghorn	7 (22.6)	14 (46.7)	
Longest stone diameter (mm)	25.0 [20.0-27.0]	30.0 [20.0-46.3]	0.015[a]
Stone composition			0.488[c]
Calcium oxalate monohydrate	6 (19.4)	5 (16.7)	
Uric acid	6 (19.4)	3 (10.0)	
Struvite	3 (9.6)	1 (3.3)	
Brushite	0 (0.0)	1 (3.3)	
Mixed	16 (51.6)	20 (66.7)	
Tract size			0.344[c]
18 Fr	9 (29.0)	5 (16.7)	
24 Fr	6 (19.4)	4 (13.3)	
30 Fr	16 (51.6)	21 (70.0)	

The values are presented as median [interquartile range] or number (%).
In cases of multiple stones, the location and size of the stones were measured based on the largest stone.
Statistically significant at $p<0.05$.
BMI: body mass index, SF: stone-free, RF: residual fragments.
[a]Mann Whitney U test.
[b]Chi-square test.
[c]Fisher's exact test.

vitality scores differed significantly in the two groups. Therefore, the enrolled patients were divided into two groups depending on the surgical method, RIRS or PCNL, to minimize the effect of the operation type on the patients' HRQOL. Furthermore, the impact of RFs on HRQOL was analyzed in the same surgery group.

Interestingly, the postoperative D2, D3, D4, and D7 domain scores and total WISQOL scores were significantly better in the RF subgroup after RIRS than the SF subgroup, while the preoperative scores were not statistically different, except for the D4 domain scores, between the two groups. Although the reason why the postoperative WISQOL scores were higher in the RF subgroup is unclear, it might be due to several unmeasured factors, such as more exquisite patients and more basketing, which can induce post-operative pain or irritating symptoms because of the higher chance of urothelial mucosal abrasion, as well as more cases of improper ureteral stent position in the SF subgroup.

Table 4. Comparison of the surgical outcomes and the Korean version of the Wisconsin Stone Quality of Life Questionnaire scores between the stone-free and residual fragments subgroups in the percutaneous nephrolithotomy group

Variable	SF (n=31)	RF (n=30)	p-value
Hospital stay (d)	7.0 [7.0-8.0]	7.0 [6.0-8.0]	0.976[a]
Operation time (min)	80.0 [75.0-95.0]	92.5 [80.0-110.0]	0.010[a]
Duration between the first follow-up and surgery (d)	19.0 [15.0-26.0]	21.0 [15.0-28.0]	0.816[a]
Complication			0.492[b]
No complication	28 (90.3)	29 (96.7)	
Postoperative febrile UTI	2 (6.5)	0 (0.0)	
Intervention	1 (3.2)	0 (0.0)	
ICU care	0 (0.0)	1 (3.3)	
Preoperative K-WISQOL scores			
Energy and fatigue (D1)	12.0 [9.0-14.0]	12.0 [10.0-15.0]	0.488[a]
Sleep (D2)	16.0 [13.0-18.0]	17.0 [15.0-19.0]	0.159[a]
Work and family (D3)	23.0 [18.0-25.0]	24.0 [20.0-25.0]	0.393[a]
Nutrition and pharmacological therapies (D4)	12.0 [11.0-14.0]	13.0 [11.0-15.0]	0.597[a]
Physical symptoms (D5)	16.0 [13.0-18.0]	16.0 [14.0-18.0]	0.766[a]
Concerns related to intimacy and travel (D6)	13.0 [11.0-15.0]	14.0 [11.0-15.0]	0.520[a]
General emotional well-being (D7)	27.0 [22.0-30.0]	26.5 [22.0-30.0]	0.872[a]
Total score	119.0 [94.0-130.0]	119.5 [109.5-133.3]	0.507[a]
Postoperative K-WISQOL scores			
Energy and fatigue (D1)	12.0 [9.0-15.0]	13.0 [11.8-15.0]	0.210[a]
Sleep (D2)	18.0 [12.0-19.0]	18.0 [16.0-19.0]	0.228[a]
Work and family (D3)	22.0 [20.0-25.0]	24.5 [21.0-25.0]	0.083[a]
Nutrition and pharmacological therapies (D4)	13.0 [11.0-15.0]	13.0 [11.8-15.0]	0.537[a]
Physical symptoms (D5)	16.0 [14.0-20.0]	17.0 [15.8-20.0]	0.457[a]
Concerns related to intimacy and travel (D6)	14.0 [11.0-15.0]	14.0 [12.0-15.0]	0.905[a]
General emotional well-being (D7)	29.0 [23.0-30.0]	29.00 [25.5-30.0]	0.796[a]
Total score	124.0 [99.0-133.0]	128.5 [114.0-133.0]	0.367[a]
Changes in the K-WISQOL scores			
Energy and fatigue (D1)	0.0 [-2.0-2.0]	0.0 [-1.0-2.0]	0.457[a]
Sleep (D2)	0.0 [-2.0-1.0]	0.0 [-1.0-2.0]	0.474[a]
Work and family (D3)	0.0 [-4.0-3.0]	0.0 [-1.0-1.3]	0.724[a]
Nutrition and pharmacological therapies (D4)	0.0 [-1.0-2.0]	0.0 [-1.0-2.0]	0.866[a]
Physical symptoms (D5)	1.0 [-1.0-3.0]	1.5 [0.0-3.0]	0.636[a]
Concerns related to intimacy and travel (D6)	0.0 [-1.0-2.0]	0.0 [-1.0-1.0]	0.607[a]
General emotional well-being (D7)	0.0 [-1.0-5.0]	0.5 [0.0-4.0]	0.855[a]
Total score	3.0 [-3.0-11.0]	3.0 [-2.5-15.3]	0.885[a]

Values are presented as median [interquartile range] or number (%).
The intervention was angioembolization.
Intensive care unit care was due to postoperative pulmonary embolism.
Change in the K-WISQOL score=postoperative-preoperative K-WISQOL score.
Statistically significant at $p<0.05$.
UTI: urinary tract infection, ICU: Intensive care unit, K-WISQOL: Korean version of the Wisconsin Stone Quality of Life Questionnaire, SF: stone-free, RF: residual fragments.
[a]Mann Whitney U-test.
[b]Fisher's exact test.

Nevertheless, the overall QOL was similar in the two groups after RIRS because the mean changes in scores were similar.

According to the assumption, patients with RFs after PCNL might have lower HRQOL scores than the SF subgroup. On the other hand, the mean changes in the total WISQOL scores and all subdomain scores after PCNL were similar in the SF and RF subgroups. This study assumed that patients who underwent PCNL usually have relatively large-sized stones and a higher risk of experiencing stone-related symptoms. After surgery, the patients could visually confirm that many stone fragments had been removed. Even if some RFs remained, a considerable portion of the large calculus had been removed, and the stone-related symptoms relatively decreased, which became a factor in improving the QOL for patients with RFs.

This study assessed the patients' QOL after kidney stone surgery using the K-WISQOL. By incorporating patient-reported outcomes, physicians can gain valuable insights into the real-life impact of the surgical procedures on the individuals' daily lives beyond merely evaluating the surgical success rates. Although this study found that postoperative RFs did not impair the patients' QOL, RFs can cause damage in some patients. Proper follow-up and additional treatment strategies must be planned and discussed with patients

because asymptomatic RFs can regrow and progress to symptomatic RFs over time [12,24-26]. Repeat interventional therapy may be beneficial if RFs have a risk of becoming symptomatic or causing obstruction, which can cause renal function deterioration over time.

Achieving the SF status in a single procedure is important, but attempting excessive surgery to remove kidney stones can lead to serious complications, such as sepsis or renal damage. This study showed that the factor affecting the patients' QOL in the short term after stone surgery is not the presence of RFs. Therefore, if the complete removal of kidney stones is challenging in a single procedure and clinically insignificant residual fragments are expected, planning a proper surgical strategy and discontinuing surgery at an appropriate point might be a better choice, considering the patient's QOL.

Further research is needed to confirm the long-term effects of RFs on the patients' QOL. Although the short-term follow-up provided valuable initial insights, monitoring patients over an extended period is essential for understanding how RFs might influence patients' well-being over the long term. Long-term follow-up data will enable researchers to identify any delayed effects of RFs and determine if the initial negative impact persists or changes over time.

The retrospective nature and relatively short follow-up are notable limitations. Future studies will be enhanced by prospective data collection and extended follow-ups to understand the relationship between RFs and the patients' QOL. In addition, exploring other patient-related factors, such as pain, complications, and psychological well-being, could provide a more comprehensive assessment of the QOL.

CONCLUSIONS

This study highlights the importance of considering the patients' QOL in the context of kidney stone surgery. RFs might not influence the patients' short-term QOL outcomes after RIRS and PCNL. Thus, healthcare providers can make more informed decisions in tailoring treatment approaches that optimize surgical success and patients' well-being. Nevertheless, further research with an extended follow-up is warranted to understand the long-term effects of RFs.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

FUNDING

No funding to declare.

ACKNOWLEDGMENTS

This study was supported by the National Research Foundation of Korea (NRF) grant funded by the Korean government (MSIT) (2022R1I1A3069482) (2023R1A2C3003807), by the Korean Fund for Regenerative Medicine (KFRM) grant funded by the Korea government (the Ministry of Science and ICT, the Ministry of Health & Welfare) (23A0206L1), and by a grant of the Korea Health Technology R&D Project through the Korea Health Industry Development Institute (KHIDI), funded by the Ministry of Health & Welfare, Republic of Korea (HR22C1832).

AUTHOR CONTRIBUTIONS

S.H.L.: conceptualisation and manuscript writing, J.K.K.: data collection, J.W.C.: data collection, Y.S.H.: statistical analysis, J.N.L.: study design and coordination, S.H.C.: investigation, H.T.K.: investigation, T.H.K.: study design and coordination, E.S.Y.: data curation, T.G.K.: funding acquisition and critical revision, B.S.K.: conceptualisation and critical revision. All authors read and approved the final manuscript.

ORCID

Sang Hee Lee, https://orcid.org/0000-0002-2217-8593
Jun-Koo Kang, https://orcid.org/0000-0002-8857-3406
Jae-Wook Chung, https://orcid.org/0000-0002-1055-2357
Yun-Sok Ha, https://orcid.org/0000-0003-3732-9814
Jun Nyung Lee, https://orcid.org/0000-0002-6342-9846
Seock Hwan Choi, https://orcid.org/0000-0003-3796-2601
Hyun Tae Kim, https://orcid.org/0000-0002-4730-3776
Tae-Hwan Kim, https://orcid.org/0000-0003-4924-4826
Eun Sang Yoo, https://orcid.org/0000-0002-7442-6886
Tae Gyun Kwon, https://orcid.org/0000-0002-4390-0952

Bum Soo Kim, https://orcid.org/0000-0002-4873-3049

REFERENCES

1. Romero V, Akpinar H, Assimos DG. Kidney stones: a global picture of prevalence, incidence, and associated risk factors. Rev Urol 2010;12:e86-96.
2. Sorokin I, Mamoulakis C, Miyazawa K, Rodgers A, Talati J, Lotan Y. Epidemiology of stone disease across the world. World J Urol 2017;35:1301-20.
3. Lee SH, Jeon SH. Lasers for the treatment of urinary stone disease. Investig Clin Urol 2021;62:241-2.
4. Jung HD, Lee JY, Kang DH, Ko K, Koh DH, Kwon O, et al; Korean Society of Endourology and Robotics (KSER) Publication and Research Committees. Korean Society of Endourology and Robotics (KSER) recommendation on the diagnosis, treatment, and prevention of urolithiasis. Investig Clin Urol 2023;64: 325-37.
5. Bensalah K, Tuncel A, Gupta A, Raman JD, Pearle MS, Lotan Y. Determinants of quality of life for patients with kidney stones. J Urol 2008;179:2238-43; discussion 2243.
6. Mehmi A, Jones P, Somani BK. Current status and role of patient-reported outcome measures (PROMs) in endourology. Urology 2021;148:26-31.
7. Penniston KL, Antonelli JA, Viprakasit DP, Averch TD, Sivalingam S, Sur RL, et al. Validation and reliability of the Wisconsin Stone Quality of Life questionnaire. J Urol 2017;197:1280-88.
8. Danilovic A, Cavalanti A, Rocha BA, Traxer O, Torricelli FCM, Marchini GS, et al. Assessment of residual stone fragments after retrograde intrarenal surgery. J Endourol 2018;32: 1108-13.
9. York NE, Zheng M, Elmansy HM, Rivera ME, Krambeck AE, Lingeman JE. Stone-free outcomes of flexible ureteroscopy for renal calculi utilizing computed tomography imaging. Urology 2019;124:52-6.
10. Ozdedeli K, Cek M. Residual fragments after percutaneous nephrolithotomy. Balkan Med J 2012;29:230-5.
11. Kang HW, Lee SK, Kim WT, Kim YJ, Yun SJ, Lee SC, et al. Natural history of asymptomatic renal stones and prediction of stone related events. J Urol 2013;189:1740-6.
12. Dropkin BM, Moses RA, Sharma D, Pais VM Jr. The natural history of nonobstructing asymptomatic renal stones managed with active surveillance. J Urol 2015;193:1265-9.
13. Streeper NM. Asymptomatic renal stones-to treat or not to treat. Curr Urol Rep 2018;19:29.
14. Sahin C, Kafkasli A, Cetinel CA, Narter F, Saglam E, Sarica K. How do the residual fragments after SWL affect the health-related quality of life? A critical analysis in a size-based manner. Urolithiasis 2015;43:163-70.
15. Sahin C, Tuncer M, Yazıcı O, Horuz R, Çetinel AC, Eryıldırım B, et al. Do the residual fragments after shock wave lithotripsy affect the quality of life? Urology 2014;84:549-54.
16. Streeper NM, Galida M, Boltz S, Li S, Nakada SY, Raffin EP, et al. Is stone-free status after surgical intervention for kidney stones associated with better health-related quality of life? - a multicenter study from the North American Stone Quality of Life Consortium. Urology 2021;148:77-82.
17. Okada T, Hamamoto S, Taguchi K, Okada S, Inoue T, Ando R, et al.; SMART study group. Quality of life after urinary stone surgery based on Japanese Wisconsin Stone Quality of Life questionnaire: multicenter analysis from SMART study group. Urolithiasis 2023;51:113.
18. Yoon YE, Cho SY. Translation and linguistic validation of the Korean version of the Wisconsin Stone Quality of Life Questionnaire. Int Neurourol J 202;24:77-83.
19. New F, Somani BK. A complete world literature review of quality of life (QOL) in patients with kidney stone disease (KSD). Curr Urol Rep 2016;17:88.
20. Lundeen C, Lim JRZ, Scotland KB, Ardekani RS, Penniston KL, Streeper NM, et al. What is the relationship of stress to patients' kidney stone-related quality of life? Can Urol Assoc J 2021;15:E256-60.
21. Penniston KL, Nakada SY. Health related quality of life differs between male and female stone formers. J Urol 2007;178: 2435-40; discussion 2440.
22. Atis G, Culpan M, Ucar T, Sendogan F, Kazan HO, Yildirim A. The effect of shock wave lithotripsy and retrograde intrarenal surgery on health-related quality of life in 10-20 mm renal stones: a prospective randomized pilot study. Urolithiasis 2021;49:247-53.
23. Di Mauro D, La Rosa VL, Cimino S, Di Grazia E. Clinical and psychological outcomes of patients undergoing retrograde intrarenal surgery and miniaturised percutaneous nephrolithotomy for kidney stones. A preliminary study. Arch Ital Urol Androl 2020;91:256-60.
24. Goyal NK, Goel A, Sankhwar S. Outcomes of long-term follow-up of patients with conservative management of asymptomatic renal calculi. BJU Int 2012;110:E5-6.
25. Rebuck DA, Macejko A, Bhalani V, Ramos P, Nadler RB. The natural history of renal stone fragments following ureteroscopy. Urology 2011;77:564-8.
26. Choi T, Yoo KH, Choi SK, Kim DS, Lee DG, Min GE, et al. Analysis of factors affecting spontaneous expulsion of ureteral stones that may predict unfavorable outcomes during watchful waiting periods: what is the influence of diabetes mellitus on the ureter? Korean J Urol 2015;56:455-60.