

Risk factors of febrile urinary tract infections following retrograde intrarenal surgery for renal stones

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Abstract

We aimed to evaluate the risk factors of febrile urinary tract infection (UTI) following retrograde intrarenal surgery (RIRS) for treating renal stones.

We retrospectively reviewed the data of patients with 10 – 30 mm kidney stones who underwent RIRS from January 2014 to July 2017. Evaluation included age, gender, body mass index, stone size, stone location, and operative time. All surgeries were performed by a single surgeon and ureteral stenting was not done prior surgery. The risk factors of febrile UTI after RIRS were assessed by univariate and multivariate logistic regression analysis.

A total of 150 patients were included in the present study, and 17 patients (11.3%) had febrile UTI after RIRS. Mean patient age was 56.64 ± 13.91 years, and both genders were evenly distributed. Mean stone size was 14.16 ± 5.89 mm, and mean operation time was 74.50 ± 42.56 minutes. According to univariate analysis, preoperative pyuria was associated with postoperative febrile UTI. Multivariate logistic regression analysis showed that preoperative pyuria was the only independent risk factor of infectious complications after RIRS (odds ratios 8.311, 95% confidence intervals 1.759 – 39.275, $P = .008$). Age, gender, body mass index, comorbidity, preoperative bacteriuria, presence of hydronephrosis, renal stone characteristics, and operative time were not associated with febrile UTI after RIRS.

Preoperative pyuria was the only risk factor of infectious complications following RIRS. Therefore, careful management after RIRS is necessary especially when preoperative urinalysis shows pyuria.

Abbreviations: BMI = body mass index, OR = odds ratios, RIRS = retrograde intrarenal surgery, UTI = urinary tract infection.

Keywords: endoscopy, renal calculi, urinary tract infections

1. Introduction

Retrograde intrarenal surgery (RIRS) using a flexible ureteroscope with holmium laser is one of the main methods used

for renal stone removal.^[1] It allows minimally invasive access to renal stones without renal parenchymal injury and decreased risk of bleeding while achieving a success not inferior to that of percutaneous approaches.^[2] With increased experience, the removal of larger stones initially designated to be inappropriate for RIRS is now considered feasible,^[2] and it can be incorporated with percutaneous nephrolithotomy to perform endoscopic combined intrarenal surgery.^[3] Currently, RIRS is an indispensable tool in modern renal stone surgery and its efficacy and safety has also been proven in other endoscopic procedures^[4]

RIRS is not without its weaknesses. Limited visual field, expensive flexible scopes and lithotripters that have a high maintenance cost,^[5] and a steep learning curve^[6] are some of the reasons that hinder RIRS from becoming a more widely used procedure. Despite these disadvantages, it is commonly considered a safe procedure with little complications.^[5] Common complications are fever, hematuria, and infection, and most are low modified Clavien system grade.^[7] More severe complications are uncommon and include obstruction due to steinstrasse and urosepsis.

Various efforts have been made to decrease perioperative complications in RIRS. However only a few studies have dealt with postoperative febrile urinary tract infection (UTI).^[8–14] Although rare, UTI aggravation may lead to more life-threatening conditions such as sepsis,^[15] and a more thorough in-depth study on the risk factors of postoperative UTI should be conducted to prevent such serious complications.

In this study, we evaluated different risk factors associated with febrile UTI following RIRS to treat renal stones.

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This study was reviewed by our institutional review board and approved for its retrospective aspect and its application of standard practice.

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

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2. Methods

From January 2014 to July 2017, the medical records of 289 patients who underwent RIRS for renal stones at Kyung Hee University Medical Center were evaluated. RIRS cases involving renal stones with a maximal diameter between 10 and 30 mm were included. Patients who were lost during follow-up and patients with insufficient data or medical records were excluded. The first 50 cases were also excluded from the study to account for the number of cases needed to overcome the learning curve for RIRS. A total of 150 patients were included in the final analysis.

Patients with a fever of over 38°C persisting for 48 h and positive blood or urine culture after RIRS were considered to have postoperative febrile UTI. The relevant clinical parameters such as sex, age, body mass index (BMI), history of diabetes mellitus, preoperative pyuria, bacteriuria, and antibiotic use were analyzed. Pyuria was defined as ≥ 5 WBCs per high-power field (HPF) on urinalysis.^[16] No ureter stents were inserted prior to surgery. The location (upper/mid/lower pole/pelvis), size, and multiplicity of the stones, operation duration, and the method of stone removal (dusting vs. basketing)^[17] were evaluated.

RIRS was performed by a single surgeon using a flexible dual-channel ureteroscope with fluoroscopic guidance if needed. Fluid irrigation was accomplished with gravity at a level of 1 m above the patient. Factors associated with surgical procedures and equipment were the same for every surgery and were kept consistent to exclude them as variable factors during analysis.

For statistical analysis, SPSS v. 20 (IBM, Armonk, NY) was used. Student *t*-test and Chi-square test were used to compare parametric and non-parametric data. Univariate and multivariate logistic regression analysis was performed to evaluate the predictors of febrile UTI after RIRS. The level of significance was set at $P < .05$.

This study was approved by our Institutional Review Board (KHUH 2020-10-030) due to its retrospective nature and adherence to scientifically proven medical guidelines and procedures.

3. Results

3.1. 1) Patient characteristics

The medical records of 150 patients were reviewed retrospectively. The specific characteristics of the patients are summarized in Table 1. The mean patient age was 56.64 ± 13.91 years, and both genders were evenly distributed (male 49.6% vs female 50.7%). The mean BMI was 25.04 ± 4.10 .

3.2. 2) Renal stone characteristics and perioperative findings

The mean stone diameter was 14.16 ± 5.89 mm. More than half (51.4%) of the renal stones were located at the lower pole. The mean operative time was 74.50 ± 42.56 min. Postoperative febrile UTI was observed in 17 patients (11.3%). The blood and urine culture of febrile UTI patients showed negative results for 8 patients. Patients with positive culture results included 2 patients with *Escherichia coli*, 3 patients with extended-spectrum beta-lactamase-producing *Escherichia coli*, 2 patients with *Pseudomonas aeruginosa*, and 2 patients with *Acinetobacter baumannii*. The renal stone characteristics and blood culture results are summarized in Table 1 and Table 2.

Table 1

Clinical characteristics of patients.

Characteristics	Mean or number of patients (n = 150)
Age (yr)	56.64 ± 13.91
Sex [n (%)]	
Male	74 (49.3%)
Female	76 (50.7%)
BMI (Kg/m ²)	25.04 ± 4.10
Stone size (cm)	14.16 ± 5.89
Stone location (main) [n (%)]	
Upper	32 (20.4%)
Mid	28 (17.6%)
Lower	76 (51.4%)
Pelvis	14 (10.6%)
Operation duration (min)	74.50 ± 42.56
Postoperative infection [n (%)]	
None	133 (88.7%)
Infection	17 (11.3%)

Values are presented as mean ± standard deviation or number (percentage).
BMI = body mass index.

3.3. 3) Logistic regression analysis and risk factors of postoperative febrile UTI

Variables associated with febrile UTI occurrence after RIRS were evaluated by logistic regression analysis. The results are summarized in Table 3. In univariate analysis, preoperative pyuria was the only statistically significant predictive factor for postoperative febrile UTI (odds ratios 2.988, 95% confidence intervals 1.110 – 8.039, $P = .017$). In multivariate analysis, preoperative pyuria was also the only significant predictor of infective complications following RIRS (odds ratios 8.311, 95% confidence intervals 1.759 – 39.275, $P = .008$). Gender, BMI, stone size, preoperative bacteriuria, operative time, and operative techniques were not risk factors of febrile UTI.

4. Discussions

RIRS along with percutaneous nephrolithotomy is a widely used method for the removal of renal stones.^[5] UTI is among the most common complications that can occur after endoscopic procedures of the urinary tract.^[18] Despite efforts to reduce post-procedure complications, infection may occur and may lead to life-threatening conditions.^[10] In this study, we retrospectively analyzed the data of patients who had undergone RIRS by a single surgeon to evaluate the risk factors of postoperative febrile UTI.

In our study, 17 patients (11.3%) had febrile UTI after RIRS. The proportion of febrile UTI patients was similar to that in previous studies, which showed a range of 7.6 – 13.4%.^[8,9] The

Table 2

Urine and blood culture results of febrile urinary tract infection patients.

Positive culture	Number of patients
<i>Pseudomonas aeruginosa</i>	2
<i>Acinetobacter baumannii</i>	2
Extended-spectrum beta-lactamase-producing <i>Escherichia coli</i>	3
<i>Escherichia coli</i>	2
None	8

Table 3
Risk factors of febrile urinary tract infection after retrograde intrarenal surgery.

Variables	Univariate analysis			Multivariate analysis		
	OR	95% CI	P value	OR	95% CI	P value
Sex (male vs female)	1.520	0.552–4.185	.146	-	-	-
BMI (< 25 vs ≥ 25)	1.500	0.572–3.931	.137	1.997	0.554–7.326	.297
Stone size (< 2 cm vs ≥ 2 cm)	2.020	0.696–5.867	.098	1.472	0.251–8.640	.668
Preoperative pyuria (negative vs positive)	2.988	1.110–8.039	.017	8.311	1.759–39.275	.008
Preoperative bacteriuria (negative vs positive)	1.772	0.576–5.455	.141	0.929	0.199–4.343	.926
Operative time (< 2 h vs ≥ 2 h)	1.147	0.302–4.361	.259	0.657	0.090–4.782	.678
Operative technique (dusting vs basketing)	0.708	0.272–1.841	.150	0.532	0.113–2.506	.425

95% CI = 95% confidence intervals, BMI = body mass index, OR = odds ratios.

mean operative time was 74.50 ± 42.56 min, which was also comparable to that in earlier studies (ranging from 40.0 ± 14.8 min to 99.42 ± 19.08 min).^[7,9] In terms of the patient pool and perioperative factors, the findings of our study were similar to those of other studies.

In this study, preoperative pyuria was the only statistically relevant risk factor of postoperative febrile UTI. Studies on postoperative UTI have reported various relevant risk factors. Berardinelli et al identified coronary heart disease, chronic kidney disease, alteration of lipid metabolism, anticoagulant therapy, past surgery for renal stone, and presence of residual fragments as predictors of infective complications in RIRS based on univariate analysis. However, in multivariate analysis, no predictors of infection were discovered.^[8] Fan et al found that pyuria, operative duration, and infectious stones were independently related to infectious complications.^[9] Zhong et al found that gender, stone size, irrigation flow rate, and irrigation volume were correlated with the systemic inflammatory response after flexible ureteroscopic lithotripsy in univariate analysis, and in multivariate logistic regression analysis, stone size, small-caliber ureteral access sheath, irrigation flow rate, and struvite calculi were identified as independent risk factors.^[10] The wide spectrum of risk factors suggests that infection risks after endoscopic surgery may be associated with various preoperative and postoperative factors. However, in our study, only preoperative pyuria was observed as a risk factor. Pyuria itself is not an indicator of underlying urinary tract infection. However, it has been shown to be a predisposing risk factor for post-ureteroscopic infection^[9,19] and may have contributed to developing an infection susceptible environment inside the urinary tract during ureteroscopic manipulation.

A single surgeon was involved in the RIRS cases included in this study, and the same dual-channel flexible ureteroscope was used. Instead of using a mechanical or manual pump, the irrigation fluid used during surgery was administered continuously by gravity at a height of 1 m above the patient. The aim of such intra-operative practices along with ureteral access sheath use is to limit excessive irrigation pressure in the renal pelvis and parenchyma.^[20] Another source of infection is the ureteroscope itself, and the safe decontamination or use of disposable ureteroscopes has been considered as important safety measures.^[21] However, due to the lack of supporting systematic reviews and evidence, only a consensus on good clinical practices such as limiting the operative time, maintaining a low irrigation pressure, and consistent decompression of the upper urinary tract is available.^[22] The factors related to surgical procedures were constant among the subjects in our study; this allowed us to rule out intra-operative

components as risk factors of postoperative UTI, and we were able to focus more on patient-related and renal stone-related factors in this study.

The European Association of Urology guidelines for urologic infections^[23] recommend antibiotic prophylaxis to reduce the rate of symptomatic urinary infection after ureteroscopy. In our study, patients with preoperative bacteriuria were treated with antibiotics before surgery, and patients with only preoperative pyuria were given prophylactic antibiotics on the day of surgery. Preoperative pyuria was found to be a predictor of postoperative febrile UTI in this study, suggesting the need for a wider range of criteria when deciding to use preoperative antibiotics. However, one must always be wary of the consequences of aggressive antibiotic use and follow antimicrobial stewardship practices.^[24] Cai et al reported increased post-RIRS infective complications among patients with fluoroquinolone use.^[13] A comprehensive approach should be considered during preoperative evaluation to ensure appropriate antibiotic use.

Though it was not included in our main analysis, an additional 142 patients received RIRS at our clinic from July 2017 to December 2020. Pre-operatively analysis of these patients showed 21 had pyuria without bacteriuria. As with patients with bacteriuria, they received empirical anti-biotics for 1-week prior surgery. No infectious complications were seen in all cases. In light of these findings, a wider indication including the presence of pyuria, can be considered for the use empirical antibiotics, especially if prevention of infection is essential. Our study's strong point is that we were able to control intra-operative factors and thus concentrate on patient-related and renal stone-related factors to predict post-RIRS infective complications. However due to its retrospective design and relatively small patient pool from a single institute, the results of this study will need to be confirmed in a larger prospective study.

5. Conclusions

Preoperative pyuria was the only risk factor associated with an increased risk of febrile UTI in patients undergoing RIRS for renal stones. Careful preoperative evaluation and prophylactic measures are important to prevent unnecessary postoperative UTI.

Author contributions

Conceptualization: Sang Hyub Lee.

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