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ORIGINAL ARTICLE

Which factors affect the hospital re-admission and re-hospitalization after flexible ureterorenoscopy for kidney stone?

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Abstract
Purpose To investigate patient- and procedure-related factors associated with hospital re-admission (HR) and re-hospitalization following flexible ureteroscopy (f-URS). Patients and methods: The records of patients who underwent f-URS for renal stones in two reference centers between 2011 and 2015 were examined retrospectively. Patients who were re-admitted to the hospital or re-hospitalized for any reason within 30 days after hospital discharge related to the f-URS procedure were evaluated. The patient- and procedure-related factors affecting the re-admission and re-hospitalization rates were revealed using backward stepwise multiple binary logistic regression analysis.
Results The study included 647 patients with a mean age of 46.1 ± 13.7 years. The mean BMI was 27.3 ± 4.6 kg/m^2, and the median ASA score was 1.85. The mean stone diameter was 14.2 ± 5.3 mm. The mean operation and fluoroscopy times were 50.2 ± 16.9 min and 43.1 ± 37.6 s, respectively. The mean hospitalization time was 1.42 ± 0.84 days, and the complication rate was 12.8 % (83/647). Overall, 523 (80.3 %) patients became stone-free, while residual fragments <4 mm were detected in 73 (11.3 %) patients. The procedure failed in 7.9 % of the cases. While 82 (12.7 %) patients were re-admitted, 31 (4.8 %) patients were re-hospitalized for further treatment. Stone-free status was an independent predictor of HR, while the stone-free status, hospitalization time, and postoperative complications all predicted re-hospitalization.
Conclusions We found that inability to achieve stone-free status predicted HR and re-hospitalization, while postoperative complication and prolonged hospitalization also predicted re-hospitalization.

Keywords Kidney stone · Flexible ureteroscopy · Re-admission · Re-hospitalization · Risk factor

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Introduction

Hospital re-admission (HR) or re-hospitalization following urinary stone treatment is not a desired condition by either the patient or the urologist, as after other surgical procedures [1, 2]. Parallel to the increasing incidence of urolithiasis, HR is seen more frequently, leading to serious financial losses [3, 4]. HR rates range from 5 to 15 % after various endourological interventions used in the treatment of urolithiasis, such as shock-wave lithotripsy (SWL), ureteroscopy (URS), and percutaneous nephrolithotomy (PNL) [2].

With technological advances, many patients with renal stones are treated with flexible URS (f-URS), a safe, effective, minimally invasive method for managing renal stones, especially those smaller than 2 cm [5–8]. f-URS has higher stone-free rates than SWL and lower morbidity rates than PNL [8, 9]. Nevertheless, f-URS is associated with complications, including pain, urinary tract infection, sepsis, ureteral trauma, re-admissions, and prolonged hospital stays

[10]. However, the factors affecting the rates of HR and re-hospitalization after f-URS are not clear.

This study investigated patient- and procedure-related factors that increase the risk of HR and re-hospitalization following f-URS. To our knowledge, this is the first study to assess the factors affecting these rates.

Materials and methods

The medical records of patients who underwent f-URS for renal stones in two reference centers between 2011 and 2015 were examined retrospectively. Patients who were re-admitted to the hospital or re-hospitalized for any reason within 30 days after hospital discharge related to the f-URS procedure were evaluated. The study excluded patients requiring auxiliary procedure for stone removal such as SWL, f-URS, or PNL, those recalled for scheduled double-J stent removal, and pediatric patients (<18 years).

The study evaluated demographic data, including patient age, gender, body mass index (BMI), American Society of Anesthesiologists (ASA) score, stone size, stone complexity [simple (isolated pelvis or calyceal stone) or complex (partial or complete staghorn, multiple calyceal stone)], anatomic abnormalities, comorbidity, previous renal stone surgery, and procedural parameters, such as operating, fluoroscopy, and hospitalization time, preoperative and postoperative double-J stent placement, success and complication rates, and decrease in hematocrit level.

The serum creatinine, complete blood counts, and urine cultures were evaluated in all patients. Patients with positive urine culture were treated based on the culture antibiogram. Sterile urine cultures were required before the procedure. Stone size was calculated preoperatively and expressed as the sum of the largest diameter of each stone as estimated on ultrasound, plain radiograph of kidney–ureter–bladder (KUB), or computed tomography (CT). Complications were classified using the Clavien–Dindo classification. Stone-free status was evaluated with ultrasonography (US) and/or a kidney–ureter–bladder radiograph (KUB) performed 1 month postoperatively. CT was preferred in selected cases such as obese patients and those with radiolucent stones and suspected fragments on KUB or US.

Surgical technique

Under general anesthesia and antibiotic prophylaxis with second-generation cephalosporin, cystoscopy was done and a guidewire was advanced to the kidney through the ureter under fluoroscopic control with the patient in the lithotomy position. Then, ureteroscopy was performed to exclude any ureteral pathology. In all patients, the ureteral access sheath (9.5/11.5Fr) was engaged up to the level of the proximal ureter under fluoroscopic guidance. In patients in whom an access sheath could not be inserted because of ureteral stenosis, a ureteral double-J stent was placed, and the procedure was repeated 2 weeks later. In patients with an implanted ureteral access sheath, a flexible ureteroscope (Storz, Flex X2) was inserted into the collecting system. In some cases, stones are re-located to an easily accessible location (upper or medial calyx and renal pelvis) using baskets. For stone fragmentation, a 200- or 273-μm laser fiber and Ho:YAG laser (Stone Light, Mountain View, CA; Quanta System, Group, Italy) were used at low-energy high-frequency settings (0.8–1.5 J and 10–15 Hz). At the end of the procedure, the stone-free status of the collecting system was evaluated using endoscopic and fluoroscopic methods. Based on the surgeon's experience, a double-J stent (4.8Fr, Geotek, Ankara, Turkey) was implanted in the collecting system under fluoroscopic imaging and removed 2 weeks later. Patients with uneventful postoperative period were discharged at postoperative day 1 with antibiotics (for 5 days) and analgesics treatment.

Statistical analysis

Data were analyzed using SPSS 20. Numerical data are expressed as means and standard deviations, while categorical data are given as numbers and percentages. To compare patient groups, the *Chi*-square and Mann–Whitney *U* tests were used. The factors affecting the re-admission and re-hospitalization rates were revealed using backward stepwise multiple binary logistic regression analysis. The level of significance was $p < 0.05$.

Results

The study included 647 patients (369 [57 %] males and 278 [43 %] females) with a mean age of 46.1 ± 13.7 (range 19–86) years. The mean BMI was 27.3 ± 4.6 (range 17.9–47.8) kg/m^2, and the median ASA score was 1.85. Using the ASA physical status classification, the patients were categorized as ASA 1 ($n = 133$; 20.6 %), ASA 2 ($n = 478$; 73.9 %), or ASA 3 ($n = 36$; 5.6 %). The mean stone diameter was 14.2 ± 5.3 mm. Of the patients, 85.9 % had renal pelvic or single calyceal stones, 12.8 % had multiple calyceal stones, and 1.2 % had partial staghorn stones. More than half (50.7 %; $n = 328$) of the patients had previously undergone at least one treatment for ipsilateral kidney stones, including SWL, f-URS, PNL, or open surgery. In our series, 19.8 % (128/647) were prestented. Table 1 summarizes the patients' demographic parameters.

The mean operation and fluoroscopy times were 50.2 ± 16.9 (range 18–90) minutes and 43.1 ± 37.6 (range

Table 1 Demographics of the patients enrolled into the study

Parameter	Value
N	647
Mean age (years)	46.1 ± 13.7
Sex (male/female)	369/278
Mean BMI (kg/m^2)	27.3 ± 4.6
Mean ASA score	1.85 ± 0.5
ASA score (*n*)	
1	133 (20.6 %)
2	478 (73.9 %)
3	36 (5.6 %)
Mean stone size (mm)	14.2 ± 5.3 (6–50)
Stone configuration	
Simple	556 (85.9 %)
Partial staghorn	8 (1.2 %)
Complete staghorn	0
Multiple calyceal	83 (12.8 %)
Anatomic abnormality rate	77/647 (11.9 %)
Comorbidity rate	137/647 (21.2 %)
Stone location	
Lower calyx	165 (25.6 %)
Middle calyx	92 (14.2 %)
Upper calyx	97 (15.0 %)
Pelvis	217 (33.5 %)
Multiple calyx	76 (11.7 %)

Table 2 Peri-operative variables and outcomes

Mean operation time (minutes)	50.2 ± 16.9 (18–90)
Mean fluoroscopy time (seconds)	43.1 ± 37.6 (0–420)
Mean hospitalization time (days)	1.4 ± 0.8
Hematocrit drop (%)	0.6 ± 0.2
Outcome	
Stone-free	523/647 (80.8 %)
Fragments <4 mm	73/647 (11.3 %)
Rest	51/647 (7.9 %)
Complication rate (%)	83/647 (12.8 %)
Unplanned re-admission rate (%)	82/647 (12.7 %)
Re-hospitalization (%)	31/647 (4.8 %)

0–420) seconds, respectively. Ureteral double-J stent was placed in 79.9 % of the patients postoperatively. The mean hospitalization time was 1.42 ± 0.84 (range 1–12) days, and the complication rate was 12.8 % (83/647). Overall, 79 (12.3 %) patients had Clavien–Dindo scores of Grade 1 (renal colic, $n = 65$; hematuria, $n = 11$; fever, $n = 3$) or Grade 2 (urinary tract infection, $n = 4$). No major complication was observed in any patient. Overall, 523 (80.3 %) patients became stone-free, while residual fragments

Table 3 Univariate analysis of the factors affecting the ER visit and re-hospitalization rate

	p1	p2
Age	0.896	0.103
Sex	0.473	0.53
BMI	0.581	0.955
Comorbidity	0.364	0.189
ASA score (1, 2, 3)	0.000	0.307
Anatomic abnormality (yes/no)	0.476	0.516
Prestenting	0.102	0.035
Stone size (cm)	0.302	0.000
Mean operation time	0.468	0.019
Mean fluoroscopy time	0.206	0.87
Stone complexity	0.361	0.13
Hospitalization time	0.255	0.000
Success of Flex URS procedure	0.000	0.000
Presence of postoperative complication	0.146	0.000
DJ stent implanted	0.191	0.566

P1 p for unplanned re-admission, *P2* p for re-hospitalization

<4 mm were detected in 73 (11.3 %) patients. The procedure failed in 7.9 % of the cases. Table 2 summarizes the operative data.

After they had been discharged from the hospital, 82 (12.7 %) patients were re-admitted, while 31 (4.8 %) patients were re-hospitalized for further treatment. The most common diagnoses of re-admitted patients were renal colic (69.6 %), hematuria (13.4 %), and urinary tract infection (UTI; 9.8 %). Re-hospitalization was required in five patients (6.2 %) with UTI, four patients (4.8 %) with hematuria, and 11 (13.4 %) patients with renal colic. The renal colic resolved with ureteral stent insertion in 10 cases, while the remaining patients were treated medically. Re-admission was observed in 14 of the cases with small residual fragments (14/73, 19.7 %). Renal colic was most common reason (*n*: 8) for hospital re-admission.

In univariate analyses, the HR rate was significantly associated with higher ASA scores and procedure outcome. Re-hospitalization was related to the stone size, operation time, hospital stay, presenting, stone-free status, and postoperative complications. In multivariate analysis, stone-free status was an independent predictor of HR, while the stone-free status, hospitalization time, and postoperative complications all predicted re-hospitalization (Tables 3, 4).

Discussion

Hospital re-admission may follow various surgical interventions, and many studies have investigated its increased financial burden and relevant comorbidities [1, 2]. Many

Table 4 Multivariate analysis for unplanned re-admissions and re-hospitalization

	P	Odds ratio	95 %CI
Dependent: unplanned re-admissions			
Stone-free status	0.001	1.73	0.695–1.706
Dependent: re-hospitalization			
Stone-free status	0.004	2.53	1.348–4.759
Hospitalization time	0.013	1.68	1.116–2.532
Postoperative complication	0.000	2.15	1.423–3.266

CI confidence interval

procedural and patient-related risk factors may cause HR. Assessment of these factors may contribute to the prediction and prevention of unplanned HR. Unfortunately, only limited number of studies have enlightened us about potential HR occurring after urolithiasis treatment and the majority of those studies have used national healthcare data that do not include clinical or operative data [1, 3, 4, 11].

An analysis of MarketScan data evaluated re-admission rates after SWL, URS, and PNL and found that the median rate of HR was 12 % overall, but 15 % after PNL and URS. The rate of HR was elevated in high-volume hospitals and was even higher in cases with Charlson scores ≥2 points [1]. In a study involving British National Health Service data, unplanned hospital re-admissions occurred in approximately one in every 10 patients, with elective and emergency re-admission rates of 13.6 and 9 %, respectively. Re-admitted patients had relatively longer initial hospital stays [11].

In a retrospective clinical study of patients at higher risk of re-admission among those suffering from renal colic due to ureteral stones, specifying patients who would benefit more readily from SWL versus URS, the median re-admission rate was 18.1 % and stone size and location and white blood cell count predicted the re-admission rates [3].

Beiko et al. reported their ambulatory PNL series including the assessment of rates of emergency department visits and re-admissions postambulatory PNL. The authors noted a rate of 12 % for returning to emergency department and 4 % for re-admission rate [12]. Tepeler et al. found unplanned re-admission and re-hospitalization rates of 5.76 and 5.27 %, respectively, after PNL; anatomic abnormalities, postoperative complications, and stone complexity were independent predictors of unplanned re-admissions, while the duration of hospitalization and the presence of postoperative complications were associated with re-hospitalization. In addition, 91.5 % (54/59) of patients re-admitted after PNL were re-hospitalized for further treatment [13]. In our study, the median re-hospitalization rate after f-URS was 4.8 % (31/647). While most of the re-hospitalized cases were treated medically, intervention (ureteral stent placement) was needed only in 10 cases with resistant pain. This rate may be attributed to the minimally invasive nature of f-URS compared to PNL.

Rambachan et al. [2] investigated the five most frequently performed outpatient urological procedures (transurethral resection of the bladder tumor, laser prostatectomy, transurethral resection of the prostate, hydrocelectomy, and sling operations) and found median re-admission rates of 4.97, 4.24, 4.27, 1.92, and 0.85 %, respectively (overall median rate 3.7 %). A history of malignancy, bleeding disorders, male gender, ASA 3–4, and age were risk factors for re-admission. In that study, medical complications were seen in 30.9 % of the re-admitted patients, and the most common medical complication was UTI (20.6 %). Surgical complications were seen in 4.1 % of the patients, and 21.3 % of these were wound infections. In 21.3 % of re-admitted patients, re-operation was required.

Our clinical study investigated the procedural and patient-related factors that increase the risk of re-admission and re-hospitalization in patients following f-URS for renal stone disease. As far as we know, this is the first such study. Similar to studies of other procedures, the study included all admissions within 30 postoperative days. This study revealed the effects of factors such as success rate, duration of hospitalization, and postoperative complications. In other studies, the rate of re-admission following stone treatment was 5–15 % and the average re-admission rate after f-URS (12.7 %) in our study was similar.

Our study provides useful information for urologists. Determination of the risk factors for HR may improve the rapport between patient and physician, and unplanned complications may become more predictable. Urologists may also recognize patients who require detailed consultation before their discharge from the hospital. In addition, emerging complications and their appropriate treatment may decrease rates of HR.

The current study has some limitations such as retrospective nature and lack of sociocultural data and re-admission times of the patients. The use of only hospital records may be regarded as the other limitation of the study. However, in our country, the patients are generally referred to the hospitals where their initial treatment was given. Despite all these limitations, we believe that our findings shed light on re-admissions following f-URS.

Conclusion

Although flexible ureterorenoscopy is a safe, effective, minimally invasive treatment, HR and re-hospitalization can occur after hospital discharge. These rates were similar to those of other endourological procedures. We found that stone-free status predicted HR and re-hospitalization, while complications and prolonged hospitalization also predicted re-hospitalization.

Authors' contributions Buldu., Tepeler, Unsal, and Karatag contributed to the study design, writing, and interpretation, Ozyuvali and Elbir collected the data, and Buldu conducted the data and created the tables.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical standard The study was performed in accordance with the Declaration of Helsinki and its amendments. All patients provided written informed consent.

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