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Comparison of Outcomes Between Disposable and Reusable Flexible Ureteroscopes in the Treatment of Lower Pole Renal Stones

Alt Kutup Böbrek Taşlarının Tedavisinde Tek Kullanımlık ve Yeniden Kullanılabilir Üreteroskopların Sonuçlarının Karşılaştırılması

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ABSTRACT

Objective: Kidney stone disease is a significant health problem that substantially affects individuals' quality of life. Approximately 30% of kidney stones are located in the lower pole, which presents challenges in accessing these stones during retrograde intrarenal surgery. In the surgical treatment of lower pole kidney stones, we aimed to evaluate the efficacy and success rates of single-use and reusable flexible ureterorenoscopes, and to determine the most optimal option based on these findings.

Material and Methods: This study included patients with lower pole kidney stones who underwent retrograde intrarenal surgery. Patients were divided into two groups based on the type of ureterorenoscope used: single-use or reusable. The collected data were compared between the two groups.

Results: A total of 61 patients, including 34 men and 27 women, were included in the study. Thirty-four patients were evaluated in the single-use group, and 27 patients in the reusable group. The median stone size was 78.5 mm^2 (50.3–127.6) mm^2 in the reusable group and 125.3 mm^2 (56.5–201.1) mm^2 in the single-use group. There was no statistically significant difference between the groups in terms of demographic characteristics, Clavien-Dindo scores, or postoperative complications ($p > 0.05$). However, vomiting was observed significantly less frequently in the single-use group compared to the reusable group ($p < 0.05$).

Conclusion: Flexible ureterorenoscopes are commonly used in the surgical management of lower pole kidney stones. When choosing between single-use and reusable flexible ureterorenoscopes, factors such as cost and ease of use should be taken into consideration. To better compare the advantages of each type and obtain more reliable results, larger case series and prospective studies are needed.

Keywords: ureteroscopes, urolithiasis, kidney stone

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ÖZET

Amaç: Böbrek taşı hastalığı, önemli bir sağlık sorunu olup bireylerin yaşam kalitesini büyük ölçüde etkiler. Böbrek taşlarının yaklaşık %30'u alt kutupta yer alır ve bu durum retrograd intrarenal cerrahi sırasında taşlara erişimde zorluklara neden olur. Alt kutup böbrek taşlarının cerrahi tedavisinde tek kullanımlık ve yeniden kullanılabilir üreterorenoskopların etkinliğini ve başarı oranlarını değerlendirmeyi; bu bulgulara dayanarak en iyi seçeneği belirlemeyi amaçladık. **Gereç ve Yöntemler:** Çalışmamıza, esnek üreterorenoskopi kullanılarak retrograd intrarenal cerrahi ile tedavi edilen alt kutup böbrek taşı olan hastalar dahil edildi. Hastalar, kullanılan üreterorenoskop tipine göre tek kullanımlık veya yeniden kullanılabilir esnek üreterorenoskop gruplarına ayrıldı. Elde edilen veriler bu iki grup arasında karşılaştırıldı. **Bulgular:** Çalışmamıza 34 erkek ve 27 kadın olmak üzere toplam 61 hasta dahil edildi. Tek kullanımlık grupta 34 hasta ve yeniden kullanılabilir grupta ise 27 hasta değerlendirildi. Yeniden kullanılabilir grupta ortanca taş boyutu 78.5 mm^2 (50.3–127.6) mm^2, tek kullanımlık grupta ise 125.3 mm^2 (56.5–201.1) mm^2 olarak bulundu. Gruplar arasında demografik özellikler, Clavien-Dindo skorları veya postoperatif komplikasyonlar açısından istatistiksel olarak anlamlı bir fark gözlenmedi ($p>0,05$). Tek kullanımlık grupta kusma, yeniden kullanılabilir gruba göre anlamlı ölçüde daha az sıklıkta gözlendi ($p<0,05$). **Sonuç:** Alt kutup böbrek taşlarının cerrahisinde esnek üreterorenoskoplar yaygın olarak kullanılır. Tek kullanımlık ve yeniden kullanılabilir esnek üreterorenoskoplar arasında seçim yaparken, maliyet ve kullanım kolaylığı dikkate alınmalıdır. Her iki üreterorenoskop tipinin avantajlarını karşılaştırmak ve daha güvenilir sonuçlar elde etmek için daha büyük serilere ve prospektif çalışmalara gereksinim duyulmaktadır.

Anahtar Kelimeler: üreteroskoplar, ürolitiyazis, böbrek taşı

INTRODUCTION

With a global prevalence of approximately 10% , kidney stone disease is a significant health issue that adversely affects quality of life (1). Treatment options include retrograde intrarenal surgery (RIRS), percutaneous nephrolithotomy (PCNL) and extracorporeal shock wave lithotripsy (ESWL) in interventional or surgical approaches (2). About 30% of stones are found within the lower pole kidney stones (LPKS), often complicating access during RIRS (3).

Flexible ureterorenoscopes were first introduced in 1964 as reusable fiberoptic instruments, and with subsequent technological advancements, digital flexible ureterorenoscopes emerged in 2006 (4,5). Disposable flexible ureterorenoscopes were introduced later, in 2015 (6). These single-use ureterorenoscopes were designed to address some of the limitations associated with reusable models, such as high costs, maintenance and repair requirements, infection risks, and restricted reusability (7).

Recognizing the importance of deflection for reaching LPKS, we sought to compare the effectiveness and success rates of disposable versus reusable flexible ureterorenoscopes in surgical treatment. The goal was to provide data that could guide the selection of most appropriate device based on these outcomes.

MATERIAL AND METHODS

After obtaining approval from local ethics committee (decision number 01 and date 02.05.2024), we conducted a retrospective review of records for patients who visited our clinic for kidney stone treatment between January 2023 and June 2024. Sixty-one adult patients with LPKS treated via RIRS with flexible ureterorenoscopy were included. Patients younger than 18 years, those with kidney stones located outside the lower pole, and those who did not undergo RIRS were excluded.Collected patient data included age, history of kidney stones, comorbidities, prior surgical or stone--related treatments, presence of a preoperative JJ catheter, stone size (estimated surface area – mm^2), Hounsfield unit (HU) of the stone, infundibulopelvic angle (IPA), infundibulopelvic length (IL), operative time, hospitalization duration, postoperative JJ catheter duration, stone-free status, occurrence of postoperative complications, and the need for reoperation due to residual stones. Patients were grouped based on whether they underwent treatment

with a disposable or reusable flexible ureterorenoscope, and the data were then analyzed between these two groups.

Surgical Technique

Patients were placed in the lithotomy position. Out of the 61 cases, 53 were performed under spinal anesthesia, while 8 were conducted under general anesthesia. For each patient, a 6 Fr semi-rigid ureteroscope (Storz, Germany) was initially inserted up to the renal pelvis to achieve active ureteral dilation, after which a hydrophilic guidewire was placed. Once the semi-rigid ureteroscope was withdrawn, the subsequent approach varied based on the type of flexible ureterorenoscope used. Intracorporeal laser lithotripsy was utilized in every case.

In the disposable ureteroscope group, a 10.7/12.7 Fr ureteral access sheath was advanced into the ureter along the hydrophilic wire under fluoroscopic guidance. A disposable flexible ureteroscope (F-URS, HugeMed HU30 9.0 Fr, Shenzhen HugeMed Medical Technical Development Co., China) with an inner diameter of 3.6 Fr was then used for stone management. In the reusable ureteroscope group, a 9.5/11.5 Fr ureteral access sheath was inserted in a similar manner along the hydrophilic wire with fluoroscopic guidance. A reusable flexible ureteroscope (F-URS, Olympus URF-P6 7.95 Fr, Canada) with an inner diameter of 3.6 Fr was used for the procedure.

Statistical Analysis

Descriptive statistics were presented as mean ± standard deviation for normally distributed numerical variables,median (interquartile range) for non-normally distributed variables, and n (%) for categorical variables. The Kolmogorov-Smirnov and Shapiro-Wilk tests were used to assess variable distribution. For independent quantitative variables, the independent samples t-test was applied to normally distributed data, and the Mann-Whitney U test was used for non-normally distributed data. The Chi-square test was applied for independent categorical variables; if Chi-square assumptions were not met, Fisher's exact test was used instead. All statistical analyses were performed using SPSS version 28.0.

RESULTS

The study included 61 patients in total, with 34 men and 27 women, and a mean age of 48.4 years. Of these, 34 patients were placed in the disposable ureteroscope group, while 27 were in the reusable group. The median stone size was 78.5 mm^2 (50.3–127.6) mm^2 in the reusable group and 125.3 mm^2 (56.5–201.1) mm^2 in the disposable group. In terms of surgical laterality, 31 surgeries were performed on the right side and 30 on the left. No statistically significant differences were found between the disposable and reusable groups regarding age, gender distribution, comorbidity rates, side of surgery, ASA scores, or Clavien-Dindo scores ($p > 0.05$). Similarly, no significant differences in postoperative symptoms, such as flank pain, dysuria, hematuria, or the proportion of asymptomatic patients, were noted between the groups ($p > 0.05$). Postoperative nausea, however, was observed significantly less frequently in the disposable group ($p < 0.05$). Additionally, both groups showed no significant differences ($p > 0.05$) in terms of surgical history, spontaneous stone passage, presence of previous urinary tract infections (UTI), or preoperative JJ catheter history (Table 1).

No statistically significant differences ($p > 0.05$) were observed between the reusable and disposable groups in terms of anesthesia type, preoperative catheter placement, stone size, stone count, HU value, IPA, IL, operative time, residual stone size, JJ stent duration, hospitalization or postoperative JJ stent use. In the disposable group, the use of kidneys, ureters, and bladder (KUB) radiography during follow-up was significantly lower ($p < 0.05$) than in the reusable group. There was no significant difference ($p > 0.05$) between groups in the use of ultrasonography (USG) imaging for follow-up. However, the rate of computed tomography (CT) imaging during follow-up was significantly higher ($p < 0.05$) in the disposable group compared to the reusable group. No significant differences were found between the groups regarding stone-free rates, postoperative UTI, sepsis, or readmission rates ($p > 0.05$). Detailed comparative values are presented in Table 2.

Tablo 1. Comparison of Demographic Characteristics of Reusable and Disposable Ureteroscopy Groups

Parameter	Reusable (N:27)	Disposable (N:34)	p value
Age	49.3±13.2	47.4±13.3	0.575 [t]
Gender			
Male	19(55.9%)	15 (55.6%)	0.980 [x²]
Female	15(44.1%)	12 (44.4%)	
Side			
Right	18 (52.9%)	13 (48.1%)	0.710 [x²]
Left	16 (47.1%)	14 (51.9%)	
ASA Score			
I	6 (17.6%)	7 (25.9%)	0.433 [x²]
II	28 (82.4%)	19 (70.4%)	
III	0 (0.0%)	1 (3.7%)	
Clavien Dindo Score			
I	33 (97.1%)	25 (92.6%)	0.579 [x²]
II	1 (2.9%)	2 (7.4%)	
Comorbidity			
(-)	29 (85.3%)	19 (70.4%)	0.157 [x²]
(+)	5 (14.7%)	8 (29.6%)	
Symptoms			
Flank pain	32 (94.1%)	26 (96.3%)	1.000 [x²]
Nausea	8 (23.5%)	0 (0.0%)	***0.007*** [x²]
Dysuria	2 (5.9%)	5 (18.5%)	0.124 [x²]
Hematuria	4 (11.8%)	1 (3.7%)	0.254 [x²]
Asymptomatic	2 (5.9%)	0 (0.0%)	0.498 [x²]
Surgical History			
(-)	17 (63.0%)	12 (46.2%)	0.219 [x²]
(+)	10 (37.0%)	14 (53.8%)	
Stone Passage History			
(-)	14 (43.8%)	11 (40.7%)	0.973 [x²]
(+)	20 (62.5%)	16 (59.3%)	
UTI History			
(-)	31 (91.2%)	20 (74.1%)	0.073 [x²]
(+)	3 (8.8%)	7 (25.9%)	
Preoperative Catheter			
(-)	25 (73.5%)	19 (70.4%)	0.785 [x²]
(+)	9 (26.5%)	8 (29.6%)	

UTI; urinary tract infection

Tablo 2. Comparison of Perioperative Findings between Reusable and Disposable Ureteroscopy Groups

Parameter	Reusable	Disposable	p value
Anesthesia Type			
Spinal	30 (88.2%)	23 (85.2%)	0.726 $^{X^2}$
General	4 (11.8%)	4 (14.8%)	
Stone size/mm^2	78.5 (50.3–127.6)	125.3 (56.5–201.1)	0.142 ^{m}
Stone Count	1.0 (1.0–1.0)	1.0 (1.0–2.0)	0.511 ^{m}
Hounsfield Unit (HU)	1021.0 (743.0–1138.2)	933.0 (666.5–1041.0)	0.309 ^{m}
Infundibulopelvic Angle (IPA)	65.6 ± 20.29	63.1 ± 29.8	0.237 ^{m}
Infundibulopelvic Length (IL)	22.96 ± 8.2	21.5 ± 5.8	0.988 ^{m}
Surgery Time/min	85.0 (70.0–105.0)	85.0 (75.0–110.0)	0.070 ^{m}
Residual Stone Size/mm^2	0.0 (0.0–0.0)	0.0 (0.0–10.0)	0.213 ^{m}
Catheter Duration/Days	30.0 (21.0–30.0)	28.0 (21.0–31.0)	0.510 ^{m}
Hospitalization/Days	1.0 (1.0–1.0)	1.0 (1.0–2.0)	0.761 ^{m}
Postoperative Catheter			
DJ (-)	2 (5.9%)	0 (0.0%)	0.498 $^{X^2}$
DJ (+)	27 (79.4%)	25 (92.6%)	
Ureteral Catheter	5 (14.7%)	2 (7.4%)	
Control Imaging			
KUB	30 (88.2%)	16 (59.3%)	***0.009*** $^{X^2}$
USG	1 (2.9%)	2 (7.4%)	0.579 $^{X^2}$
CT	3 (8.8%)	9 (33.3%)	***0.017*** $^{X^2}$
Stone Free			
(+)	27 (79.4%)	22 (81.5%)	0.840 $^{X^2}$
(-)	7 (20.6%)	5 (18.5%)	
Postoperative UTI			
(-)	34 (100.0%)	25 (92.6%)	0.192 $^{X^2}$
(+)	0 (0.0%)	2 (7.4%)	
Postoperative Sepsis			
(-)	33 (97.1%)	27 (100.0%)	1.000 $^{X^2}$
(+)	1 (2.9%)	0 (0.0%)	
Readmission			
(-)	32 (94.1%)	21 (77.8%)	0.060 $^{X^2}$
(+)	2 (5.9%)	6 (22.2%)	

KUB; kidney ureter bladder grapghy , USG; ultrasonograhpy

^{m} Mann-whitney u test / $^{X^2}$ Chi-square test (Fischer test)

DISCUSSION

The annual incidence of kidney stones is approximately 9 per 1,000 individuals, making it a prevalent condition that adversely affects health and quality of life (8). Symptoms frequently reported by patients with kidney stones include flank pain, hematuria, dysuria, nausea, vomiting, fever, chills, and even chronic kidney disease (9). Initial management typically focuses on addressing acute symptoms through hydration and analgesia, followed by medical therapies aimed at preventing stone recurrence. To promote spontaneous expulsion of stones, α-blockers and calcium channel blockers may be prescribed. If medical treatment proves insufficient, ESWL or surgery might be required (10).

Achieving optimal stone clearance with minimal complications is the primary goal of kidney stone surgery. The choice of technique is guided by the stone size and location. With advancements in technology, minimally invasive techniques have largely replaced open surgical procedures (11). However, the selection of specific endourological approaches, such as PCNL or RIRS, remains a topic of continued debate (12).

Flexible ureteroscopy has emerged as a widely adopted technique, with stone-free rates (SFR) exceeding 90% (13). Although it is frequently preferred for treating LPKS, several factors can negatively impact its success. According to Göger et al., variables such as stone burden, stone count, HU, and IPA lowered SFR (14). Likewise, Jessen et al. observed that a long infundibulum and narrow IPA correlated with reduced SFR, though full clearance was achievable in a second session (15).

To boost SFR and minimize complications through reduced intrarenal pressure, ureteral access sheaths have been suggested. However, Ergün et al. reported in their study that there was no significant difference between the use of a ureteral access sheath and surgical success or complication rates (16). At our clinic, the use of ureteral access sheaths is part of our standard practice. Although we did not find significant differences in surgical outcomes between different types of flexible ureteroscopes, our experience suggests that digital flexible ureteroscopes offer superior image quality but are more prone to deformation, whereas reusable ureteroscopes provide greater durability. This factor should be considered when evaluating cost-effectiveness.

The objective of RIRS is to achieve a high SFR while minimizing complications. Despite efforts to optimize outcomes, approximately 20% of patients may experience general complications, including flank pain, hematuria, and UTI (17). In rare cases, severe complications such as massive retroperitoneal hematoma or sepsis may occur (18). Ensuring proper sterilization, especially for reusable ureterorenoscopes, is crucial to minimize the risk of postoperative infections (19). Bragaru et al. reported no significant difference in postoperative complication rates or SFR between disposable and reusable ureteroscopes, consistent with our findings (20). In our study, we observed that the rate of Clavien-Dindo scores >1 in the evaluation of complications was between %2 and 7%, which was similar to the literature (21).

In our clinical practice, we have utilized both types of flexible ureteroscopes effectively and safely. While neither demonstrated definitive superiority, we observed that disposable ureteroscopes are advantageous for training purposes due to their enhanced digital imaging capabilities and lighter weight, whereas the tips of reusable ureteroscopes are notably more durable. However, larger-scale studies are needed to validate these findings. We hope our results will enrich the literature and support future studies in this domain.

Our study has limitations such as small sample size, retrospective design and limited access to data. In addition, the recent introduction of flexible ureterorenoscopes in our institution contributed to the limited number of cases. Furthermore, cost-effectiveness analysis could not be performed due to insufficient access to relevant data.

CONCLUSION

Flexible ureteroscopes including those used for the treatment of LPKS, represent a valuable minimally invasive option for the surgery of kidney stones. When choosing flexible ureteroscopes, ease of use should be a key consideration. To more definitively assess the comparative benefits of each type and obtain more reliable outcomes, larger-scale prospective studies are warranted.

Conflict of Interest: The authors have no conflict of interest regarding this study.

Financial Disclosure: There are no financial conflicts of interest to disclose.

Ethics Approval: Ethics approval was obtained from Uşak University ethics committee with the decision number 367-367-01 on 02.05.2024.

Authors Contribution: Concept ATU,ATo , Design ATU, ATO, EA , Data Collection and/or Processing ATU,ATO , Analysis and/or Interpretation ATU, SS, YA, EA , Writing-review-revision ATU, SS , Literature Review: ATU, SS , Writing: ATU, SS , Critical Review: ATU, SS.

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