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For upper ureteral stone, semirigid ureteroscopy or flexible ureteroscopy? Strengths and weaknesses

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Abstract

Background Flexible and semirigid ureteroscopy are two often used modalities in treating for upper ureteral stone. How about the outcome of each procedure?

Methods A retrospective cohort study among 167 patients who underwent flexible or semirigid ureteroscopic lithotripsy was performed. The pre-, intra-, postoperative and one-year follow-up outcomes were taken into comparison.

Results Significantly higher instant stone-clearance rate (81.3% vs. 92.4%, $p=.032$) and less operative time (62.1 ± 27.6 min vs. 44.1 ± 24.6 min, $p<.001$) were found in semirigid ureteroscopy. However, the stone-clearance rate at one month (90.7% vs. 93.5%, $p=.500$) was similar. Baseline characteristics including patient demographics, stone characteristics, duration of stone symptoms, hospital stay, expense, and complications between groups were approximately same. Three cases of stricture were found in the flexible ureteroscopy, and two in the semirigid ureteroscopy. Outcomes showed no significant difference. Further analysis showed that flexible ureteroscopy was likely more negatively affected by hydronephrosis and stone size, and semirigid ureteroscopy was more affected by stone location.

Conclusion flexible ureteroscopy and semirigid ureteroscopy both had high stone clearance rate in the treatment for upper ureteral stones. They had similar outcomes and follow-up results. However, they also had their each most suitable application object.

Keywords Follow up, Stone free, Stricture, Ureteral stone, Ureteroscopy

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Introduction

Urolithiasis has been worldwide prevalent, and is on the rise for the last decades [1]. When surgery is needed, ureteroscopy is the often used in the treatment for upper ureteral calculi [2]. At present, flexible ureteroscope (fURS) and semirigid ureteroscope (URS) are the two classic modalities. How about the strengths and weaknesses of each of them? Besides the perioperative outcomes, did the two ureteroscopy differ in the follow-up results? Hence, we conducted this retrospective cohort study to try to answer these questions.

Materials and methods

General information

The study was approved by committee of Tongji Hospital, Tongji Medical College, Huazhong University of Science and Technology (TJ-IRB20210954). Totally 167 patients with upper ureteral stones treated by ureteroscopy with holmium: YAG laser were enrolled in this retrospective cohort study. Patients also treated for concomitant other stones were excluded. They were grouped by their first operation methods, fURS or URS. Data about intra- and postoperative outcomes and one-year follow-up results were analyzed. Follow-up results, focusing on ureteral stricture were obtained from the recheck records and telephone inquiries in the one year over the operation.

Surgical methods

URS: After anesthesia, all patients were placed a guidewire up to the stone under the WOLF 8/9.8 F ureteroscope in the lithotomy position. The semirigid ureteroscope was inserted along the guidewire under 100–200 ml/min irrigation pressure (STORZE). When reached the stone, took out the guidewire and placed the antiretropulsive device (N-Trap, COOK medical). Then, Lumenis holmium: YAG laser with 550 µm fiber, settings of 1–1.5 J, 15–20 Hz was used to disintegrate the stones. Using the N-Trap to move the stone while disintegrating, avoiding prolonged time of in-situ operation. Fragments were swept out from ureter also by the N-Trap. In the end, a double J stent was placed to protect the ureter.

fURS: The procedure of placing the guidewire was the same. Unstable stones were pushed back into renal pelvis. Ureteral access sheath was inserted reaching the stone and the Olympus digital flexible ureteroscope was placed through the working channel. 50–200 ml/min irrigation pressure was taken (STORZE). Same laser was used, but with 200 µm fiber, settings of 0.7–1.5 J, 20–40 Hz. Dusting the stone as much as possible, and using a retrieval basket to retrieve the relatively large fragments. Checked the renal pelvis and all calyces for debris, and also placed a double J at the end.

Table 1 Patients and stones characteristics

	fURS	URS	*P* value
No. Patients	75	92	-
Mean patient age ±SD(year)	49.2 ± 14.2	47.4 ± 12.6	0.390
Mean body mass index ±SD	24.4 ± 3.1	24.9 ± 4.0	0.381
No. Males/Females	47/28	70/22	0.060
Stone laterality (L/R)	42/33	52/40	0.946
Mean stone size (mm) ±SD:			
Length	11.7 ± 3.6	12.4 ± 5.0	0.345
Width	8.1 ± 2.7	7.4 ± 2.3	0.092
No. hydronephrosis grade I/II/III	2/47/16[a]	1/45/38[a]	0.030
Distance of stones to UPJ (median)	40.1±36.6 (30.5)	65.1± 37.5 (65)	< 0.001
Stones duration			0.502
≤two weeks	27	41	0.262
> two weeks	48	51	

[a] The residual patients were lack of relevant information

Criteria

Kidney-ureter-bladder radiography (KUB) was used to assess for residual stone. Stone clearance rate (SCR) was defined by the absence of clinically significant debris (>2 mm). Obvious dilation up to calyces, renal pelvis or only ureter were defined as grade III, II, I of hydronephrosis, respectively. Stones duration was equal to period from the first emergency timing to the date of operation. The distance of stone from UPJ was defined as the vertical distance between planes. Expense was obtained from in-house billing. Routine kidney-ureter-bladder ultrasound was used to assess whether hydronephrosis occurred or not after the removal of JJ stent. Further imaging and(or) ureteroscopy were used to confirm the formation of in-situ stricture.

Statistic

IBM SPSS statistics v.26 software was used to analyze and process the data. All numeric variables were tested in Q-Q plot for normality, and then all normally distributed continuous variables were presented as mean±standard deviation and analyzed by the independent t test. Non-normal distributed variables were accessed by Mann-Whitney U test. The counting data were expressed as percentage, and the data were compared by $\chi 2$, or Fisher's exact test when the expected numbers were smaller than 5. We did not fill any missing value and just analyzed all available data. All p values were 2-tailed, and <0.05 was considered as statistically significant.

Results

Firstly, patients and stones characteristics were presented in Table 1. No baseline data showed significant difference except more high-degree hydronephrosis and longer distance of stone to the ureteropelvic junction (UPJ) in URS group. As shown in Table 2, obvious longer operative time (62.1 ± 27.6 vs. 44.1 ± 24.6, $p< .001$) was observed

Table 2 Surgical details and outcomes

	fURS	URS	*P*-value
Operative time (min, median)	62.1±27.6 (57)	44.1±24.6 (39)	< 0.001
Postoperative hospital stay (d)	4.2±1.6	3.9±2.0	0.349
Total expense (¥)	26974.7±12366.9	26158.9±13415.0	0.686
Urine culture, n	9	3	0.030
Urine nitrite test, n	2	1	0.589
Intraoperative complication, n	0	0	-
Postoperative complication, n			
fever	4	4	1.000
SIRS/sepsis	3	2	0.658
Sepsis shock	1[b]	0	
bleeding	1[b]	0	-
others	1[c]	0	-
Stone-clearance rate			
One-day	81.3%(61/75)	92.4%(85/92)	0.032
One-month	90.7%(68/75)	93.5%(86/92)	0.500

[b] One patient had renal bleeding and sepsis shock concurrently

[c] Unexplained headache

in the fURS group. Except that, two groups were similar in perioperative outcomes. Both had few complications such as fever, sepsis and bleeding. In the judgement of the SCR, fURS showed a lower overall SCR at the one day over operation, 81.3% vs. 92.4%, $p=.032$, but no significant difference at the one month (90.7% vs. 93.5%, $p=.500$). The phenomenon was because of the big difference in the number of spontaneous stones pass, seven in the fURS and one in the URS.

In order to reveal the biggest influencing factors of the two procedures, further analysis of the SCR was conducted and exhibited in Fig. 1. We found that the SCRs for two groups both trended down as increasing stones sizes, and more dramatical decline was observed in fURS. In addition, it seemed that fURS was negatively affected by hydronephrosis, but URS was likely affected by the distance of stone to the UPJ.

Patients were followed up one year and results were placed in Table 3. Almost all patients recovered well. It was worth noting that there were three cases of stricture in the fURS, and comparably two cases in the URS. Moreover, another patient in the fURS was identified who had an expanding hydronephrosis during the follow-up. Due to the small number, no predictable factor was found contributed to the stricture formation.

Discussion

Ureteroscopy including flexible and semirigid ureteroscopy has become the first line choice for upper ureteral stone, and even renal transplant lithiasis [3]. It is safe and cost-effective [4]. Nowadays, both of them have a high stone-clearance rate. With its bendable properties, flexible ureteroscope could reach the majority of calyces [5]. Semirigid ureteroscope makes it in other way. Combining with antiretropulsive devices, it could efficiently prevent stones from migration [6]. Gradually, there is no clear line between the two surgical methods. However, hindered by the higher cost of equipment and maintenance and so on, fURS had not been widely used in many centers. In this paper, we demonstrated that fURS and URS both performed well on stone treatment, and only had slight difference in stone choice.

The SCR of fURS at the one day was significantly lower than that of URS. It was because of that fragment in fURS procedure always in the kidney which was harder to clear. Making good use of the two modes of dusting and fragmentation would help to improve the stone-free rate [7]. Moreover, retrieval tools were also able to remove big fragments. However, it would significantly increase the operation time. In our study, the mean operation time in fURS was 18 min longer than that in URS. Moreover, as the stone size increased, there was so much dust liked debris left, which led to a low SCR. Other procedure like external physical vibration lithecbole might be needed. That was one of the biggest obstacles for the current fURS. As the fragments passed spontaneously, similar SCR was observed at one month. A latest paper suggested that 51.11% of fragments could manage to pass within one month [8].

Since there were few stones escaping from antiretropulsive devices block, it seemed that URS had a higher priority. However, the real was the stones in URS were further away to UPJ. In the stones close to UPJ, fURS was performed more for fear of up-migration. As the same as mentioned by Perez et al., fewer patients with fURS failed treatments or need retreatment [9]. Further analysis in this study revealed that URS was did more susceptible to the stone location. It was consistent with our previous study, which demonstrated that antiretropulsive device was unlikely to be cost-effective for those stones too close to the UPJ [10].

Though significant difference did not occur yet, fURS seemed to be more susceptible to hydronephrosis and stone burden. Lower SCR might be caused by following reasons: (1) High-degree hydronephrosis mainly caused by the large impacted stones. The larger stones would produce the more debris. Then more debris redeposited in the lower renal calyces due to gravity. (2) After relief of obstruction, high-degree hydronephrosis was more likely to cause mucosal bleeding, resulting a poor operative insight. High-degree hydronephrosis also meant expanded renal inner space and abnormal anatomical structure. It resulted in more effort to refind the stone, especially in bleeding environment.

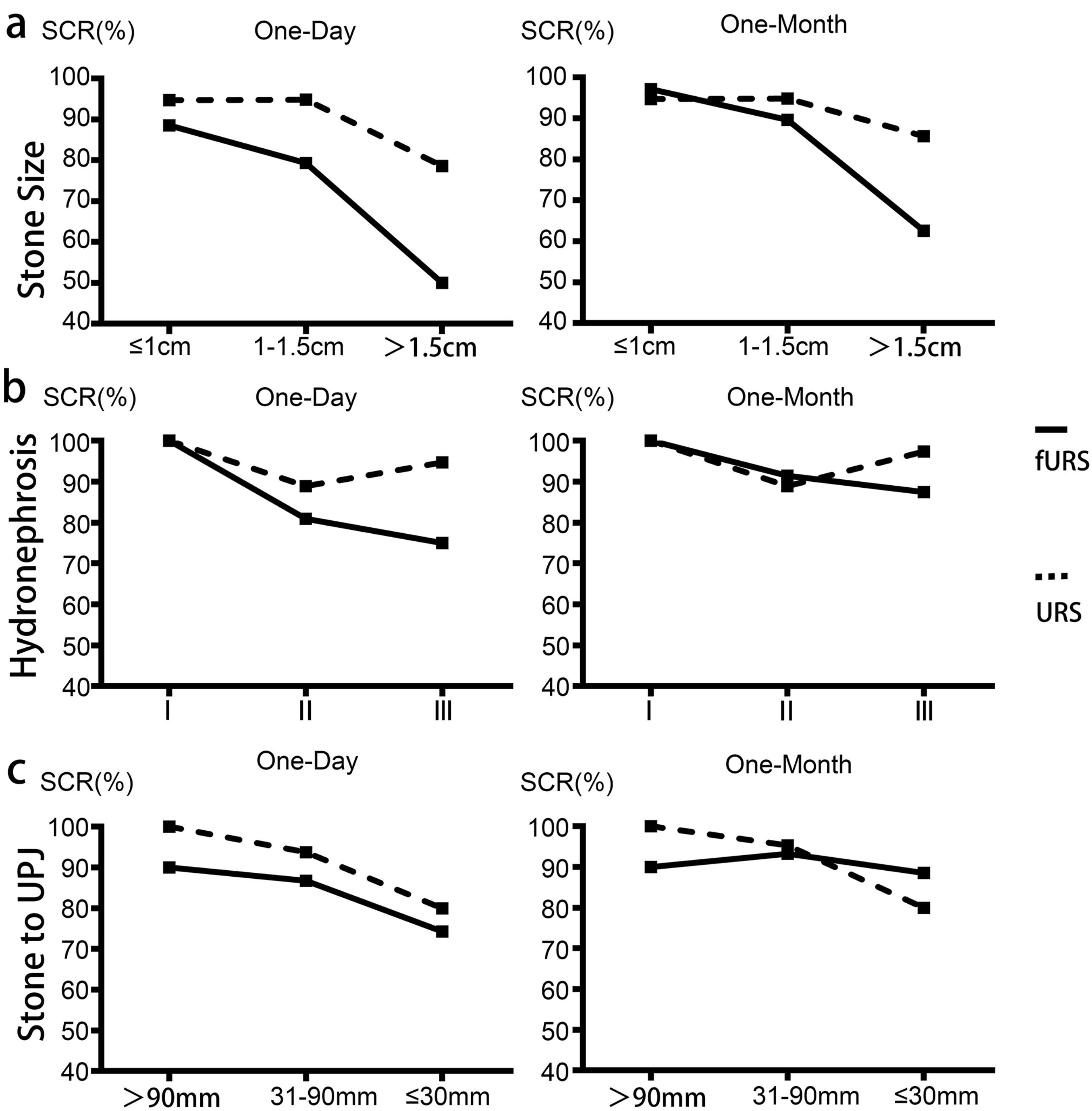

Fig. 1 Stone clearance rates (SCR) according to stones size(**a**), hydronephrosis(**b**) and location(**c**)

Table 3 Follow-up results

	fURS	URS	*P* value
No. patient	66[d]	81[d]	-
Mean follow-up month	12	12	0.915
Stricture	3	2	0.659
Backache	5	7	0.814
Residual stone	5	2	0.244
Secondary surgery	1	2	1.000
Expanding hydronephrosis	1	0	-

[d] The residual patients were out of follow-up

"Ureterostenosis is a kind of rare but severe postoperative complication, with a low success rate of endoscopic management and a high procedural burden that may lead to nephrectomy [11]. " Several studies tried to find out predictable factors for ureteral stricture formation [12–14]. Up till now, we have much conjecture but little evidence about it. Few patients formatted stricture in our two groups. It benefited from ectopic disintegration and proper irrigation. With antiretropulsive device, stones were hauled out while dusting. With flexible ureteroscope, stones were partly disintegrated in the renal space.

In other words, committed with prior papers, we demonstrated that Holmium: YAG laser lithotripsy with appropriate irrigation was a safe treatment modality [15, 16]. Impacted ureteric stones are also suspected of carrying a risk of stricture development [17]. Purposely, we collected preoperative hydronephrosis and stone duration. Although it led to bias, it provided important reference information about the duration of obstruction. However, we did not extract any clue. Routine postoperative imaging remains necessary to observe the formation of stricture early after endoscopic treatments [18].

The major limitations of this study were its retrospective design and small sample size. Selective bias potentially existed. We also had no data about the compositions of stones. The number of strictures was small too. Furthermore, we had no stringent standard to judge the hydronephrosis degree. We reduced the bias by letting one to finish all the judgments. Twenty cases of follow-up results were incomplete, and more detailed follow-up results are necessary.

Conclusions

All in all, fURS and URS both had high stone clearance rate in the treatment for upper ureteral stones. They had similar outcomes and follow-up results. It was seemed that fURS was more negatively affected by hydronephrosis and stone size. And URS had a shorter operative time and a higher instant stone clearance rate, however it was likely affected by the stone location. Higher level of evidence is needed.

Abbreviations

fURS Flexible ureteroscopy
KUB Kidney-ureter-bladder radiography
SCR Stone clearance rate
UPJ Ureteropelvic junction
URS Semirigid ureteroscopy

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Author contributions

WS Wu: Data collection, Data analysis, Manuscript writing; WL Wan: Data collection; JY Yang: Data collection; Y Amier: Date process; XM li: Data collection; JQ Zhang: Project development, Manuscript editing; X Yu: Project development, Manuscript editing, Data management, Data analysis.

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Data availability

The datasets generated and/or analyzed during the current study are not publicly available due to limitations of ethical approval involving the patient data and anonymity but are available from the corresponding author on reasonable request.

Declarations

Ethics approval

All procedures were performed under the permission of the ethics committee of Tongji Hospital, Tongji Medical College, Huazhong University of Science and Technology (TJ-IRB20210954). All methods had been performed in accordance with the Declaration of Helsinki.

Consent to participate

Informed consent was waived due to anonymous study design (Ethics Committee of Tongji Hospital, Tongji Medical College, Huazhong University of Science and Technology). No special patients nor personally identifiable data was included.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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