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Feasibility and safety of flexible ureteroscopy with intelligent control of renal pelvis pressure without urinary catheter: a retrospective study

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Abstract

Background To explore the feasibility and safety of aflexible ureteroscopy with intelligent control of renal pelvic pressure(FUS-ICP) without a post-operative indwelling urinary catheter .

Methods In this retrospective study, we assessed patients with upper urinary tract stones who were treated with FUS-ICP at the Ganzhou People's Hospital from February 2022 to December 2023. Patients were divided into the non-urinary catheter (non-UC) and urinary catheter (UC) groups according to whether an indwelling catheter was used after surgery.

Results In total, 142 patients were included in the study. There was no significant difference in the preoperative general data between the two groups. Patients in the non-UC group performed better than those in the UC group in terms of catheter-related bladder irritation ($P=0.001$), the Sedation-Agitation Scale score ($P=0.012$), and the numerical rating scale ($P=0.003$). The incidences of urinary retention ($P=0.620$), urinary tract infection ($P=0.529$), and replacement of urethral catheter s ($P=0.438$) in the UC group were inferior to those in the non-UC group, but there was no statistical significance.

Conclusions It is feasible and safe to perform FUS-ICP without a post-procedure indwelling urinary catheter.

Keywords Urinary catheter, Flexible ureteroscopy, Renal pelvic pressure

Introduction

A perioperative indwelling urinary catheter is a common practice because catheter is placed for draining urine and preventing blood clots in bladder [1].In urological surgery, the indwelling urinary catheter is convenient for draining urine and blood clots, maintaining low bladder pressure, preventing infection, and promoting post-operative recovery. With the advancement of minimally invasive technology and the promotion of enhanced recovery after surgery (ERAS), the operation time and hospital stay have been further shortened, and the routine use of an indwelling urinary catheter after surgery has brought a lot of discomfort to patients [2]. It is safe and feasible for gynecology and thoracic surgery patients who have undergone general anesthesia to not undergo placement of an indwelling urinary catheter after surgery. This greatly reduces the negative experience of patients, such as urethral pain or urinary tract discomfort, and also reduces the incidence of urinary tract infection and the length of hospital stay [3, 4]. At present, there is a lack of reports pertaining to the exclusion of the urinary catheter after urology surgery.

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Flexible ureteroscopy is associated with less trauma and a faster recovery, with most procedures performed as a day surgery [5]. The indwelling urinary catheter is still routinely placed after surgery, which can result in urethral pain or urinary tract discomfort and burning sensation during recovery from anesthesia; this can seriously affect the rapid recovery of patients [6]. In recent years, with the improvement of the access sheath, laser, and ureteroscope, particularly flexible ureteroscopy with intelligent control of renal pelvis pressure (FUS-ICP), the surgical safety and effectiveness have been greatly improved, the operation time is shorter, and the recovery of patients is promoted [7–9].

This study reviewed and analyzed cases of non-indwelling urethral catheters in our hospital and discussed the feasibility and safety of non-urinary catheters after FUS-ICP to further accelerate patient recovery.

Methods

Patient data

This study was approved by the Ethics Committee of the Ganzhou People's Hospital and included patients who underwent FUS-ICP under general anesthesia in the Department of Urology from February 2022 to December 2023. The inclusion criteria were as follows: (1) age 18–70 years; (2) kidney or ureteral stones, where the diameter of a single stone is ≤2 cm or the maximum diameter of multiple stones is ≤2 cm; (3) American Society of Anesthesiologists (ASA) score I/II; and (4) operation time<60 min. All patients voluntarily participated in this study and signed informed consent. They were informed before surgery whether a urinary catheter would be placed or not, and in some cases, no urinary catheter was placed during the operation according to the preoperative wishes of the patients. Patients with bladder outlet obstruction, obvious hematuria and ureteral renal injury were excluded.

The exclusion criteria were as follows: (1) uncontrolled urinary tract infections (UTIs); (2) patients in which pyonephrosis was identified during the operation; (3) patients with structural abnormalities (ectopic kidney, horseshoe kidney, kidney transplant patients and duplicate kidney), ureteral stenosis, and diversion of urine; (4) severe hydronephrosis; (5) preoperative mental illness or cognitive dysfunction; (6) severe systemic hemorrhagic disease; (7) patients undergoing simultaneous bilateral surgery; (8) severe hip deformity and difficulty in positioning; (9) urinary disorders caused by nervous system disorders, prostatic hyperplasia, urethral stenosis, etc.; and (10) pregnant women.

Surgical methods

The surgery was performed by two doctors experienced in flexible ureteroscopy with intelligent control of RPP for more than 3 years, with 200 cases each year. The patient was positioned at an angle 60° oblique to the supine lithotomy position with the diseased side positioned upward. Initially, ureteroscopy was performed with a semirigid 7/8.4 Fr ureteroscope (KARL Storz, Germany) guided by a zebra guide wire. A Zebra guide wire was placed through the ureteroscope. A 12/14 or 11/13Fr patented ureteral access sheath(UAS) with pressure-measuring suctioning (Fig. 1)was inserted over the guidewire without fluoroscopic guidance. The platform selection mode was set to fully automatic (Fig. 2). The pressure sensory and suctioning channels of the ureteral access sheath were connected to the irrigation and suctioning platform. After the sensor is injected with normal saline using a syringe, the normal saline and urine in the renal pelvis are drained through the sheath to completely empty the air in the pressure sensor pipe for accurate pressure measurement. After that, zero calibration was performed at the platform. The actual pressure in the renal pelvis displayed on the platform was 0 mmHg. The perfusion flow was initially set at 100 mL/min. The pressure control values were set at -5. The 8.5Fr flexible ureteroscope (Hawk, China) was connected by a peristaltic tube and inserted to confirm the location of the sheath. First, 276 μm holmium laser fiber (Chunhui, China) was used with a power of 2.0 ~ 3.0 J/20 ~ 30 Hz. 5 Fr ureteral stents were placed at the end of the procedure. The stents were removed at 2–4 weeks after confirmation of stone free status according to kidney-ureter-bladder ultrasound or computed tomography examination. For patients with residual calculi, extracorporeal lithotripsy or re-operation were performed.

Urinary catheter management

Patients were divided into the non-urinary catheter (non-UC) and urinary catheter (UC) groups according to whether an indwelling catheter was used after surgery. FUS-ICP was performed under general anesthesia in both groups. In the non-UC group, a 14Fr disposable urinary catheter was removed immediately after thoroughemptying the bladder. After the patients were awakened from anesthesia, patients in the non-UC group were instructed to use physical stimulation methods (hot compressing the bladder area, listening to the sound of running water, etc.) to achieve self-urination for patients who had difficulty to void; patients were instructed to get out of bed to urinate and pay attention to prevent accidents such as falls. In the UC group, a 14Fr disposable urinary catheter was placed and fixed to an urine bag after the operation, which was subsequently removed 1–2 days after the operation.

The training staff recorded the observation indicators according to the scoring criteria and compared them between the two groups of patients. ①The signs of catheter -related bladder irritation include suprapubic

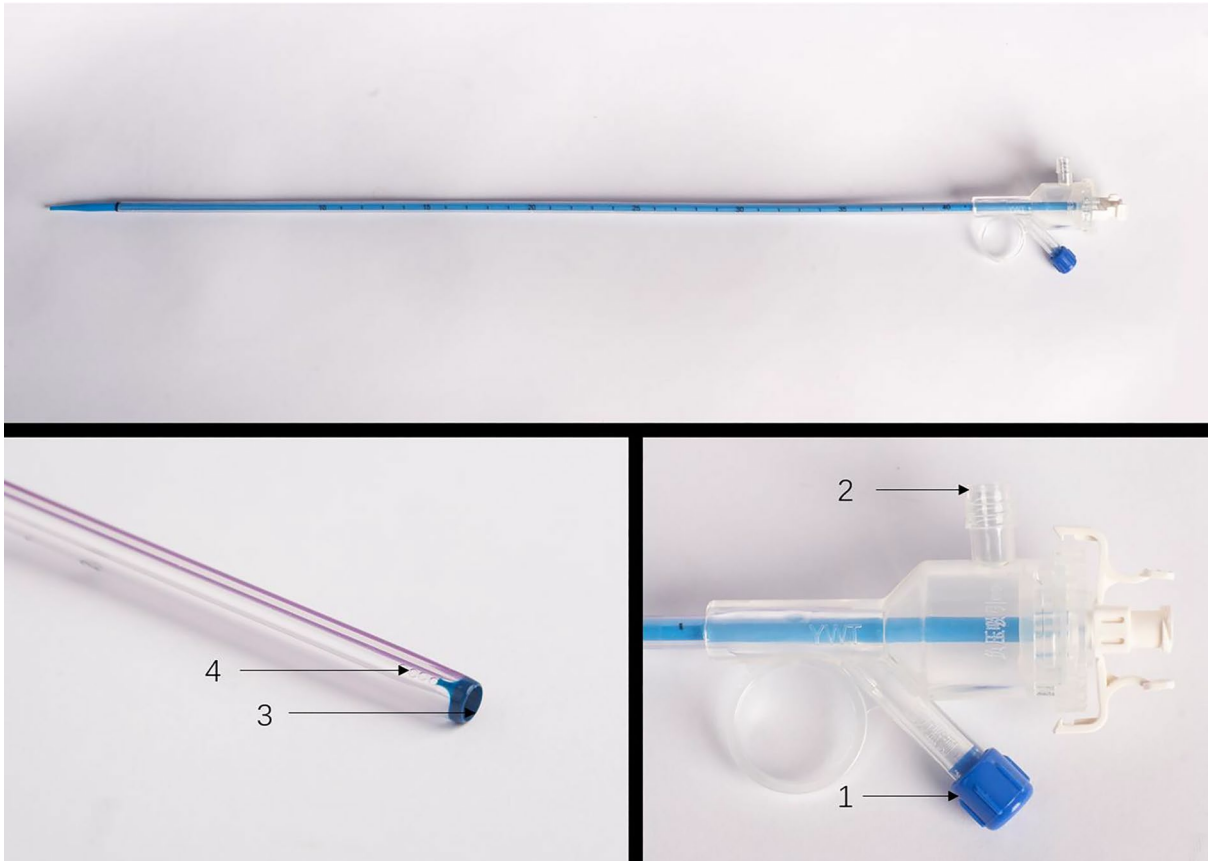

Fig. 1 UAS 1 pressure channel, 2 suctioning channel, 3 working channel, and 4, pressure measuring hole

Fig. 2 Platform_

Table 1 Scoring criteria of catheter-related bladder irritation

Score	Term
1	No complaints
2	Tolerable mild discomfort
3	Moderate discomfort without behavioral reaction
4	Severe discomfort accompanied by behavioral reactions such as fidgeting limbs and scratching

discomfort, burning, urgency, and pain, which can lead to agitation in severe cases. The occurrence of urinary catheter-related bladder irritation was assessed and recorded by nurses in the anesthesia and resuscitation rooms. The scoring criteria were showed at Table 1 [10].

②The Sedation-Agitation Scale (SAS; range 1–7, unarousable to dangerous agitation) was used to assess patients [11].③ pain refers to pain caused by irritation of the bladder wall, bladder trigone, or urethra by the urinary tube. Catheter related pain was evaluated using a numerical rating scale (NRS) [12].

Urination was scored as follows: (1) smooth urination; (2) induced urination: the patient has difficulty urinating and can discharge urine after induction; (3) urinary catheter reset: no urination and abdominal distension within 4–6 h after surgery were defined as urinary retention. In cases of urinary retention, a physical examination revealed swelling of the lower abdomen and a full bladder. Urination induction was ineffective, and an indwelling urinary catheter was required. Smooth and induced urination were defined as the absence of urinary retention. A UTI was diagnosed if there was 10^3 CFU/mL on culture in the setting of a positive urinalysis result at the first day after surgery.

Results

In total, 142 patients were included in the study. There were no significant differences in the preoperative general data between the two groups (Table 2). Patients in the non-UC group significant improvements compared to those in the UC group in terms of catheter-related bladder irritation, SAS and NRS scores ($P<0.05$). Postoperative hospital stay in the UC group was longer than that in the non-UC group ($P=0.731$). In the non-UC group, a lower rate of UTI was observed ($P=0.620$).Furthermore, the incidence of urinary retention and re-insertion urinary catheters in the UC group was lower than that in the non-UC group; however, the difference was not statistically significant ($P>0.05$).

Discussion

With the advancement of minimally invasive technology and the promotion of the ERAS concept, increasing evidence supports the expedient removal of catheters and the absence of indwelling urethral catheters after surgery [13, 14]. Due to problems such as high renal pelvic pressure and low lithotripsy efficiency, traditional ureteroscopy is prone to postoperative complications such as infection and bleeding. To facilitate observations of the urine volume and prevent high bladder pressure, urinary catheters are routinely placed after surgery, which results in urethral pain or urinary discomfort, burning sensation and confusion, limb shaking, and other restless behaviors during recovery from anesthesia. Agitation immediately after general anesthesia is common and can lead to serious adverse events, including injury, increased pain, bleeding, or catheterization [15]. Agitation during recovery from general anesthesia carries great safety risks, which may lead to inaccurate patient monitoring data, accidental extubation, accidental fall from the bed, surgical site bleeding, decreased patient satisfaction, prolonged hospital stay, and even secondary surgery [16]. A postoperative indwelling urinary catheter may be the cause of agitation after general anesthesia. Therefore, avoiding the use of postoperative indwelling urinary catheters may reduce the risk of agitation after general anesthesia. Furthermore, the longer the catheter retention time, especially>2 days, the greater the probability of patients developing catheter-associated UTIs [17, 18]. Early removal of unnecessary urinary catheters, either immediately or after 1–2 days, does not result in higher recatheterization rates, whereas immediate removal leads to earlier activity and a shorter hospital stay [13, 19, 20].

Table 2 General data and perioperative data of two groups of patients

Item	Non-UC group ($N=70$)	UC group ($N=72$)	*P* value
Age	42.6±8.2	43.6±9.3	0.716
BMI(kg/m^2)	22.3±3.2	21.8±2.4	0.424
Sex(Male)(n%)	26 (37.1%)	31(43.1%)	0.472
Diabetes	5 (7.1%)	4(5.6%)	0.743
History of urinary retention	3(4.3%)	6(8.3%)	0.494
Stone size (mm)	19.8±5.2	18.4±4.6	0.531
Operation time(min)	46.5±14.1	51.2±13.3	0.546
Postoperative hospital stay(d)	1.3±0.3	1.8±0.5	0.731
Urinary catheter-related bladder irritation	1.8±2.1	4.8±4.2	0.001
SAS	3.5±2.7	5.8±5.2	0.012
NRS	4.6±2.4	7.1±4.6	0.003
UTI	1(1.4%)	3(4.2%)	0.620
Urinary retention	6(8.6%)	4(5.6%)	0.529
Re–indwelling urinary catheter	4(5.7%)	2(2.8%)	0.438

FUS-ICP can be used to effectively monitor and control the intrapelvic pressure, resulting in large intraoperative flow, clear vision, continuous and rapid lithotripsy, and stone removal, shortening of the operation time and postoperative recovery time, great improvements in surgical safety and stone removal rate, and a reduction in postoperative complications, such as fluid absorption, vomiting, and lower back pain [8]. In this study, patients in the non-UC group showed better outcomes than those in the UC group in terms of postoperative hospital stay, catheter-related bladder irritation signs, SAS score, NRS score, and UTI. The differences were considered statistically significant. Furthermore, the incidence of urinary retention and re-retention was higher in the non-UC group than in the UC group; however, the difference was not statistically significant. In contrast to the traditional belief that non-indwelling catheters increase the risk of infection and urinary retention, non-indwelling catheters improved patient satisfaction with surgery. The length of hospital stay was shortened; ERAS programs have been reported to reduce the length of hospital stay by 30–50%, with a corresponding reduction in costs and complications [2]. Urinary catheter placement is a common area of dissatisfaction when assessing patient satisfaction with the surgical experience [10]. For many years, concerns have been raised regarding the safety and feasibility of not placing urinary catheters in urological patients; however, it is believed that patients undergoing flexible ureteroscopy without indwelling urinary catheters can avoid urinary catheter-related problems such as catheter-associated urinary tract infections and catheter-associated bladder discomfort.

This study has some limitations. First, this was a single-center, retrospective study with a small sample size. Second, there were no strict criteria to determine the non-placement of indwelling catheters, and the selection was mainly based on the preoperative wishes of the patients, which may have affected the conclusion. Therefore, in future, we will refine the indications for

non-indwelling urinary catheters and exclude factors that may affect the conclusion.

Conclusion

Non-indwelling urinary catheters are safe and feasible for patients undergoing FUS-ICP.

Abbreviations

FUS-ICP	Flexible ureteroscopy with intelligent control of renal pelvic pressure
UC	Urinary catheter
ERAS	Enhanced recovery after surgery
UTIs	Urinary tract infections
SAS	Sedation-Agitation Scale
NRS	Numerical rating scale

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Author contributions
DXL and SLM: design; HM and YBH: data acquisition; YBH and LXH：data analysis and interpretation; YBH and DXL: manuscript drafting and statistical analysis; HM and SLM: Critical revision. All the authors have read and approved the final version of this manuscript.

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Data availability
The datasets used or analyzed in the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
The study was approved by institutional ethics committee of Ganzhou People's Hospital(TY-HKY2021-012). All patients provided written informed consent.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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