Effect of preoperative ureteral stent on urinary tract infection and the outcomes of flexible ureteroscopic lithotripsy

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Abstract

Background: To investigate the effect of preoperative ureteral stent on preoperative antibiotic application and explored whether these stent aggravated the patient's urinary tract infection and increased the risk of postoperative urosepsis.

Method: All patients treated for urinary stones with flexible ureteroscopy interventions between January 2018 to September 2019 at our institution was enrolled to this study. The patient's baseline data, operative time, total length of hospital stay, duration of antibiotic use before surgery, days from admission to surgery, and perioperative laboratory results were recorded. The chi-square test was used to analyze categorical variables, and the independent sample Student's t test was used for numerical variables.

Result: A total of 469 patients were included in the analysis eventually. The positive rate of urine culture in the stent group was higher. The white blood cell (WBC) level within 1 hour after surgery in the stent group was significantly lower. The urinary leukocyte counts (ULC) at admission in patients in the stent group were significantly higher, as well as for the preoperative ULC. The serum albumin (ALB) level at admission and 1 hour after surgery of patients in the stent group was significantly lower than that in the non-stent group at admission. The total length of hospital stay of stent group was prolonged. The probability of postoperative urosepsis had no statistical difference.

Conclusion: The patient's urinary tract infections were aggravated by preoperative stent. Although the stent group had a higher probability of postoperative sepsis in 48 hours, yet there was no significant differences in the incidence of postoperative urosepsis between the two groups.

Background

Ureteral stents were fundamental to many urological procedures since they were created (1). While stents served many functions, including relief of renal obstruction, but they were most commonly used after diagnostic and therapeutic endoscopic procedures (2). Plenty of research had reported that stenting might be associated with higher postoperative morbidity (3,4), including flank pain/discomfort, urinary frequency and dysuria (5,6,7). Many researchers had also explored infection-related complications of ureteral stents (8,9). However, there was little literature report on the effect of preoperative ureteral stent placement for various reasons on the infection status, preoperative antibiotic application and surgical outcomes in patients with urolithiasis.

In this retrospective study, we investigated the effect of preoperative ureteral stent on preoperative antibiotic application and explored whether these stent aggravated the patient's urinary tract infection and increased the risk of postoperative urosepsis within 48 hours after the procedure.

Methods

Initially, 531 consecutive patients treated for unilateral urinary stones with flexible ureteroscopy interventions performed by single surgeon between January 2018 to September 2019 at the Urinary stone treatment center, Tianjin Medical University Second Hospital was enrolled to this study.

The main indications for placement of a ureteral stent were: a. mitigating complications caused by the obstruction of stones; b. following a ureterorenoscopy or percutaneous nephrolithotomy procedure. After placement of the ureteral stent, the patient was generally not given antibiotic treatment unless the patient had a feverish symptom during the stent implantation.

In order to avoid bias, we excluded patients with peroperative ureteral stents for urinary tract infections, and atients with urinary tract infections after ureteral stent placement were also excluded. After exclusion, 469 patients were included for this research eventually. Depending on whether the patient carried a ureteral stent before surgery, the patient was divided into a stent group (124 patients) and non-stent group (345 patients).

A physical examination, urinalysis, urine culture, blood count, and serum biochemical test were performed at the time of the initial admission.

If the patient's leukocytic cells in the urine at admission did not exceed normal values or is only slightly higher than normal, surgery would be performed on the second day after admission with empirical antibiotic 30 minutes before the surgery. In this situation, we would not exam the urinary leukocyte counts again, but treat the admission and preoperative urinary leukocyte counts as equal. Patients with positive urine culture results were treated with sensitive antibiotics based on drug susceptibility results until the urine culture results turned negative. While patients with negative urine culture results but elevated leukocytic cells in the urine were treated with empirical antibiotics until the urinary leukocyte counts dropped significantly or were lower the upper limit of normal.

Helium laser was used for lithotripsy.In order to provide a clear view, saline infusion was employed during the operation. According to the surgeon's judgment of the size of the ureteral lumen and the ureteral expansion ability of the patient, the diameter of the ureteral sheath were 12 / 14Fr or 11 / 13Fr. The duration of the entire operation was up to 90min, if there were too many residual stones, the patients would underwent stone removal operation again after 2-4 weeks to remove the residual stones. At the end of the procedure, the ureteral stent was left in the patient. If the patient does not show any significant signs of sepsis within24-48 hours after surgery, the patient was allowed to be discharged. If there were no special circumstances, the ureteral stent in the patient's body would be removed within 2-4 weeks after surgery.

The patient's baseline data, operative time, total length of hospital stay, duration of antibiotic use before surgery, days from admission to surgery, and perioperative laboratory results were recorded for further analysis. Baseline data included age, sex, body mass index, major comorbidities. Perioperative laboratory results included urine culture results, white blood cell (WBC) level at admission, WBC level within 1 hour after surgery, urinary leukocyte counts (ULC) under high power filed (HPF) at admission, ULC under HPF that was the most recent form surgery, serum albumin (Alb) level at admission and serum ALB level within 1 hour after surgery. The duration of antibiotic use before surgery included the surgical day, for the reason that antibiotics were still applied on that day before the procedure.

Definition

The end point of this research was urosepsis within 48 hours after the procedure. In this study, urosepsis was defifined as temperature >38 °C within 48 h of surgery, in addition to one or more of the following: heart rate >90 beats/min, respiratory rate >12 breaths/min or arterial carbon dioxide pressure count >12 000/mm^3 or □4000/mm^3, which was proposed by the International Sepsis Defifinitions Conference of 2001.

Statistical analysis

SPSS ver. 18 software (IBM Corp., Armonk, NY, USA) was used for the statistical analysis. Numerical data are expressed as mean ± standard deviation, and categorical data are indicated as numbers and percentages. The chi-square test was used to analyze categorical variables, and the independent sample Student's t test was used for numerical variables. A P-value of □0.05 was considered statistically significant. All statistical analyses were two-sided.

Result

As shown in Table 1, there were no significant differences in age (53.9±12.0 years vs 52±12.1 years, p=0.138), gender (75 male vs 216 male, p=0.746), BMI (26.7±4.0 vs 26.6±4.0, p=0.948), hypertension (54 vs 147, p=0.916) and diabetes mellitus (31 vs 67, p=0.199) between the two groups. There was no significant difference in the operation time between the two groups of patients (46.10±17.10 min vs 46.86±16.90 min, p=0.055).

Table 2 shows the comparison results of laboratory test between the two groups of patients. The positive rate of urine culture in the stent group was 25%, which was much higher than that (14.8%) in the non-stent group (p=0.013).

Although the preoperative WBC level of the stent group was lower than that of the non-stent group (6.71±1.81*10^9/L vs 6.96±1.92*10^9/L), there were no significant differences in preoperative WBC levels between the two groups (p=0.195), but in terms of the WBC level within 1 hour after surgery, the stent group (6.39±1.90*10^9/L) was significantly lower than the non-stent group(7.23±3.57*10^9/L, p=0.013).

In addition, the ULC at admission in patients in the stent group (139.7±368.4 /HPF) were significantly higher than those in the non-stent group (18.8±109.6 /HPF, p□0.001), as well as for the preoperative ULC in the stent group (45.0±80.1 /HPF) and the non-stent group (8.6±29.1 /HPF, p□0.001).

The serum ALB level of patients in the stent group (41.1±4.1 g/L) was significantly lower than that in the non-stent group (43.0±3.6 g/L) at admission (p□0.001). For serum ALB levels within 1 hour after surgery, patients in the stent group (35.9±3.9 g/L) were also significantly lower than patients in the non-stent group (37.4±4.8 g/L, p=0.002).

The preoperative antibiotic use days, days from admission to surgery and total days of hospital stays in stent group were 3.4±1.8, 2.9±1.8 and 5.6±2.5, respectively. While these parameters for the non-stent group were 2.3±1.7 (p<0.001), 2.5±1.5 (p=0.023), and 5.0±1.8 (p=0.025), respectively. As for the incidence of postoperative urosepsis, there was no significant difference between the two group (p=0.202). These information was summarized in Table 3.

Discussion

In this study, we compared the effect of preoperative ureteral stent on the infection status and surgical outcomes of patients undergoing flexible ureteroscopy interventions.

According to our analysis, there were no significant difference in each demographic data item between the two groups, this comparison could rule out the interference of demographic differences on the results of the study. Longer duration of the ureteroscopic procedure resulted increased incidence of postoperative complications (10), so we strictly control the operation time below 90 minutes. We found that there was no significant difference in the operative time between the two groups of patients.

It was generally believed that urine culture results can reflect the patient's urinary tract infections. For patients with positive urine culture results, clinicians should apply a full range of sensitive antibiotics based on drug susceptibility results (11).

Among the patients enrolled in our study, the positive rate of urine culture in the stent group was higher than that in the non-stent group (p=0.013). This result suggested that the urinary infection in the stent group was more severe than the non-stent group.

Interestingly, however, some researchers believed that the results of urine culture did not accurately reflect the bacterial colonization of the ureteral stent and a negative culture did not rule out a colonized stent (12,13), which further strengthened the connection between ureteral stent and urinary tract infections. In the research reported by Kehinde, E. O, of the 104 patients with positive stent cultures, in 62 patients (60%), urine culture was sterile (14).

Another test that can visually reflect the urinary tract infection in patients was urinary leukocyte count (ULC). In the patient population of this study, patients in the stent group received routine oral antibiotics after placement of the ureteral stent, yet their ULC at admission was higher than the non-stent group. It was unclear whether the cause of this phenomenon was that oral empiric antibiotics were ineffective or that the infection in the stent group was still heavier than the non-stent group after oral antibiotics did take effect.

Furthermore, even though receiving longer intravenous antibiotic treatment before surgery, and the ULC had a certain degree of decline in both group, the ULC of the stent group was still significantly higher than that of the non-stent group. The comparison of these two indicators prompted that the antibiotic dosage and duration of use in the stent group were much higher than those in the non-stent group. However, the treatment effect of antibiotic therapy on urinary tract infection associated with ureteral stent was not satisfactory.

Albumin was considered as a negative acute phase protein and nutritional marker. Earlier researchers have reported that preoperative hypoalbuminemia/malnutrition was one of the unfavorable factors leading to postoperative complications, including infection-related complications (15,16). Gong J, et al. pointed out that there might be a correlation between albumin and inflammatory response, because they found a correlation between postoperative serum albumin levels and postoperative CRP levels, and lower albumin levels suggested a more severe inflammatory response (17). For patients in the stent group, their ALB levels at admission and ALB levels within 1 hour after surgery were both significantly lower than those in the non-stent group. This result indirectly demonstrated that patients in the stent group had a greater infection status preoperatively and postoperatively than the non-stent group and had a higher risk of postoperative infection complications.

At the initial stage of severe infection, a decrease in WBC levels was a characteristic feature (18,19). It was well known that WBC reduction (WBC $<4.0*10^9$/L) was included in the diagnostic criteria of SIRS and sepsis, since the decline in blood leukocyte levels was closely related to infection. Although there was no statistically significant difference, the WBC level at admission was still lower in the stent group ($6.71\pm1.81*10^9$/L vs $6.96\pm1.92*10^9$/L). The WBC difference in the two groups after surgery was very obvious. Compared with the preoperative level, the WBC level in 1 hour after surgery of the stent group decreased ($6.71\pm1.81*10^9$/L to $6.39\pm1.92*10^9$/L), while this indicator in non-stent group increased ($6.96\pm1.81*10^9$/L to $7.23\pm1.92*10^9$/L). This significant difference further suggested that preoperative ureteral stents could aggravate perioperative urinary tract infections in patients.

Current mainstream theory considered that the mechanism leading to ureteral stent-associated infection was bacterial colonization and the formation of biofilm. Bacteria were capable of interacting and adhering to the stent surface, besides, they could express adhesins that could help form the biofilm (20). Thereafter, once the biofilm was formed, the phenotype and behavior of bacteria would change a lot, which caused the process of treating chronic bacterial infection was fraught with difficulties (21).

The total days of hospital stays and days from admission to surgery of the stent group were significantly prolonged due to the use of intravenous antibiotics for a longer period of time prior to surgery. Correspondingly, this would increase the financial burden and mental stress of the patient in a single hospitalization. However, considering the passive dilation of the ureteral stent could increase the ureterorenoscopy access success rates, preoperative stenting might reduce the total cost for ureterorenoscopy. (22)

In the final outcome comparison, although the incidence of postoperative urosepsis was higher in the stent group than in the non-stent group, this difference was not statistically significant. The main cause of this phenomenon might be the longer-term intravenous antibiotic use and the use of oral antibiotics during the stent retention for the stent group. Another important reason was that the passive expansion effect of the ureteral stent could reduce the pressure of the renal pelvis during surgery, and high renal pelvic pressure was an considerable factor leading to postoperative infection (23). Although preoperative stents did not significantly increase the probability of postoperative urosepsis, further research on how to reduce stent-related urinary tract infections was still imminent, as it related to the quality of life of patients carrying stent.

There were still some shortcomings in this research. In the first place, this study was a single-center retrospective study with a relatively small sample size. Besides, we did not pay attention to the impact of the duration of carrying the stent and the length of surgery and on the occurrence of postoperative urosepsis. Finally, large-scale prospective studies and basic research were needed to confirm our findings.

Conclusion

Our results suggested that even with adequate, full-course antibiotics therapy during preoperative ureteral stent retention, the patient's urinary tract infections were still aggravated by preoperative stent. The specific performance were that compared to the non-stent group, the patients in stent group had higher positive rate of urine culture, preoperative urine leukocyte level increased more, the postoperative blood leukocyte level reduced more, and the patient's preoperative antibiotic time was also prolonged. In addition, the patient's preoperative serum albumin level and serum albumin level 1 hour after surgery were also lower. In the end, the total length of hospital stay was extended accordingly.

There was no significant differences in the incidence of postoperative urosepsis between the two groups, but it was worth noting that the incidence of postoperative urosepsis of patients in the stent group (8.9%) was still higher than that of the non-stent group (5.5%).

Declarations

Author's Contribution

JH collected and analyzed interpreted the patient data, and was a major contributor in writing the manuscript. HX interpreted data analysis results, and help edit the manuscript. CL came up with the work and revised the manuscript.

Ethics approval and consent to participate

The study was approved by the Ethics Committee of the Second Hospital of Tianjin Medical University. This clinical study was a retrospective study. We only collected the patient's clinical data, did not interfere with the patient's treatment plan, and did not pose risks to the patient's physiology, therefore, we only asked the patients for verbal consent, which was approved by the Ethics Committee of the Second Hospital of Tianjin Medical University.

Consent for publication：

Not applicable.

Availability of data and materials：

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

Competing interests：

The authors declare that they have no competing interests.

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Abbreviations

BMI: body mass index; WBC: White blood cell count; ULC: urinary leukocyte counts; HPF:high power filed; Alb: albumin

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Tables

Table 1. Demographic and intraoperative data for the patient with preoperative ureteral stent or not

Parameters	Preoperative ureteral stent		p value
	Yes(124)	No(345)	
Age (year)	53.9±12.0	52±12.1	0.138
Gender,n (%)			0.746
Male	75（60.5%）	216（62.6%）	
Female	49（39.5%）	129（37.4%）	
BMI (kg/m^2)	26.7±4.0	26.6±4.0	0.948
Comorbidities, n (%)			
Hypertension	54（43.5%）	147（42.6%）	0.916
Diabetes mellitus	31（25.0%）	67（19.4%）	0.199
Operative time (min)	46.10±17.10	46.86±16.90	0.055

BMI body mass index; p values were calculated by chi-square test and Student's t test; * p value < 0.05

Table 2. Laboratory test results for the patient with preoperative ureteral stent or not

Parameters	Preoperative ureteral stent		p value
	Yes(124)	No(345)	
Urine culture			0.013*
Positive	31（25.0%）	51（14.8%）	
Negative	93（75.0%）	294（85.2%）	
WBC level at admission（*10^9/L）	6.71±1.81	6.96±1.92	0.195
WBC level within 1hour after surgery（*10^9/L）	6.39±1.90	7.23±3.57	0.013*
ULC at admission（/HPF）	139.7±368.4	18.8±109.6	＜0.001*
The most recent ULC result form surgery（/HPF）	45.0±80.1	8.6±29.1	＜0.001*
Alb level at admission（g/L）	41.1±4.1	43.0±3.6	＜0.001*
Alb level within 1hour after surgery（g/L）	35.9±3.9	37.4±4.8	0.002*

p values were calculated by chi-square test and Student's t test; * p value < 0.05

Table 3. Related variables and outcomes during hospitalization for the patient with preoperative ureteral stent or not

Parameters	Preoperative ureteral stent		p value
	Yes(124)	No(345)	
Preoperative antibiotic use days	3.4±1.8	2.3±1.7	<0.001*
Total days of hospital stays	5.6±2.5	5.0±1.8	0.025*
Days from admission to surgery	2.9±1.8	2.5±1.5	0.023*
Postoperative urosepsis with 48 hours			0.202
Yes	11 (8.9%)	19 (5.5%)	
No	113 (91.1%)	326 (94.5%)	

p values were calculated by chi-square test and Student's t test; * p value < 0.05