Ureteral Stent Removal Using an Extraction String After Uncomplicated Ureteroscopy: A Cost-Benefit Analysis

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Purpose: Some urologists use the extraction strings for removal of ureteral stent without cystoscopy. While some urologists may have concern about perceived risks, including accidental dislodgement, infection, renal colic and lower urinary tract symptoms. Therefore, we performed a retrospective study to help resolve this conflict.

Materials and Methods: Patients who had an indwelling ureteral stent with (n = 58) or without (n = 82) extraction strings inserted after ureteroscopy for unilateral ureteral stone were enrolled. For ureteral stent removal, the strings were pulled by physician, no string-stents were removed by cystoscopy. Postoperative morbidity was assessed. Patients' medical expense due to postoperative morbidity was gathered.

Results: Patients with extraction string had shorter stent dwell time (5.3 ± 1.8 versus 11.2 ± 3.2 days, $P = .001$) and less costly (8.97 ± 3.07 versus 455 ± 0 CNY, $P = .001$)) for ureteral stent removal. However, six patients with extraction string had an accidental dislodgement, additional medical expenses were 345±137.9 CNY. There was no difference in the cost due to urinary tract infection, renal colic and LUTS between the two groups. The overall cost of patients without an extraction string was significantly more than in patients with an extraction string (86.7 ± 167.7 versus 507.9 ± 147.8 CNY, $p = .008$).

Conclusion: Despite an increase in stent dislodgement related risks to the extraction string, it results in significant cost savings for patients, and the most patients remove with extraction strings might benefit from it.

Keywords: ureteral stent; cost-benefit analysis; extraction string

INTRODUCTION

Nowadays, most of the urologists placed an indwelling ureteral stent following uncomplicated ureteroscopy(URS). However, ureteral stent may impact quality of life (QoL) of patients. And additional suffering due to cystoscopic extraction is even more painful. Current ureteral stents are manufactured with a string attached to the distal end, allowing for removal without cystoscopy, which may lead to a reduction of the dwell time(usually less than one week)[1-8]. Although stent extraction strings have many advantages, more than two-thirds of urologists remove extraction strings prior to their insertion[9]. Surgeons who do not adopt this method may have concern about perceived risks, including accidental dislodgement, infection, renal colic and lower urinary tract symptoms(LUTS). But how about incidence rate of the risk aforementioned? Does this increase the patient's financial burden compared with patients remove without extraction strings? Whether patients remove with extraction strings might benefit from it? Therefore, we performed a retrospective study to help address these questions by comparing patients those who underwent ureteric stent placement with and without extraction strings after URS for stone disease.

PATIENTS AND METHODS

Study population

This study was approved by the Ethics Review Board of The Second Affiliated Hospital of Zhejiang University School of Medicine. Inclusion criteria were patients who had an indwelling ureteral stent with or without extraction strings inserted after URS for unilateral ureteral stones. Patients with congenital anomaly of the urinary tract, solitary kidney, renal insufficiency, ureteral stricture, pregnant, underwent bilateral URS or requiring long-term stent placement (>7 days) were excluded[2,4]. In total, 140 patients at our institution between January 2017 and September 2017 were enrolled.

Study design and surgical technique

All stents were 6F soft ureteric stents from Cook Medical(Bloomington, IN, USA) and the lengths were determined based on patient height. Before placed stents with extraction strings, as described by Bockholt et al[7] and kim et al[2], the string was cut at the level of the knot and tied with a new air knot 1-2 cm from the stent end, the distal end of the string were left 4cm protruded from the urethral meatus for women to easily find the string, and 10cm for men to have an erection. The stent string was not secured to the patient's skin.

All patients were discharged on the first day after sur-

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Table 1. Patient Characteristics

vareable	patients with extraction string(n=58)	patients without extraction string(n=82)
Mean age(years)	45.4 ± 14.8	47.1 ± 15.9
Gender		
Male(n)	30	46
Female(n)	28	36
Side		
right(n)	31	27
left(n)	45	37
Localization		
upper(n)	18	28
middle(n)	20	24
lower(n)	20	30
Mean operative duration(min)	49.2 ± 15.8	45.5 ± 20.1
Mean stent dwell time(day)	5.3 ± 1.8 #	11.2 ± 3.2
Mean cost for stent removal(CNY)	8.97 ± 3.07 #	455 ± 0

#$P < 0.001$, vs without extraction string group.

gery with prescriptions for prophylactic antibiotics and alpha-blockers, and patients were informed that the stents should be removed within one week at the outpatient department. For ureteral stent removal, the string was pulled by continuous and gentle force until the entire stent was out, without use of lidocaine jelly or an analgesic. No string-stents were removed by cystoscopic in which 2% lidocaine jelly was applied to the urethra without any analgesic.

Outcome assessment

Demographic and patient characteristics were gathered, including gender and age. Other variables included were side, localization of calculus, operative duration, stent dwell time, use of extraction string and the cost for stent remove. Postoperative morbidity including accidental dislodgement, infection, renal colic and LUTS was assessed by review of the medical record for the first three months after URS. Dislodgment was identified as the stent leaving the body whether or not intended before prescribed follow up. The urinary tract infection(UTI) was defined according to urinalysis of the laboratory department, The Second Affiliated Hospital of Zhejiang University School of Medicine. And UTI was considered as surgical site infection (SSI) if they occurred within one month after stent placement or stent removes[1].We also record the patients' medical expense when they visited the outpatient or emergency department due to postoperative morbidity.

SPSS version 19.0 was used for statistical analysis. Numeric data are presented as the mean ± standard deviation and categorical data as counts and percentages. Numerical data were compared using Student's t-test. Categorical data were analyzed using the χ^2 test. Statistical significance was set at $P < 0.05$.

RESULTS

A total of 140 patients were identified with this analysis. Of these 140, 58 patients (41.4%) had an extraction string, including 28 females and 30 males. An overview of demographic and patient characteristics is shown in **Table 1.** There were no differences between patients with or without a string in regard to age, gender, side, localization of calculus or operative duration. In general, patients with extraction string had shorter stent dwell time(5.3 ± 1.8 versus 11.2 ± 3.2 days, $P = .001$) and cost less for ureteral stent removal(8.97 ± 3.07 versus 455 ± 0 CNY, $P = .001$).

6 cases (1 male, 5 females) had an accidental dislodgement representing 10.3% of cases with extraction string and 4.3% of all cases. No dislodgment occurred when extraction string was not used. The stent was dislodged in 3 patients at the inpatient department on postoperative day 1 when the catheter was removed. 3 patients presented to the emergency or outpatient department for accidentally pulled the stent out at home on 1–4 days postoperatively. No patients complained about discomfort except one patient who presented to the emergency department for hematuria. None of these patients required replacement. Additional medical expenses including imaging test, laboratory examination

Table 2. Medical expenses due to complication

Complication	patients with extraction string(n=58)	patients without extraction string(n=82)
Dislodgement		
number(n)	6	0
mean cost(CNY)	345 ± 137.9 #	0 ± 0
UTI		
number(n)	3	4
mean cost(CNY)	340.3 ± 76.7	387.5 ± 101.6
Renal colic		
number(n)	3	6
mean cost(CNY)	519.7 ± 56.1	516.3 ± 55.5
LUTS		
number(n)	5	6
mean cost(CNY)	75.6 ± 78.9	76.2 ± 70.1

#$P < 0.05$, vs without extraction string group.

Table 3. Overall cost

	patients with extraction string(n=58)	patients without extraction string(n=82)
Mean Overall cost(CNY)	86.7 ± 167.7 #	507.9 ± 147.8

#$P < 0.001$, vs without extraction string group.

and registration fee due to accidental dislodgement are shown in **Table 2**. Expenses for patients with an extraction string were significantly more than in patients without an extraction string (345 ± 137.9 versus 0 ± 0 CNY).

7 patients had a post-operative UTI, including 5.2% and 4.9% of patients with and without extraction string, respectively. Most of these patients presented to the emergency department for odynuria and take oral antibiotics for 3-5 days until urinalysis negative. One patient had a febrile UTI (>38.0℃) and was administered antibiotics intravenously for 3-7 days until urinalysis negative. Medical expenses including laboratory examination, medicines and registration fee are shown in Table2. There was no difference in cost due to UTI between the two groups(340.3 ± 76.7 versus 387.5 ± 101.6 CNY, $P = .093$).

There was no significant difference in the rate of renal colic and LUTS between the group of patients with and without an extraction string (5.2% versus. 7.3%, $P = .082$, 8.6% versus. 7.3%, $P = .078$). All patients who had a renal colic were treated with anticonvulsants and/or analgesic. Whether prescribe anticholinergic agents to the patients with LUTS depended on the physician's judgment. There was no difference in the cost due to renal colic and LUTS between the two groups(519.7 ± 56.1 versus 516.3±55.5 CNY, $P = .103$, 75.6 ± 78.9 versus 76.2 ± 70.1 CNY, $P = .098$, **Table 2**). The median overall cost was 86.7±167.7 CNY for patients with extraction string and 507.9±147.8 CNY for patients without extraction string. The cost of patients without an extraction string was significantly more than in patients with an extraction string ($p = .008$). **Table 3**.

DISCUSSION

Although some reports indicate that placement of an indwelling ureteral stent following uncomplicated ureteroscopy(URS) may be unnecessary[10,11], over three-quarters of urologists report stenting after uncomplicated URS for stone disease[12]. The main benefit are the prevention of ureteral obstruction, renal colic and facilitation of residual stone fragment passage[5,10,13]. However, cystoscopic extraction is time-consuming and laborious, more importantly, it augments the pain of the patients, especially for men. Therefore, some urologists used extraction strings to remove stent without cystoscopy, which may lead to a reduction of the dwell time as well as morbidity associated with cystoscopic extraction. But most of the urologists remove extraction strings prior to their insertion[6,14].They may have concern about perceived risks, including accidental dislodgement, infection, renal colic and LUTS. In our study, we did not observe an increased rate of post-operative infection, renal colic and LUTS in patients with an extraction string. Our study also reveals that 10.3% of patients with strings had an accidental dislodgement and most of these patients were women, presumably due to female hygiene practices and urethral anatomy. The cost of stent removal by cystoscopy is 455 CNY in our center, mainly for equipment maintenance, instrument sterilization, medical consumables and personnel salary. By contrast, patients with extraction strings only need to pull the strings until the entire stent was out by their physicians at the outpatient service. Therefore, the cost of stent removal in patients with strings was significantly reduced compared with patients without strings. This conclusion has also been confirmed by studies from different countries. Bockholt et al[7]. found that an estimated $1300 per patient cost associated with cystoscopic stent removal, which would be avoided by using strings. Barnes et al[4]. reported that stent removed by cystoscopy cost $243.43, and it would have resulted in about $97000 cost savings in their study population if all patients had an extraction string placed. Beyond that, when patients could remove stents at home by themselves, it also reduces costs associated with patients travel and registration. They estimated a $68–185 saving per patient on travel costs if patients removed their stents at home. In our study, all extraction strings were pulled by urologists, so we do not count the costs associated with patient travel.

Some studies have reported that the main complication associated with the use of stent extraction strings was stent dislodgement. These data were supported by our study, which was reported 6 cases of stent dislodgement occurring in patients with extraction strings. Most patients do not feel uncomfortable when they had dislodgement. The physician will evaluate the condition through the computed tomography or plain film of the abdomen and urinalysis. Althaus et al[6]. reported 13 cases with dislodgement, none of these patients required replacement. No patients need intervention except one patient who submitted to the emergency department for flank pain and intravenous pain medication was prescribed. In our study, all 6 patients with dislodgement do not need replacement, and fortunately, don't need medication. The additional medical expenses due to accidental dislodgement were imaging test, laboratory examination and registration fee. The average cost was 345 ± 137.9 CHY.

Some urologists concern for postoperative UTI caused by stent extraction strings. Based on our study, this concern may be unfounded as we were incapable to find a difference in postoperative UTI rate between patients with and without extraction strings. Furthermore, there was no difference in the rate of renal colic and LUTS between groups. Our data are in line with previous studies performed by Fröhlich et al[1]. and Barnes et al[4]. Moreover, the extraction string did not increase the severity of these complications, for example, no difference was noticed when stratifying for febrile UTI or urosepsis. Therefore□there was no difference in the cost due to UTI, renal colic and LUTS between the two groups

Overall, patients with extraction string cost less for ureteral stent removal, but they have the potential to pay additional medical expenses caused by stent dislodgement. More importantly, the mean overall cost of patients with an extraction string was much lower than in patients without an extraction string. Most of the patients remove with extraction strings might benefit from it. While the present results are supportive evidence for the use of ureteral extraction strings, this should be considered in clinical decision making and patient counseling.

In fact this study has several limitations: First of all, it is possible that few patients did not present at our center when postoperative complications occurred, and this part of the data was not collected in our study. Secondly, we did not collect the costs associated with patient travel and time taken off work. These data may be gathered in future studies.

CONCLUSIONS

Despite an increase in stent dislodgement related to the extraction string, it results significant cost savings for patients and the healthcare system, and the most patients remove with extraction strings might benefit from it. However, this must be considered in clinical decision making and patient counseling, and might not be a good option for all patients.

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CONFLICT OF INTEREST

The authors report no conflict of interest.

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