Central European Journal of Urology

ORIGINAL PAPER

UROLITHIASIS

A ureteral stent crossing the bladder midline leads to worse urinary symptoms

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Citation: Taguchi M, Yoshida K, Sugi M, Matsuda T, Kinoshita H. A ureteral stent crossing the bladder midline leads to worsening of urinary symptoms. Cent European J Urol. 2017; 70: 412-417.

Article history
Submitted: Aug. 6, 2017
Accepted: Oct. 29, 2017
Published online: Nov. 7, 2017

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Introduction To investigate the correlation between the position of a ureteral stent and stent-related symptoms, excluding the influence of ureteroscopic maneuvers.

Material and methods From January 2016 to December 2016, we analyzed 130 patients who placed a ureteral stent before ureteroscopic lithotripsy (URSL). A total of 108 patients were enrolled, including 77 (71.3%) men and 31 (28.7%) women, and the mean age was 58.9 ±14.3 years. On the day before URSL, plain radiography (kidney, ureter, bladder X-ray [KUB]) was used to confirm the stone location and ureteral stent position. According to KUB, we defined the crossing midline group as when the distal loop of the ureteral stent was crossing the bladder midline, and the not crossing midline group as when the distal loop of the ureteral stent was not crossing the bladder midline. We assessed urinary symptoms of the two groups using the overactive bladder symptom score (OABSS) on the day before URSL.

Results The crossing midline group had a worse total OABSS ($p < 0.001$) and worse scores for each item of daytime frequency ($p = 0.047$), nocturia ($p < 0.001$), urgency ($p = 0.002$), and urgency incontinence ($p = 0.045$) than did the not crossing group. In multivariate analysis, stent position had the strongest association with the total OABSS ($p = 0.002$) among the other factors of age, sex, body mass index, stent side, stent diameter, stent length and stent indwelling time.

Conclusions This study shows that a ureteral stent crossing the bladder midline leads to worse urinary symptoms. Choosing the appropriate stent length for each patient is important for improving stent-related symptoms.

Key Words: stents ‹› ureteroscopy ‹› urinary symptom ‹› urolithiasis

INTRODUCTION

Since Zimskind et al. [1] introduced ureteral stents in 1967, they have become widely used for maintenance of renal function, pain relief, and treatment of urinary tract infections. However, many complications of ureteral stenting have been reported, such as incomplete emptying, bladder pain, frequency, hematuria, and migration. Ureteral stenting has been reported to cause a decline in urination-related quality of life (QOL) in 80% of patients who have undergone ureteral stenting [2]. Several factors have been investigated for their effects on ureteral stent symptoms, including stent length [3, 4], diameter [5, 6, 7], material [7], softness [8], position [9], and loop completeness [3].

Some studies have reported that placement of overly long ureteral stents that cross the bladder midline can lead to worsening of urinary symptoms [3, 10, 11]. The position of a ureteral stent appears to be an important factor in stent-related surgery. However, there is conflicting evidence on this issue. Abt et al. investigated the correlation between the position of a ureteral stent and stent-related symptoms using the ureteral stent symptom uestionnaire (USSQ) in 73 patients who underwent ureteroscopic lithotripsy (URSL) [12]. They discussed that depending on the configuration of the bladder neck

doi: 10.5173/ceju.2017.1533

and intramural ureter, distal stent loops with an apparent initial ideal length may interfere more with the bladder neck. They concluded that the position of ureteral stents was not associated with morbidity [12]. Therefore, the association between the position of ureteral stents and stent-related symptoms remains unclear. Kourambas et al. reported that using a ureteral access sheath or ureteral balloon dilation increased postoperative symptoms [13]. Damage of the urinary tract from operative maneuvers might cause worse urinary symptoms. All previous reports evaluated patients including post-URSL, however ureteral stent-related symptoms excluding the influence of URSL need to be investigated.

The reason for the controversy regarding the association between the position of ureteral stents and stent- related symptoms could be because of a strong effect of URSL in previous reports. Therefore, to exclude the effect of ureteric damage from operative maneuvers, this study aimed to investigate the associations between the position of a ureteral stent and stent-related symptoms in patients who had a ureteral stent placed before URSL.

MATERIAL AND METHODS

This study was approved by our institutional review board. A retrospective review of prospectively collected data was performed. From January 2016 to December 2016, 130 patients in whom a ureteral stent was placed before URSL, were enrolled. On the day before the operation (URSL), a questionnaire was provided to every patient to assess urinary symptoms. A total of 108 patients were analyzed. Twenty-two patients were excluded from the study because of bilateral ureteral stent insertion, vaginal vault eversion beyond the introitus, benign prostatic hyperplasia, chronic prostatitis, prostate carcinoma, overactive bladder, urinary incontinence, and concomitant medication with alpha-blockers, anticholinergics, analgesics and other drugs, which might interfere with lower urinary tract function.

We inserted a double-pigtail ureteral stent using flexible cystoscopy to decrease the possibility of causing urinary symptoms, as based on previous reports [14, 15]. All stents were Inlay Optima (C.R. Bard Inc., NJ, USA), and the diameter (6 or 4.7 Fr) and length (24 or 26 cm) were chosen according to the surgeon's discretion. On the day before the operation, plain radiography (kidney, ureter, bladder X-ray: [KUB]) was performed for all of the patients to confirm the stone location and ureteral stent position. Filming conditions of KUB were standardized at maximum inspiration and the supine position. According to the KUB, we reviewed the position of the

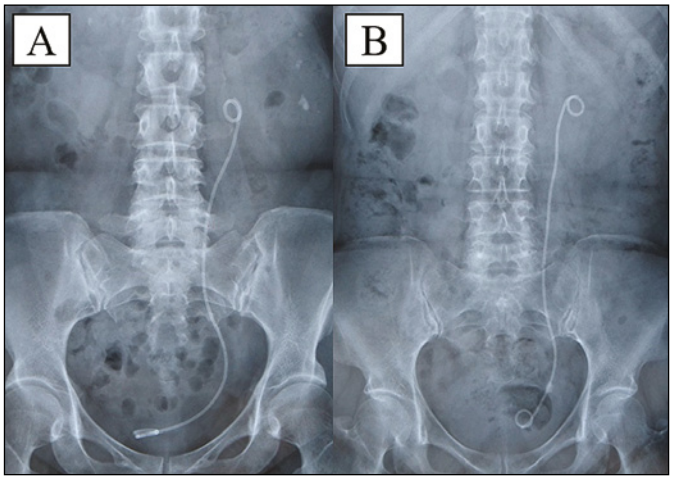

Figure 1. *Classification of the intravesical ureteral stent position. (A) Crossing the midline. (B) Not crossing the midline.*

Table 1. *Characteristics of the patients and comparison between the two groups*

	All	Crossing midline group	Not crossing midline group	p value
	n (%) or mean ±SD	n (%) or mean ±SD	n (%) or mean ±SD	
Patients	108	51	57	
Age (years)	58.9 ±14.3	59.7 ±14.9	58.3 ±13.6	0.62
Sex				
Male	77 (71.3)	37 (72.5)	40 (70.2)	0.79
Female	31 (28.7)	14 (27.5)	17 (29.8)	
Body height (m)	1.62 ±0.08	1.62 +0.09	1.63 +0.08	0.56
Body weight (kg)	65.7 ±15.3	65.7 +14.9	65.7 +15.6	0.99
BMI (kg/m^2)	24.7 ±4.4	24.9 +4.3	24.4 +4.6	0.56
Stent side				
Left	57 (52.8)	30 (58.8)	27 (47.4)	0.23
Right	51 (47.2)	21 (41.2)	30 (52.6)	
Stent diameter (Fr)				
6	89 (82.4)	44 (86.3)	45 (78.9)	0.32
4.7	19 (17.6)	7 (13.7)	12 (21.1)	
Stent length (cm)				
24	69 (63.9)	29 (56.9)	40 (70.2)	0.15
26	39 (36.1)	22 (43.1)	17 (29.8)	
Stent indwelling time (day)	18.9 +15.9	19.5 +15.8	18.4 +15.9	0.73
Stone size (mm)	10.4 ±5.6	10.1 ±5.6	10.8 ±5.5	0.51
Stone location				
Renal	43 (39.8)	15 (29.4)	28 (49.1)	
Proximal ureter	36 (33.3)	20 (39.2)	16 (28.1)	0.13
Mid ureter	11 (10.2)	5 (9.8)	6 (10.5)	
Distal ureter	18 (16.7)	11 (21.6)	7 (12.3)	

BMI – body mass index

distal loop of the ureteral stent by a single urologist. Using a report by Giannarini et al. [11] as a reference, we defined the crossing midline group as when the distal loop of the ureteral stent (Figure 1A) was crossing the bladder midline and the not crossing midline group as when the distal loop of the ureteral stent (Figure 1B) was not crossing the bladder midline. Further, we used the overactive bladder symptom score (OABSS) as a questionnaire to assess urinary symptoms. The USSQ is globally considered the gold standard for evaluating ureteral stent-related symptoms. However, there is no validated Japanese version of the USSQ. Therefore, in the present study, we evaluated ureteral stent-related symptoms with the OABSS. The OABSS questionnaire was developed and validated in Japanese populations in 2006 by Homma et al. [16]. This questionnaire assesses four urination-related symptoms of daytime frequency, nocturia, urgency, and urgency incontinence. The patients' backgrounds and scores in the OABSS were compared between the two groups using either the Mann–Whitney U-test or $\chi 2$ test. Furthermore, we investigated factors that affected ureteral stent- related symptoms using multivariate analysis. We used multiple linear regression to assess the associations between the total OABSS and predictive factors of ureteral stent-related symptoms (age, sex, body mass index [BMI], stent side, stent diameter, stent length, stent indwelling time, and stent position).
The IBM SPSS Statistics V21.0 software package was used for statistical analysis, and the significance level was set at $p < 0.05$.

Table 2. *Comparison of the OABSS between the two groups*

	Crossing midline group	Not crossing midline group	p value
	mean score ±SD	mean score ±SD	
Total score	5.9 ±3.6	3.4 ±3.1	<0.001
Daytime frequency	0.9 ±0.6	0.7 ±0.5	0.047
Nocturia	1.8 ±1.0	1.1 ±0.9	<0.001
Urgency	2.3 ±1.8	1.2 ±1.6	0.002
Urgency incontinence	0.9 ±1.5	0.4 ±0.9	0.045

BMI – body mass index

RESULTS

The demographic data of the patients in the two study groups were comparable in terms of age, sex, body height, body weight, BMI, stent laterality, stent diameter, stent length, stent indwelling time, stone size, and stone location (Table 1). There were no significant differences in the demographic data between the two groups.
Table 2 shows comparison of the OABSS between the crossing midline group and not crossing midline group. The crossing midline group had a worse total score ($p < 0.001$) and worse scores for each item of daytime frequency ($p = 0.047$), nocturia ($p < 0.001$), urgency ($p = 0.002$), and urgency incontinence ($p = 0.045$) than did the not crossing group.
Table 3 shows single linear and multiple linear regression analyses of the associations between the total OABSS and predictive factors of ureteral stent-related symptoms. In multiple analysis, age and stent position were significantly associated with the total OABSS ($p = 0.006$, $p = 0.002$, respectively). Location of the distal loop of the stent with respect to the midline had the strongest association with the total OABSS.

Table 3. *Univariate and multivariate analyses of the associations between the total OABSS and predictive factors of ureteral stent-related symptoms*

	Univariate analysis[a]			Multivariate analysis[b]		
	β	SE	p value	β	SE	p value
Age (years)	0.294	0.024	0.003	0.283	0.025	0.006
Sex (male vs. female)	0.094	0.811	0.762	0.112	0.843	0.276
BMI (kg/m^2)	-0.048	0.081	0.636	0.010	0.085	0.927
Stent side (left vs. right)	0.237	0.281	0.060	-0.001	0.674	0.993
Stent diameter (Fr) (6 vs. 4.7)	0.074	0.950	0.459	0.043	0.964	0.672
Stent length (cm) (24 vs. 26)	0.053	0.729	0.596	-0.013	0.766	0.902
Stent indwelling time (days)	0.031	0.022	0.761	-0.018	0.021	0.854
Stent position (crossing the midline vs. not crossing the midline)	0.350	0.667	<0.001	0.318	0.697	0.002

[a]Single linear regression, [b]multiple linear regression, SE – standard error, BMI – body mass index

DISCUSSION

In this study, we investigated stent-related symptoms, excluding the influence of URSL. We investigated urinary symptoms on the day before URSL in patients in whom a ureteral stent was placed preoperatively. We compared urinary symptoms between the crossing bladder midline group and the not crossing bladder midline group using the OABSS, and the crossing bladder midline group had significantly worse scores. To the best of our knowledge, no study has investigated the associations between the position of ureteral stents and stent-related symptoms, excluding the effect of URSL. Furthermore, we found that intravesical stent position had the strongest association with the total OABSS among the other factors of age, sex, BMI, stent side, stent diameter, stent length, stent indwelling time, and intravesical stent position in multivariate analysis.

Some studies have reported a correlation between the position of a ureteral stent and stent-related symptoms. Rane et al. reported that a ureteral stent that crosses the bladder midline causes significantly more frequency and urgency than stents that do not cross the bladder midline [3]. They prospectively investigated stent-related symptoms in 60 patients undergoing URSL using non-validated questionnaires, which were answered at 7 days after the operation [3]. Ho et al. discovered that ureteral stent length was associated with irritative symptoms, as well as the position of the distal loop of the stent [10]. They reported that an overlong ureteral stent caused a longer intravesical segment and more bladder symptoms, such as frequency and urgency. They evaluated stent-related symptoms in 87 patients undergoing URSL using non-validated questionnaires at 14 days after the operation [10]. Giannarini et al. reported that sex, BMI, stent diameter, and the position of the distal loop of the stent were associated with stent-related symptoms [11]. They evaluated stent-related symptoms in 84 patients with indwelling ureteric stents, including post-URSL, using the USSQ at 7 days after ureteral stent placement [11].

However, these reports evaluated urinary symptoms in the short term (1–2 weeks) after an URSL operation. Damage of the urinary tract from operative maneuvers might cause worse urinary symptoms. Kourambas et al. reported that postoperatively, symptoms became worse with a ureteral access sheath and ureteral balloon dilation on days 1 and 6 after URSL [13]. Therefore, stent related symptoms should be evaluated at least more than 1 or 2 weeks after URSL to exclude the effect of operative maneuvers.

Even results of evaluation of urinary symptoms at 1 month after the operation are controversial. Abt et al. reported that the position of the distal loop of the stent was not associated with morbidity [12]. They evaluated stent-related symptoms in 73 patients undergoing URSL using the USSQ. Patients were provided the USSQ on the day before stent removal and the median stent indwelling time was 30 days (range: 8–94 days) [12]. Giannarini et al. also reported that BMI and the position of the distal loop of the stent were associated with stent-related symptoms at 28 days [11]. Therefore, stent-related symptoms should be evaluated by excluding the influence of URSL.

In this study, we investigated urinary symptoms before URSL in patients who had a stent inserted preoperatively. We found that the total OABSS in the crossing midline group was worse, as well as each item of daytime frequency, nocturia, urgency, and urgency incontinence compared with the not crossing midline group. Therefore, we consider that choosing an appropriate ureteral stent length for each patient is important.

Giannarini et al. [11] and Abt et al. [12] evaluated stent-related symptoms using the USSQ. Although the USSQ is considered useful for evaluating ureteral stent-related symptoms and QOL after ureteral stent placement [17, 18, 19], there is no validated Japanese version. Therefore, we evaluated urination-related QOL using the OABSS in the present study. The OABSS is an assessment tool for overactive bladder symptoms. The OABSS was developed and validated in Japanese populations in 2006 by Homma et al. [16] Previous studies have shown that the OABSS shows a relatively close correlation with the patient's perception of the bladder condition and the overactive bladder questionnaire subscales of health-related QOL [20]. At present, the OABSS is only used in clinical practice [21–24].

In multivariate analysis in our study, age was also significantly associated with the OABSS. Some previous studies have reported an association between ureteral stent-related symptoms and age [11, 25–28]. Giannarini et al. reported that age was not significantly associated with ureteral stent-related symptoms [11, 25, 26]. However, Irani et al. reported that age was significantly associated with ureteral stent-related symptoms [27, 28]. The evaluation methods of all previous reports on the association between age and ureteral stent-related symptoms were not similar. Therefore, comparing these reports is difficult. Consequently, the association between age and ureteral stent-related symptoms remains unclear.

The optimal method for determining the appropriate ureteral stent length remains unclear. In previous reports, the appropriate ureteral stent length for each patient was calculated by three different

methods. The first is direct measurement of the ureter itself using a guide wire or ureteral catheter [29]. The second involves measurement of the distance from the ureteropelvic junction (UPJ) to the vesicoureteric junction (VUJ) by either retrograde or intravenous pyelography [30, 31]. The third method provides an estimation of the appropriate stent length using a formula based on the patient's height [32]. We consider the method to determine appropriate length of ureteral stents should be investigated in the future.

This study has some limitations. First, our study was retrospective and non-randomized. The position of the distal loop of ureteral stents was not randomized. Second, this study used the OABSS, although the USSQ is globally considered the gold standard [19] for evaluating ureteral stent-related symptoms. Additionally, we did not evaluate urinary symptoms before ureteral stent placement. Because urinary symptoms might become worse with age, age might have been significant in multivariate analysis. With regard to characteristics of ureteral stents, only stent position was associated with the total OABSS among the other factors of stent side, stent diameter, stent length, and stent indwelling time in multivariate analysis. However, the placement of ureteral stents routinely before URSL is not common and it may be difficult to replicate this study at elsewhere. Third, the stent indwelling time was not standardized. In this study, there were no significant differences in the stent indwelling time between the two groups. Fourth, bladder filling was not a standard of care when KUB was performed. Because the location of the ureteral orifices is different according to whether bladder filling is performed [33], this might affect ureteral stent position. Future studies should perform re-evaluation using the USSQ and standardize the stent indwelling time, and KUB should be performed after urination.

CONCLUSIONS

This study shows that ureteral stents crossing the bladder midline lead to worse urinary symptoms. Choosing the appropriate ureteral stent length for each patient is important for improving stent-related symptoms.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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