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

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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
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 |
|---------------------------|-------------|------------------------|---------------------------|---------|
| 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/m²)               | 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 χ² 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.

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 2. Comparison of the OABSS between the two groups

|                        | Crossing midline group | Not crossing midline group | p value |
|------------------------|------------------------|-----------------------------|---------|
| **mean score ±SD**     | 5.9 ±3.6               | 3.4 ±3.1                    | <0.001  |
| Total score            |                        |                             |         |
| 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

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

|                                    | Univariate analysis | Multivariate analysis |
|------------------------------------|---------------------|-----------------------|
|                                    | 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/m²)                        | -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   |

*Single linear regression, †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.

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.

References

1. Zimskind PD, Fetter TR, Wilkerson JL. Clinical use of long-term indwelling silicone rubber ureteral splints inserted cystoscopically. J Urol. 1967; 97: 840-844.
2. Joshi HB, Okeke A, Newns N, et al. Characterization of urinary symptoms in patients with ureteral stents. Urolgy. 2002; 59: 511-516.
3. Rane A, Saleemi A, Cahill D, et al. Have stent related symptoms anything to do with placement technique? J Endourol. 2001; 15: 741-745.
4. Al-Kandari AM, Al-Shaiji TF, Shaaban H, Ibrahim HM, Elshebiny YH, Shokeir AA. Effects of proximal and distal ends of double-J ureteral stent position on postprocedural symptoms and quality of life: a randomized clinical trial. J Endourol. 2007; 21: 698-702.
5. Damiano R, Autorino R, De Sio M, et al. Does the size of ureteral stent impact urinary symptoms and quality of life? A prospective randomized study. Eur Urol. 2005; 48: 673-678.
6. Erturk E, Sessions A, Joseph JV. Impact of ureteral stent diameter on symptoms and tolerability. J Endourol. 2003; 17: 59-62.
7. Candela JV, Bellman GC. Ureteral stents: impact of diameter and composition on patient symptoms. J Endourol. 1997; 11: 45-47.
8. Lennon GM, Thornhill JA, Sweeney PA, Grainger R, McDermott TE, Butler MR. ‘Firm’ versus ‘soft’ double pigtail ureteric stents: a randomised blind comparative trial. Eur Urol. 1995; 28: 1-5.
9. Liatsikos EN, Gershbaum D, Kapoor R, et al. Comparison of symptoms related to positioning of double-pigtail stent in upper pole versus renal pelvis. J Endourol. 2001; 15: 299-302.
10. Ho C-H, Chen S-C, Chung S-D, et al. Determining the appropriate length of a double-pigtail ureteral stent by both stent configurations and related symptoms. J Endourol. 2008; 22: 1427-1431.  
11. Giannarini G, Keeley FX Jr, Valentin F, et al. Predictors of morbidity in patients with indwelling ureteric stents: results of a prospective study using the validated Ureteric Stent Symptoms Questionnaire. BJU Int. 2011; 107: 648-654.
12. Abt D, Mordasini L, Warzinek E, et al. Is intravesical stent position a predictor of associated morbidity? Korean J Urol. 2015; 56: 370-378.
13. Kourambas J, Byrne RR, Preminger GM. Does a ureteral access sheath facilitate ureteroscopy? J Urol. 2001; 165: 789-793.
14. Lumma PP, Schneider P, Strauss A, et al. Impact of ureteral stenting prior to ureterorenoscopy on stone-free rates and complications. World J Urol. 2013; 31: 855-859.
15. Assimos D, Crisci A, Culkin D, et al. Preoperative JJ stents placement in ureteric and renal stone treatment: results from the Clinical Research Office of Endourological Society (CROES) ureteroscopy (URS) Global Study. BJU Int. 2015; 117: 648-654.
16. Homma Y, Yoshida M, Seki N, et al. Symptom assessment tool for overactive bladder syndrome--
overactive bladder symptom score. Urology. 2006; 68: 318-323.

17. Joshi HB, Newns N, Stainthorpe A, et al. Ureteral stent symptom questionnaire: development and validation of a multidimensional quality of life measure. J Urol. 2003; 169: 1060-1064.

18. Joshi HB, Stainthorpe A, Keeley FX Jr, MacDonagh R, Timoney AG. Indwelling ureteral stents: evaluation of quality of life to aid outcome analysis. J Endourol. 2001; 15: 151-154.

19. Miyaoka R, Monga M. Ureteral stent discomfort: etiology and management. Indian J Urol. 2009; 25: 455-460.

20. Homma Y, Gotoh M. Symptom severity and patient perceptions in overactive bladder: how are they related? BJU Int. 2009; 104: 968-972.

21. Tsujimura A, Takao T, Miyagawa Y, et al. Urgency is an independent factor for sleep disturbance in men with obstructive sleep apnea. Urology. 2010; 76: 967-970.

22. Tanaka Y, Masumori N, Tsukamoto T. Urodynaminc effects of solifenacin in untreated female patients with symptomatic overactive bladder. Int J Urol. 2010; 17: 796-800.

23. Watanabe M, Yamanishi T, Honda M, Sakakibara R, Uchiyama T, Yoshida K. Efficacy of extended-release toterodine for the treatment of neurogenic detrusor overactivity and/or low-compliance bladder. Int J Urol. 2010; 17: 931-936.

24. Gotoh M, Yokoyama O, Nishizawa O. Japanese Propiverine Study Group. Propiverine hydrochloride in Japanese patients with overactive bladder: a randomized, double-blind, placebo-controlled trial. Int J Urol. 2011; 18: 365-373.

25. Olivera-Posada D, Suárez-Santos M, Castillejos-Molina R, Gabilondo-Navarro F, Méndez-Probst CE. Validation of the Spanish version of Ureteral Stent Symptom Questionnaire: prevalence of symptoms in a tertiary care center in Mexico. J Endourol. 2014; 28: 377-382.

26. Kuehhas FE, Miernik A, Sharma V, et al. A prospective evaluation of pain associated with stone passage, stents, and stent removal using a visual analog scale. Urology. 2013; 82: 521-525.

27. Leibovici D, Cooper A, Lindner A, et al. Ureteral stents: morbidity and impact on quality of life. Isr Med Assoc J. 2005; 7: 491-494.

28. Irani J, Siquer J, Pièrs C, Lefebvre O, Doré B, Aubert J. Symptom characteristics and the development of tolerance with time in patients with indwelling double-pigtail ureteric stents. BJU Int. 1999; 84: 276-279.

29. Pilcher JM, Patel U. Choosing the correct length of ureteric stent: a formula based on the patient’s height compared with direct ureteric measurement. Clin Radiol. 2002; 57: 59-62.

30. Jeon SS, Choi YS, Hong JH. Determination of ideal stent length for endourologic surgery. J Endourol. 2007; 21: 906-910.

31. Parick SH, Park HK, Byun SS, Oh SJ, Kim HH. Direct ureteric length measurement from intravenous pyelography: does height represent ureteric length? Urol Res. 2005; 33: 199-202.

32. Ho CH, Huang KH, Chen SC, Pu YS, Liu SP, Yu HJ. Choosing the ideal length of a double-pigtail ureteral stent according to body height study based on a Chinese population. Urol Int. 2009; 83: 70-74.

33. Hwang I, Kim SO, Yu HS, Hwang EC, Jung SI, Kang TW, Kwon D, Park K. A preliminary study of the variability in location of the ureteral orifices with bladder filling by fluoroscopic guidance: the gender difference. Int Urol Nephrol. 2013; 45: 639-643.