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Is intravesical stent position a predictor of associated morbidity?

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Purpose: Temporary drainage of the upper urinary tract by use of internal ureteral stents is a common procedure that is often associated with a variety of symptoms. The role of intravesical stent position in associated morbidity is controversial.

Materials and Methods: The German version of the ureteral stent symptom questionnaire (USSQ) was completed by 73 patients with an indwelling ureteral stent the day before stent removal. Intravesical stent position was classified into 3 categories by x-ray before stent removal. The influence of intravesical stent position on USSQ score was analyzed, including subscores and single items.

Results: Intravesical stent position showed no significant influence on associated morbidity. The median USSQ total score in all patients was 77.5 (range, 30–147). Patients with ipsilateral stents (69.0; range, 30–122) tended to have lower total scores than did those with tangential (86.5; range, 30–122) or contralateral (77.0; range, 31–147) stents, but the differences were not statistically significant (p=0.35). The USSQ subscores for urinary symptoms (p=0.80), body pain (p=0.80), general health (p=0.16), work performance (p=0.07), additional problems (p=0.81), and all of the USSQ single items of interest in the context of stent length also did not differ significantly between the three groups.

Conclusions: Intravesical stent position did not significantly influence associated morbidity in our study. An appropriate stent length should be chosen to avoid dislocation. However, complex calculations of optimum stent length, time-consuming manipulations, and costly stock holding of various stent sizes to obtain the perfect stent position do not seem worthwhile.

Keywords: Morbidity; Pain; Questionnaires; Stents; Ureter

INTRODUCTION

Temporary drainage of the upper urinary tract is a routine procedure to ensure renal function and to treat pain caused by ureteral obstruction. Internal ureteral stents offer a simple and effective method of ureteral drainage and avoid external devices. However, they are frequently associated with a well-defined side effect profile. Irritative voiding symptoms were reported in 78% of patients and stent-related pain affecting daily activities was reported in more than 80% by Joshi et al. [1]. High rates of lower urinary tract symptoms (LUTS), flank pain, and hematuria are caused by irritation from the foreign body in the bladder and the vesicoureteric reflux that is generated, and

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most of the side effects persist throughout the entire stent indwelling time [2].

In view of the prevalence of ureteral stenting and associated symptoms, Joshi et al. [3] made an important step forward by developing and validating the ureteral stent symptom questionnaire (USSQ), which analyzes various domains of health affected by stents. Over the past 10 years, the USSQ has become a well-accepted standard in the assessment of stent-associated symptoms and has been translated into different languages. Validated versions have been developed as recommended by Hutchinson et al. [4] in French [5], Italian [6], Korean [7], and Spanish [8]. Recently, a German version was developed in an analogous multistep process [4] and is at present being validated in a multicenter analysis in Regensburg and Sindelfingen-Böblingen in Germany, Salzburg in Austria, and in our own department (findings not yet published).

Several studies have investigated the reasons for and the treatment and prevention of morbidity caused by indwelling ureteral stents. Although it has been shown that alpha-blockers [9] and antimuscarinics [10] can reduce symptoms caused by ureteral stents, neither the positioning of the stent's proximal end [11] nor stent diameter [12-14] seems to have an influence.

Findings regarding the possible effect of intravesical stent position, a variable that can be easily adjusted, are ambiguous. Giannarini et al. [15] investigated predictors of morbidity in patients with ureteral stents and identified a distal loop location crossing the pelvic midline as a risk factor for urinary symptoms and body pain, impairment of general health and work performance, and sexual problems. Rane et al. [16], Al-Kandari et al. [11], and Ho et al. [17] showed similar results with the limitation of using questionnaires not specific for stent symptoms.

In contrast, Calvert et al. [18] did not find any difference between symptoms in a randomized trial comparing 24-cm and multilength stents. Also, a multicenter study by Lingeman et al. [19] using the USSQ investigated whether a reduced amount of intravesical stent material reduces stent-related symptoms and found no significant differences between different stents. Thus, in an attempt to clarify the influence of the intravesical part of indwelling ureteral stents on stent-related symptoms, we conducted a prospective survey at our institution.

MATERIALS AND METHODS

The study was conducted according to the Declaration of Helsinki and Good Clinical Practice and was approved by the Local Ethics Committee (EKSG 13/096). Between July 2013 and June 2014, a total of 83 consecutive patients who had undergone unilateral ureteral stenting were included in the trial. Inclusion criteria were a unilateral ureteral stent inserted for treatment of uretero- or nephrolithiasis and informed consent. Exclusion criteria were previous ureteral stenting, pregnancy, bilateral ureteral stenting, obstruction due to malignancy, additional procedures or operations performed during stent indwelling time, and debilitating disease.

Percuflex ureteral stents (Boston Scientific, Natick, MA, USA) with a diameter of 6 French and lengths ranging from 26 to 30 cm were used, with the choice of length depending on the surgeons' estimate of patient height and ureteral configuration by use of retrograde contrast ureteropyelography. Intravesical stent position was assessed by x-ray before stent removal and was classified into 3 categories by using a perpendicular line through the middle of the gap of the symphysis pubis. In group A, the distal

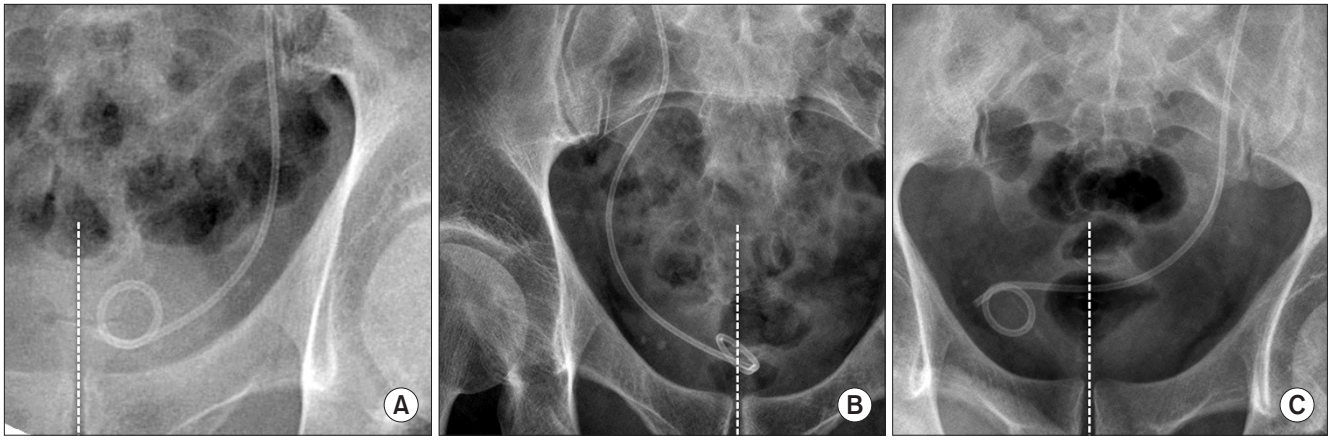

Fig. 1. Classification of intravesical stent length based on a perpendicular line through the middle of the gap of the symphysis pubis: loop completely ipsilateral (A), crossing midline (B), and completely contralateral (C).

loop of the stent was completely ipsilateral, group B had loops crossing the perpendicular line, and group C consisted of patients with completely contralateral intravesical stent loops (Fig. 1). Patients were asked to complete the German version of the USSQ, rating the entire stent dwelling time, on the day before stent removal. Patients with incompletely answered questionnaires were excluded from the study. After primary data analysis, the immediate postoperative intravesical stent position was assessed retrospectively, as much as possible, to further verify the study results.

Categorical variables are reported as number (%) and were compared by using Fisher exact test, whereas continuous variables are reported as median (range) and were compared by using the Kruskal-Wallis test. Correlations between scores were estimated by using the Pearson correlation (with corresponding 95% confidence intervals). Correlations adjusted for various factors were estimated by using linear regression. A two-sided significance level of 0.05 was used throughout. Holm's [20] method (1979) was used to control for multiple testing. All analyses were performed in the R ver. 3.1.0 (R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

Of the 83 patients enrolled in the study, six did not return the questionnaire, three were excluded owing to incomplete questionnaires, and one patient was excluded because the distal stent position was not clear on the x-ray. No cases of stent dislocation were observed and all of the remaining 73 patients had complete distal and proximal stent loops. Completely ipsilateral distal stent loops (group A) were present in 17.8% (n=13), whereas 27.4% (n=20) had distal loops tangential to the straight line through the symphysis (group B), and 54.8% (n=40) had completely contralateral loops (group C). Age, gender, intake of analgesics or alpha-blockers, stent indication, and indwelling time did not differ significantly between the three groups. Demographics and clinical characteristics are summarized in Table 1.

Intravesical stent position did not significantly influence morbidity caused by ureteral stents. The median USSQ total score for all patients was 77.0 (range, 30–147). Patients with ipsilateral stents tended to have lower total scores with a median of 69.0 (range, 30–122) compared with 86.5 (range, 30–122) for those with tangential stents and 77.0 (range, 31–147) for those with contralateral stents. These differences were not statistically significant (p=0.35). There were also no significant differences between the USSQ subscores for urinary symptoms (p=0.80), body pain (p=0.80), general health (p=0.16), work performance (p=0.07), and additional problems (p=0.81) between the three groups. Only the USSQ subscore for sexual matters showed fewer symptoms in

Table 1. Patient demographics and clinical characteristics

Variable	All	Group A	Group B	Group C
Intravesical stent position	73 (100)	13 (17.8)	20 (27.4)	40 (54.8)
Gender				
Women	17 (23.3)	3 (23.1)	7 (35)	7 (17.5)
Men	56 (76.7)	10 (76.9)	13 (65)	33 (82.5)
Age (y)	52 (20–80)	54 (22–75)	51 (23–70)	52 (20–80)
Stent indwelling time (d)	30 (8–94)	26 (8–84)	27 (8–57)	32 (12–94)
Ureteral stent indication				
Preparation for secondary ureterorenoscopy	70 (95.9)	12 (92.3)	20 (100)	38 (95)
After primary ureterorenoscopy	2 (2.7)	-	-	2 (5.0)
Preparation for shock wave lithotripsy	1 (1.4)	1 (7.7)	-	-
Analgesics				
None	10 (13.7)	2 (15.4)	1 (5.0)	7 (17.5)
Nonsteroidal anti-inflammatory drug	4 (5.5)	1 (7.7)	1 (5.0)	2 (5.0)
Paracetamol	15 (20.6)	3 (23.1)	5 (25.0)	7 (17.5)
Metamizole	7 (9.6)	1 (7.7)	3 (15.0)	3 (7.5)
Combination of two of the above analgesics	37 (50.7)	6 (46.2)	10 (50.0)	21 (52.5)
Alpha-blocker				
None	59 (80.8)	10 (76.9)	17 (85.0)	32 (80.0)
Tamsulosin	14 (19.2)	3 (23.1)	3 (15.0)	8 (20.0)

Values are presented as number (%) or median (range).
Group A, all ipsilateral; group B, tangential to symphysis pubis midline; group C, contralateral.

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patients with shorter indwelling stents (p=0.04) (Table 2).

No influence of stent position could be found for any of the USSQ single items relevant to stent length. This was shown by the absence of significant differences between groups for urinary frequency (represented by question U1, p=0.92), nocturia (U2, p=0.33), urgency (U3, p=0.40), urge incontinence (U4, p=0.39), dysuria (U7, p=0.53), incidence of hematuria (U8, p=0.81), intensity of hematuria (U9, p=0.41), pain while passing urine (P6, p=0.19), pain in the kidney area while passing urine (P7, p=0.96), difficulties with light physical activities (G1, p=0.08), and difficulties with heavy physical activities (G2, p=0.24) (Table 3). Moreover, no impact of stent position on the location of pain was found (Table 4).

X-rays performed immediately postoperatively could be analyzed retrospectively in 82.2% (n=60) of patients. We found that 43.0% (n=26) of these patients would have been assigned to a different group at this time, with 22 patients switching to a group with shorter distal stents and four patients assigned to a group with longer distal stents. Despite this, statistical analysis using this early assessment of stent position instead of stent position on the day before removal showed no influence on morbidity reflected by USSQ total scores, subscores, or single items (data not shown). With use of the initial stent position, not even the subscore for sexual matters was influenced by intravesical stent position (p=0.82).

DISCUSSION

The reasons for the morbidity caused by indwelling stents and their treatment and prevention have been investigated in several studies, the results of which can be summarized as follows:

- Oral administration of alpha-blockers [9] or antimuscarinics [10] can reduce discomfort caused by ureteral stents.

Table 2. Influence of stent length on total USSQ score and subscores

Variable	Group	No.	NA	Score, median (range)	p-value
USSQ total score	A	13	0	69.0 (30–122)	
	B	20	0	86.5 (30–122)	
	C	40	0	77.0 (31–147)	
	All	73	0	77.0 (30–147)	0.35
Urinary symptoms subscore	A	13	0	28.0 (15–42)	
	B	20	0	28.5 (13–43)	
	C	40	0	29.5 (14–48)	
	All	73	0	29.0 (13–48)	0.80
Body pain subscore	A	10	3	25.5 (11–35)	
	B	16	4	25.0 (11–30)	
	C	29	11	22.0 (11–34)	
	All	55	18	24.0 (11–35)	0.80
General health subscore	A	13	0	13.0 (5–24)	
	B	20	0	16.0 (6–25)	
	C	40	0	13.5 (6–24)	
	All	73	0	14.0 (5–25)	0.16
Work performance subscore	A	5	8	3.0 (3–11)	
	B	15	5	9.0 (3–15)	
	C	25	15	7.0 (3–15)	
	All	45	28	7.0 (3–15)	0.07
Sexual matters subscore	A	13	0	0 (0–11)	
	B	20	0	2.5 (0–11)	
	C	40	0	1.0 (0–11)	
	All	73	0	1.0 (0–11)	0.04
Additional problems subscore	A	13	0	5.0 (4–11)	
	B	20	0	6.0 (4–12)	
	C	40	0	6.5 (4–14)	
	All	73	0	6.0 (4–14)	0.81

USSQ, ureteral stent symptom questionnaire; NA, number of patients who denied having the symptom in question; Group A, all ipsilateral; group B, tangential to symphysis pubis midline; group C, contralateral.

Table 3. Influence of stent length on USSQ single items

Variable	Group	No.	NA	Score, median (range)	p-value
Diuria (U1)	A	13	0	3.0 (1–5)	
	B	20	0	3.0 (2–5)	
	C	40	0	3.0 (1–5)	
	All	73	0	3.0 (1–5)	0.92
Nocturia (U2)	A	13	0	3.0 (2–4)	
	B	20	0	3.0 (1–5)	
	C	40	0	3.0 (1–5)	
	All	73	0	3.0 (1–5)	0.33
Urgency (U3)	A	13	0	2.0 (1–4)	
	B	20	0	2.0 (1–5)	
	C	40	0	2.5 (1–6)	
	All	73	0	2.0 (1–6)	0.40
Urge-incontinence (U4)	A	13	0	1.0 (1–3)	
	B	20	0	1.0 (1–4)	
	C	40	0	1.0 (1–4)	
	All	73	0	1.0 (1–4)	0.39
Dysuria (U7)	A	13	0	2.0 (1–5)	
	B	20	0	3.0 (1–5)	
	C	40	0	3.0 (1–5)	
	All	73	0	3.0 (1–5)	0.53
Incidence of hematuria (U8)	A	13	0	3.0 (1–5)	
	B	20	0	2.0 (1–5)	
	C	40	0	2.0 (1–5)	
	All	73	0	2.0 (1–5)	0.81
Extent of hematuria (U9)	A	13	0	2.0 (1–3)	
	B	20	0	2.0 (1–3)	
	C	40	0	2.0 (1–4)	
	All	73	0	2.0 (1–4)	0.41
Pain while passing urine (P6)	A	10	3	4.0 (1–5)	
	B	16	4	3.0 (1–5)	
	C	30	10	4.0 (2–5)	
	All	56	17	4.0 (1–5)	0.19
Kidney pain while passing urine (P7)	A	10	3	2.0 (1–2)	
	B	16	4	2.0 (1–2)	
	C	29	11	2.0 (1–2)	
	All	55	18	2.0 (1–2)	0.96
Difficulties with light physical activities (G1)	A	13	0	1.0 (0–3)	
	B	20	0	2.5 (0–4)	
	C	40	0	2.0 (1–4)	
	All	73	0	2.0 (0–4)	0.08
Difficulties with heavy physical activities (G2)	A	13	0	1.0 (0–4)	
	B	20	0	3.0 (0–4)	
	C	40	0	2.0 (0–4)	
	All	73	0	2.0 (0–4)	0.24

USSQ, ureteral stent symptom questionnaire; NA, number of patients who denied having the symptom in question; Group A, all ipsilat-eral; group B, tangential to symphysis pubis midline; group C, contralateral.

- Despite many advances in stent composition, construction geometry, and design, the ideal stent has yet to be designed [21-23].
- Drug-eluting stents seem to have a very limited effect [24] and do not play a role in clinical routine.
- Positioning of the stent's proximal end [11] and stent

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Table 4. Influence of stent length on pain location

Body part	Group A	Group B	Group C	All	p-value
Lateral flank					0.46
No pain	7 (53.9)	13 (65.0)	29 (72.5)	49 (67.1)	
Pain	6 (46.1)	7 (35.0)	11 (27.5)	24 (32.9)	
Dorsal flank					0.16
No pain	6 (46.1)	8 (40.0)	26 (65.0)	40 (54.8)	
Pain	7 (53.9)	12 (60.0)	14 (35.0)	33 (45.2)	
Lower abdomen					0.72
No pain	9 (69.2)	11 (55.0)	26 (65.0)	46 (63.0)	
Pain	4 (30.8)	9 (45.0)	14 (35.0)	27 (37.0)	
Groin					0.55
No pain	10 (76.9)	15 (75.0)	25 (62.5)	50 (68.5)	
Pain	3 (23.1)	5 (25.0)	15 (37.5)	23 (31.5)	
Genitalia					0.22
No pain	13 (100)	17 (85.0)	32 (80.0)	62 (84.9)	
Pain	0 (0)	3 (15.0)	8 (20.0)	11 (15.1)	

Values are presented as number (%).
Group A, all ipsilateral; group B, tangential to symphysis pubis midline; group C, contralateral.

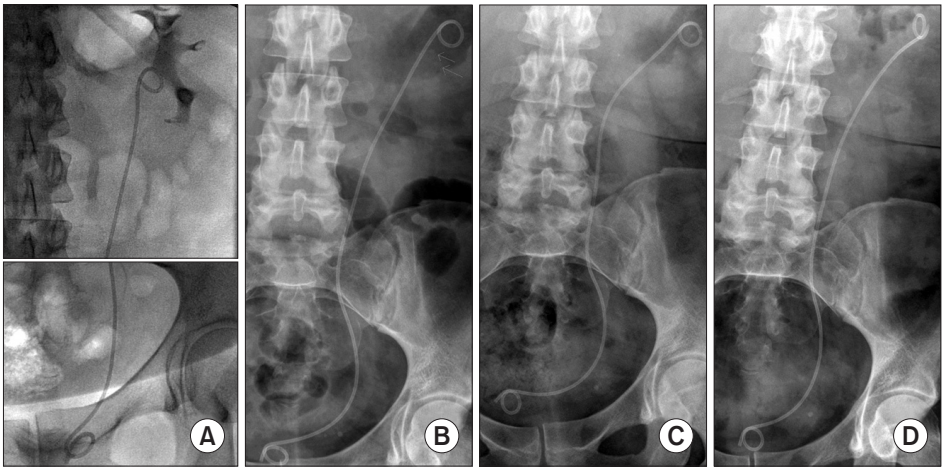

Fig. 2. Study patient treated by shock wave lithotripsy (SWL) secondary to stenting with pushback. X-rays performed before and after treatment show high variability of distal stent location. (A) Intraoperative x-ray. (B) One day after stent insertion. (C) Three weeks after insertion (before SWL). (D) Three weeks after SWL (before stent removal).

diameter [12-14] do not seem to influence morbidity.

However, previous findings regarding the possible effect of intravesical stent position are ambiguous.

The present study examined the influence of intravesical stent position on problems caused by ureteral stents by use of a questionnaire designed specifically to assess ureteral stent symptoms (the USSQ). Assessment of distal stent position and stent-related symptoms was deliberately performed at the end of stent indwelling time, because we believed that this would take into account the stent's predominant position better than early postoperative assessment.

We did not find a significant impact of intravesical stent position on typical complaints associated with indwelling ureteral stents. Only the subscore for sexual matters showed fewer symptoms in patients with shorter intravesical stents (p=0.04). This might be of questionable relevance, however, taking into account that with the use of the initial stent position, the subscore for sexual matters was not influenced by intravesical stent length (p=0.82) and, moreover, that there was no significant difference between the groups regarding difficulties with light physical activities (G1) and difficulties with heavy physical activities (G2).

The pathogenesis of stent-related symptoms is generally divided into two issues. The first is vesicoureteric reflux, which typically causes flank pain aggravated by micturition. It appears logical that this problem is not influenced by intravesical stent position as reflected by question P7 (occurrence of flank pain during micturition). The second issue is that most symptoms observed are ascribed to the intravesical part of the stent as a foreign body causing irritative voiding problems and pain in the urinary bladder,

often radiating to the genitalia. In this regard, longer intravesical stents might cause more problems because they may cause more irritation to the bladder neck and the trigone, which are well known to comprise most of the sensory afferents in the urinary bladder [25]. In our study, however, no differences in extent or site of pain were found between the different groups. Moreover, equal distribution of diuria and nocturia (reflected by questions U1 and U2) and frequency and severity of gross hematuria (U8 and U9) seem to argue against greater irritation caused by longer intravesical stents.

Studies on this topic performed so far show conflicting results. In this regard, the study by Giannarini et al. [15] may be the most important because it was prospective and used a specific questionnaire (USSQ) with assessment of symptoms and stent position on days 7 and 28 after placement. A reason for the differing results with our study might be the different time points at which stent position and symptoms were assessed, i.e., on the day before stent removal. For this reason, we analyzed the x-rays that had been performed immediately after stent insertion and found that on this basis as many as 43% of patients would have been assigned to a different group, indicating a certain flexibility of stent location. Other reasons for the differences between results may be different exclusion criteria. Our study did not exclude patients with LUTS with or without medical treatment, because LUTS are highly prevalent in the normal population and patients affected may be especially susceptible to stent-related symptoms. Unfortunately, we did not assess the prevalence of LUTS in our study groups. Moreover, to improve the accuracy of assessing intravesical stent length by x-ray, we decided to categorize patients into three instead of two groups. However, analysis of our data in only two groups showed the same results. The results of the study by Giannarini et al. [15] may also have been influenced by not being corrected for multiple testing, which we did in our study. As in our study, Giannarini et al. [15] did not randomize for distal stent positioning and they used the same type of stents, although somewhat shorter (24–28 cm instead of 26–30 cm). In both studies, bladder filling at the time of x-ray was not assessed.

There may be a fundamental problem of using intravesical stent length categorized by x-ray as a predictor of morbidity: it varies and may have more the nature of a snapshot than a fixed state. Furthermore, the influence of bladder volume on stent position has never been evaluated systemically. Moreover, stents can adopt different positions as the body moves and changes position, as demonstrated in a study by Chew et al. [26]. This assumption was also strengthened by a post hoc analysis of the study by Giannarini et al. [15], which showed no significant correlation between stent location and distal loop location. This is also well illustrated by our study patient who underwent shock wave lithotripsy after stenting and thus had several x-rays showing a high variability of distal stent location (Fig. 2).

Moreover, depending on the configuration of the bladder neck and intramural ureter, distal stent loops with an apparent initial ideal length may interfere more with the bladder neck than longer stents that may not be in contact with the bladder neck at all. In line with this, very different intravesical stent alignments were found between women, in whom pelvic floor prolapse might play an important role, and men, in whom prostate size, for example, might influence irritation caused by the stent. Both may not only influence the degree of irritation to the bladder wall and neck, but also affect assignment to groups as discussed above.

Our study had limitations. Intravesical stent position was assessed only on the day of stent removal. Thus, analysis of the stent position directly after the intervention had to be performed retrospectively and there was no assessment of symptoms at this time. We believed that this might show the stent's predominant position better than early postoperative assessment, because stents might not adopt a "permanent" position before the patient is mobilized after surgery. This time of assessment was also chosen for practical reasons: patients had an appointment for secondary stone treatment then and this offered an overview of all symptoms they had experienced during the whole stent indwelling time. Also, symptoms were not assessed after stent removal, which would have allowed a better causal link between symptoms and the indwelling stent. A further limitation is that stent insertion was not randomized, because randomization would have necessitated extensive manipulation, which may also have influenced symptoms. The German version of the USSQ is not validated. However, the USSQ is a well-established questionnaire for the assessment of symptoms associated with indwelling ureteral stents that has been validated in several languages. We used the same translation process as for all other translations, and the German version is at present undergoing validation (data not yet published).

CONCLUSIONS

Intravesical stent position did not appear to influence morbidity caused by ureteral stents in our study and focusing on length does not appear to be a promising approach to improving stent-related symptoms. Assessment

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of stent position by x-ray may be a misleading simplification of the true situation. An appropriate stent length is certainly required, if only to avoid stent dislocation, but extensive calculations using formulae or based on imaging do not seem to be reasonable. Stents that seem a little too long after insertion can generally be left, thus avoiding further time-consuming manipulation. Costly stock holding of various stent sizes to obtain the perfect length is not necessary.

CONFLICTS OF INTEREST

The authors have nothing to disclose.

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