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ORIGINAL PAPER

Ureteral stent related symptoms: A comparative study

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Summary *Background: In urology, ureteral stents are used to treat obstructive diseases. Hematuria (54%), fever, discomfort, and lower urinary system symptoms are the predominant symptoms related to ureteral stent.*
Aim: This article links stent symptoms to double-j width and length, as well as patient's height, weight, and body mass index (BMI). Ureteric Stent Symptoms Questionnaire (USSQ) was used to measure ureteral stent symptoms at 1st and 4th week of stent in situ as well as the 4th week after pigtail removal.
Methods: A 200-patient prospective study, where patients were allocated into four groups following ureteral stent insertion depending on the stent characteristics. Those groups were: 4.8 Fr./26 cm (Group A), 4.8 Fr./28 cm (Group B), 6 Fr/26 cm (Group C), and 6 Fr/28 cm (Group D).
Results: Men comprised 53.5% of 200 patients. Participants had an average age of 49 ± 15.5 years, height of 175 ± 8.94 cm, and BMI of 23.8 ± 7.6 cm. The laboratory results were identical between groups. At the first and fourth week, groups had similar urine symptoms, pain severity, health status and occupational activities. The difference in pain location was statistically significant. Group A had 82.4% renal back pain in the first week, whereas Group B had 68.8%, Group C 31.3% and Group D 62.5 ($p = 0.04$). At the fourth week, 64.7% of Group A patients reported kidney front pain, compared to 100% of Group B, 93.3% of Group C, and 100% of Group D ($p = 0.04$). There was statistical significance in the sexual activity of the patients. 24.4% of Group C patients stopped sexual activity before stent installation, compared to 10.6%, 8.3%, and 6.4% of the other groups ($p = 0.03$). A moderate percentage of patients had active sexual activity at week 4 (Group A: 7.8%, Group B: 5.8%, Group C: 8.2%, Group D: 4.1%), $p = 0.83$. In multivariate analysis, urinary catheter group, age, weight, height, and BMI did not significantly affect urine index score (UIS), pain index score (PIS), general health (GH), quality of work (QW), and quality of sex (QS).
Conclusions: Despite various attempts to establish the best ureteral stent, the effect of double-j stent physical features on stent-related symptoms remained unknown. No verdict is conceivable without adequate empirical data.

KEY WORDS: *Ureteral stents; Pigtails; Urinary symptoms; Hematuria; Pain; USSQ; Pigtail characteristics; Pigtail diameter; Pigtail length; Double-j stent; Ureteral stent.*

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INTRODUCTION

The single-pigtail stent, was first introduced to the medical community by Hepperlen and Mardis. This innovative stent design revolutionized the field by providing a reliable and effective solution for various urological conditions (1-3). On the other hand, the double-J® stent, manufactured by *American Cystoscope Makers located in Southborough, MA*, was initially described by *Finney* (1-3). This particular stent design has gained significant recognition and widespread use. Over the years, significant advancements have been made in the field of catheter technology, leading to notable improvements in both the location and design of these medical devices (4-6). These advancements have played a crucial role in enhancing patient care and overall medical outcomes. One area that has witnessed remarkable progress is the location of catheters. In the past, catheters were often placed using conventional techniques that relied heavily on the expertise of healthcare professionals. In a comprehensive study conducted by *Joshi et al.*, it was observed that a staggering 80% of individuals who had double-j stent insertion experienced the manifestation of at least one undesirable symptom related to the urinary tract (7). This finding sheds light on the significant impact that double-j stents can have on the overall health and quality of life of affected patients. In recent years, there has been a growing interest in the field of medicine regarding the potential benefits of various pharmaceutical treatments to prevent or minimize the stent related symptoms.
The primary objective of this investigation is to establish a correlation between the symptoms associated with stents and the physical attributes of the ureteral stent, namely its width and length. Additionally, we aim to examine the potential relationship between these symptoms and the patient's biometric measurements, including height, weight, and *body mass index* (BMI).

MATERIALS AND METHODS

Design of the study

This is a prospective, single center study. The collection of data was performed in patients, where ureteral stents (pigtails) were inserted in a tertiary urology hospital from September 2021 to September 2023. The study was

approved by the Institutional Review Board of the hospital (Protocol Number:6014/22.3.22). The study is registered to clinicaltrials.gov with ID:14778, clinical trials ID: NCT05598710.

Each double-j stent size that was inserted to each patient depended on the material availability and the surgeon's preference at the time of surgery. Intraoperatively the double-j stent was inserted by the standard way with the use of fluoroscopy. Postoperatively the correct position inside the kidney and the bladder was assessed by KUB X-ray. Correct position was considered the pelvis of the kidney and the lower end of the double-j stent inside the bladder not crossing to the contralateral side.

For each patient the following data were recorded:

I. *Demographic and anthropometric data*: age (in years), sex (male, female), height (in cm), weight (in kg), body mass index (BMI, in kg/m^2). The patients according to BMI were categorized according to *Centers for Disease Control* (CDC) in: normal weight (BMI 18.5-24.9 kg/m^2), overweight (BMI 25-29 kg/m^2) and obese patients (BMI ≥ 30 kg/m^2) (8).

II. *Clinical characteristics*: reason for stent insertion (urolithiasis or pelviureteral junction stenosis), stone size, stone location, length of hospital stay (*Length of Stay, LOS*) in days, temperature measurement (appearance of fever postoperatively and the duration of fever), bloodwork pre-operatively, immediately postoperatively and during exiting the hospital (*urea-U, creatinine-Cr, White Blood Cells-WBC, C-Reactive Protein*). The change of those values was calculated as 1) the difference between the post-operative and pre-operative values 2) the difference between the values at hospital exit and the pre-operative values.

III. *Ureteral Stent Characteristics*: length (cm) (26 or 28) and width (Fr) (4.8, sometimes referred to as 5 in the text, and 6). In this particular study, there were four groups of patients with different ureteral stents: Group A: 4.8Fr, 26 cm, Group B: 4.8Fr, 28 cm, Group C: 6 Fr, 26 cm, Group D: 6 Fr, 28 cm.

IV. *Ureteric Stent Symptoms Questionnaire* (USSQ) (7) was completed at the first week (t1: end of the first week) and at four weeks (t2: end of fourth week) after stent placement but also at 4 weeks after removing the ureteral stent (t3: end of fourth week after double-j stent removal).

USSQ is a questionnaire with 6 groups of questions:

- *1st group of questions*: 11 questions in Likert scale about urinary symptoms. By adding the results of those questions, we get the *Urinary Index Score* (UIS) which ranges from 11 to 56. Higher values of UIS, suggest higher severity of urinary symptoms. UIS is presented.
- *2nd group of questions*: questions regarding the body pain that the patient perceives. The P1 question is about if the patient experiences pain (yes/no), P2 question is about the body sites where the patient perceives pain (I: Kidney Front, II: Groin Area, III: Bladder Area, IV: Kidney Back). Consequently by adding the results of the questions P3-P9, we get the *Pain Index Score* (PIS). The proportion of the patients that report pain in a particular body region as well as the PIS are reported.
- *3rd group of questions*: They are 6 questions with answers in Likert scale, about the general health and physical activity. By adding the results from those questions, we get the *General Health Index Score* (GHIS), which ranges from 4 to 28. Higher GHIS values, suggest higher general health burden due to the placement of ureteral stent. GHIS is presented.
- *4th group of questions*: 7 questions about professional life. The first (question W1) is about professional status, the second (question W2) and third (question W3) is about the days that the patient was bed-ridden (W2) and did not perform his usual daily activities (W3), after the placement or removal of ureteral stent (depending on when the questionnaire was filled). The fourth question is about the kind of professional occupation, and the rest of the questions were answered only by those that were currently working and are about the quality of their work with questions in Likert scale. From adding the answers in questions W5-W7, we get the *Quality of Work Score* (QWS), which ranges from 3 to 15. By adding the QWS and the answers to the questions W2, W3, we get the *Work Performance Score* (WPS). The days of being bedridden, the half days of loss of activity, the QWS and WPS are presented.
- *5th group of questions*: it is about 3 questions (S1, S2i and S2ii or S3 and S4, the patients were asked to answer the questions S2i and S2ii or S3 and S4 depending on the answer they gave on the question S1 about sexual life). The percentage of patients that did not have active sexual life (S1), either due to stent placement or due to lack of effort on their behalf (S2i, S2ii) is presented. Additionally, by adding the values from the answered questions S3, S4, we get the Œ (QSS).
- *6th group of questions*: it is about questions regarding additional problems that emerge while the ureteral stent is in place (*in situ*). The results from the answered questions A1-A4 are presented as the percentage of patients that mention each particular problem and/or the frequency of the particular problem occurrence.
- *7th question*: it is the "*Global Quality of Life*" for the time period that the stent was in situ. The answer to the question GQ is presented.

Inclusion criteria

In this particular prospective observational study, only patients aged over 18 years old who had double-j stent placement were included. The material of the double-j stent was Percuflex. This particular material was selected due to its availability in our hospital.

The double-j stents placed were of the following sizes: 4.8Fr26cm, 4.8Fr28cm, 6Fr26cm and 6Fr28cm.

The choice of the size for each particular case depended on the double-j stent availability at the time of the operation as well as on the surgeon's preference. All the participants signed an informed consent form.

The patients should have an adequate knowledge of the English language so they would be able to fill the USSQ.

Exclusion criteria

Patients with hydronephrosis due to malignant diseases were excluded from this trial.

Outcome of interest

The purpose of this trial is to investigate the relationship between the double-j stent's characteristics and the appearance of complications from double-j stent use, as defined by «*Ureteric Stent Symptoms Questionnaire*»

Statistical analysis

The statistical analysis was performed according to protocol (per protocol analysis), for all the patients that were included in the prospective observational study. The level of statistical importance was set to 0.05 and all p- values were two-tailed. The description of the results of the quantitative variables was performed with the presentation of mean values and standard deviations. The description of the results of the qualitative variables was performed with the use of frequency and percentages. Because the sample was 200 patients (N > 50), the test used for normality was the Kolmogorov-Smirnov test. Pearson Chi-Square test was used to compare qualitative variables, and ANOVA was used to compare continuous quantitative variables. SPSS software was used for statistical analysis.

RESULTS

In total, during the period 01.09.2021-01.09.2023, BS-Percuflex double-j stents were placed in 500 patients at our tertiary *Urology Clinic*. Of these, 300 were excluded and were not included in the statistical analysis because the double-j stents were placed in those patients in order to relieve obstruction due to oncological causes. The statistical analysis according to the protocol was performed on the data of 200 patients who met all the inclusion criteria.

Basal patients' characteristics

The baseline characteristics of the patients are presented in Table 1. A total of 200 patients were enrolled in the study of which 53.5% were male. Their mean age was 49 ± 15.5 years and mean height and BMI, 175 ± 8.94 cm and 23.8 ± 7.6 cm respectively. In the majority (97%) the reason for ureteral stent placement was the presence of a stone in the ureter, either left (57.5%) or right (42.5%) with a mean size of 12.5 ± 3.7 mm.

Table 2 shows the baseline characteristics of the patients and data on urological interventions in the 4 study groups. Regarding anthropometric characteristics, there were statistically significant differences between the 4 groups in terms of weight ($p < 0.001$) and height ($p < 0.001$).

Group B and D were composed of patients of greater weight and height, compared to the other two groups (Figure 1). The sample was homogeneous in terms of the presence of comorbidities, the characteristics (diameter, material) of the Foley urinary catheter used and the reason for ureteral stent placement. In all groups, ureteral stents were placed mainly due to the presence of a stone (96.1-100%) with no statistically significant differences in size, stone location and duration of the procedure between the 4 groups.

Regarding the laboratory findings of the patients in the 4

Table 1.
Basal patient characteristics.

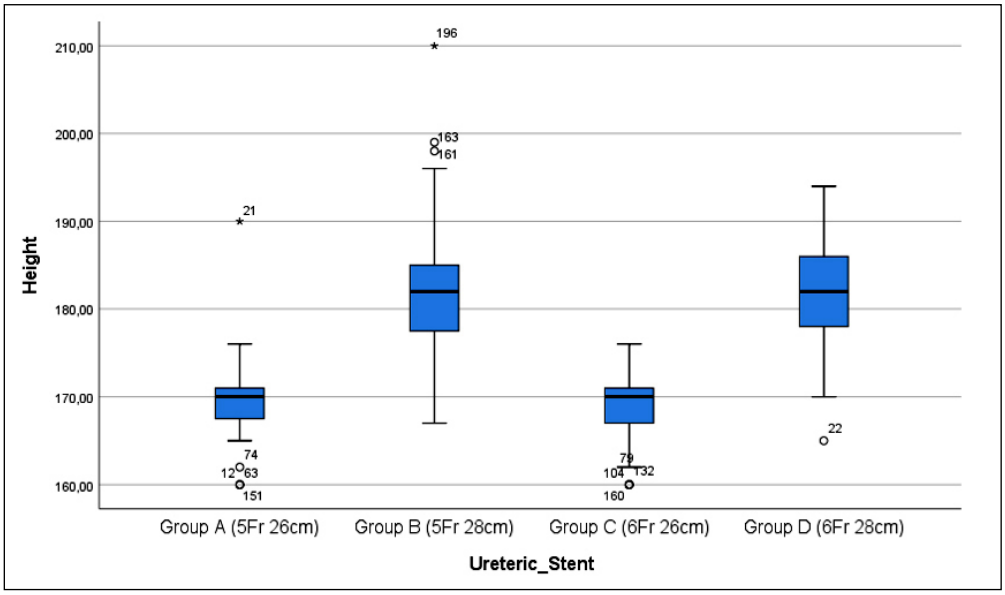
		Mean (SD)	N (%)
Sex	Male	-	107 (53.5)
	Female	-	93 (46.5)
Age (years)		49 (15.5)	-
Weight (kg)		79.84 (12.5)	-
Height (cm)		175 (8.94)	-
BMI (kg/m^2)		23.8 (7.6)	-
Reason for stent insertion	Stone	-	194 (97)
	Stenosis	-	6 (3)
Stone Size (mm)		12.5 (3.7)	-
Stone or Stenosis Location	Left	-	115 (57.5)
	Right	-	85 (42.5)

BMI: Body Mass Index; SD: Standard Deviation.

		Group A (N = 51, 25.5%) Mean ± SD	Group B (N = 51, 25.5%) Mean ± SD	Group C (N = 49, 24.5%) Mean ± SD	Group D (N = 49, 24.5%) Mean ± SD	P (95% CI)
Sex, N (%)	Male	31	25	24	27	0.58 ++
	Female	20	26	25	22	
Age (years)		51.7 ± 14	47.4 ± 15.8	49.5 ± 15.7	47.4 ± 16.5	0.14 +
Weight (kg)		72.3 ± 9.6	88.6 ± 13	73.1 ± 8.1	85.4 ± 9.6	< 0.001 +
Height (cm)		169 ± 4.6	183 ± 8.4	168.7 ± 4	181.4 ± 6	< 0.001 +
BMI (kg/m^2)		22.3 ± 9	24.6 ± 7.6	23.6 ± 7.9	25 ± 5.7	0.19 +
Hypertension		9 (17.6)	3 (5.8)	8 (16.3)	9 (18.4)	0.24 ++
Diabetes Mellitus		2 (3.9)	1 (1.9)	1 (2)	0 (0)	0.58 ++
Coronary Heart Disease		5 (9.8)	2 (3.9)	4 (8.2)	0 (0)	0.13 ++
Prostate Hyperplasia		5 (9.8)	1 (1.9)	2 (4.1)	5 (10.2)	0.24 ++
Foley Diameter (Fr.)	14	2 (3.9)	0 (0)	0 (0)	1 (2)	0.450 ++
	16	36 (70.6)	34 (66.6)	29 (59.2)	32 (65.3)	
	18	13 (25.5)	17 (33.3)	20 (40.8)	16 (32.7)	
	Latex	32 (62.7)	28 (54.9)	38 (77.5)	35 (71.4)	0.08 ++
	Silicone	19 (37.3)	23 (45.1)	11 (22.4)	14 (28.6)	
Reason for stent insertion (N %)	Stone	49 (96.1)	50 (98)	49 (100)	47 (96)	0.14 ++
	Stenosis	2 (3.9)	1 (2)	0 (0)	2 (4)	
Procedure Duration		38.2 ± 31.4	38.5 ± 19.1	39 ± 14.7	43.4 ± 28.8	0.69 +
Stone Size (mm)		12.5 ± 3.4	12.9 ± 4	12.2 ± 3.7	12.3 ± 4	0.86 +
Stone or Stenosis Location (N %)	Left	29 (56.9)	30 (58.9)	32 (65.3)	24 (49)	0.43 ++
	Right	22 (43.1)	21 (41.1)	17 (34.7)	25 (51)	

+ One Way Anova (ANOVA); ++ Pearson Chi Square.

Table 2.
Basic characteristics of patients and interventions by group.



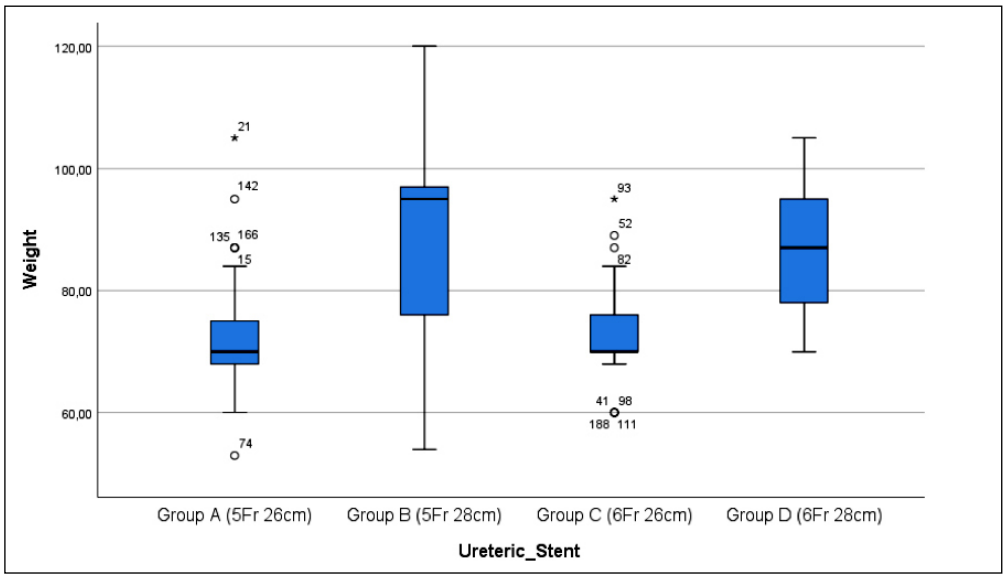


Figure 1.
Box-Plot presenting the height (up) and weight (down) of the patients in the 4 groups.
Y axis: Height (cm), Weight (kg).
X axis: Patient Group (A, B, C, D).

groups, no statistically significant differences were observed in urea, creatinine, white blood cells, *C reactive protein* (CRP), urine and blood culture. There was no difference in any of the measured time-points (preoperative, postoperative, values at discharge). The same was true for the observed change in the values of the aforementioned variables, between postoperative and preoperative period, and between discharge and preoperative period. However, in terms of clinical characteristics, febrile episodes after ureteral stent placement occurred only in patients in groups A and D, but there was no difference between these two in terms of the mean duration of febrile episodes and temperature values.

Responses to the Ureteric Stent Symptoms Questionnaire at 1 week after placement of the ureteric stent (stent in situ)

The results regarding the patients' responses during the first week after ureteral stent placement are presented in Table 4. In general, no statistically significant differences were observed between the 4 groups in terms of urinary symptoms, pain severity, general health status, occupational activity, and additional problems that may be related to the ureteral stent. However, a statistically significant difference was observed in the location of pain. In particular, 82.4% of patients in Group A reported pain in the Kidney Back region which was higher compared to the percentages of patients in the other groups (Group B: 68.8%, Group D: 62.5) and with Group C reporting the lowest percentage i.e. 31.3% (p = 0.04) (Figure 2).

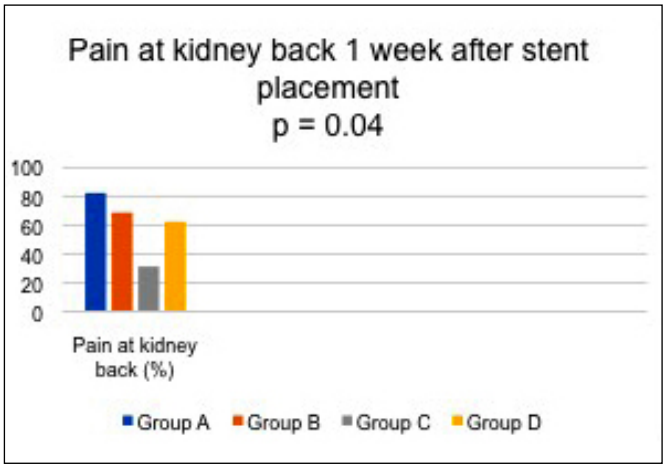
In addition, differences were also present regarding the sexual life of the patients. Although no one had an active sex life in the 1st week after stent placement, Group C patients had stopped being sexually active before stent placement, at 22. 4% which is three times higher than the rates in the other groups (Group A: 9.8%, Group B: 7.8%, Group D: 6.1%, p = 0.04). The same proportions of patients, as expected, stated that the reason for sexual inactivity was not related to the symptoms caused by the stent (p = 0.04) (Figure 3).

		Group A (N = 51, 25.5%) Mean ± SD	Group B (N = 51, 25.5%) Mean ± SD	Group C (N = 49, 24.5%) Mean ± SD	Group D (N = 49, 24.5%) Mean ± SD	P (95% CI)
Urea (mg/dl)	Preoperative	54.2 ± 85.6	38.9 ± 9.3	44.3 ± 13.4	62.6 ± 134	0.47+
	Postoperative	43.4 ± 13.4	42 ± 9.2	46.1 ± 11.8	44.7 ± 13.8	0.37 +
	Discharge	33.2 ± 10.6	32.9 ± 10.2	35 ± 10.2	57.1 ± 165.3	0.44 +
	Post-pre	-10.9 ± 80	3.1 ± 11.8	1.6 ± 11.6	-17.8 ± 126	0.44 +
	Discharge-Pre	-21 ± 79.2	-3.12 ± 15	-9.4 ± 17.2	-5.4 ± 33.9	0.20 +
Creatinine (mg/dl)	Preoperative	1.17 ± 0.7	1.05 ± 0.3	1.15 ± 0.45	0.98 ± 0.54	0.64 +
	Postoperative	1.07 ± 0.67	1.02 ± 0.24	1.01 ± 0.31	1.1 ± 0.6	0.82 +
	Discharge	0.99 ± 0.57	0.96 ± 0.15	0.91 ± 0.14	0.99 ± 0.28	0.66 +
	Post-pre	-0.1 ± 0.27	-0.02 ± 0.21	-0.14 ± 0.2	-0.04 ± 0.33	0.12 +
	Discharge-Pre	-0.2 ± 0.37	-0.09 ± 0.26	-0.24 ± 0.4	-0.15 ± 0.38	0.17 +
WBCs (x10) mg/dl)	Preoperative	7.9 ± 3.4	7.12 ± 1.8	5.85 ± 4.5	6.17 ± 3.5	0.56 +
	Postoperative	11,4 ± 5.5	9.92. ± 5.1	8.95 ± 6.1	8.57 ± 5.8	0.85 +
	Discharge	4.93 ± 5.4	4.17 ± 5.2	5.1 ± 5.4	5.42 ± 5.5	0.69 +
	Post-pre	2.6 ± 5.4	2.3 ± 3.9	3.5 ± 4.4	2.4 ± 5.1	0.59 +
	Discharge-Pre	-3.53 ± 2.1	-2.8 ± 3.3	-3.1 ± 1.6	-2.48 ± 2.3	0.86 +
CRP (mg/L)	Preoperative	85 ± 51	75 ± 64	88 ± 49	76 ± 80	0.34 +
	Postoperative	50 ± 29	46 ± 45	58 ± 81	47 ± 75	0.34 +
	Discharge	39 ± 28	33 ± 32	37 ± 23	31 ± 38	0.81 +
	Post-pre	-35 ± 22	-29 ± 19	-30 ± 32	-29 ± 5	0.65 +
	Discharge-Pre	-46 ± 22	-42 ± 32	-51 ± 26	-45 ± 42	0.33 +
Fever**	N (%)	6 (11.8)	0 (0)	0 (0)	3 (6.1)	0.01 *
	Temperature (°C)	39.3 ± 0.3	-	-	39.3 ± 0.32	0.79 ++ (-0.32, 0.4)
	Duration (days)	3 ± 0.6	-	-	2.4 ± 0.8	0.2 ++ (-0.35,1.46)
Blood Culture	Positive	0 (0)	0 (0)	0 (0)	0 (0)	
Urine Culture (positive)	Preoperative	4 (7.8)	2 (3.9)	6 (12.2)	2 (4.1)	0.32 *
	Postoperative	0 (0)	0 (0)	3 (6.1)	0 (0)	0.15 *

*+ One Way ANOVA, ++ Independent Samples t-test, *Pearson Chi-Square test, **Fever Postoperatively.*
Post-pre: Difference between postoperative and preoperative values; Discharge-Pre: Difference between discharge and preoperative values; BMI: Body Mass Index; SD: Standard Deviation; 95% CI: 95% Confidence Interval. Discharge-pre: Difference between values at hospital discharge and preoperative values; WBCs: White Blood Cells; CRP: C-reactive protein.

Table 3. *Clinical laboratory findings of patients by group.*

Figure 2.
Bar chart presenting the pain in the kidney back region, one week after ureteral stent placement.
X axis: Groups of patients.
Y axis: Percentage of patients who reported pain in the kidney back area.



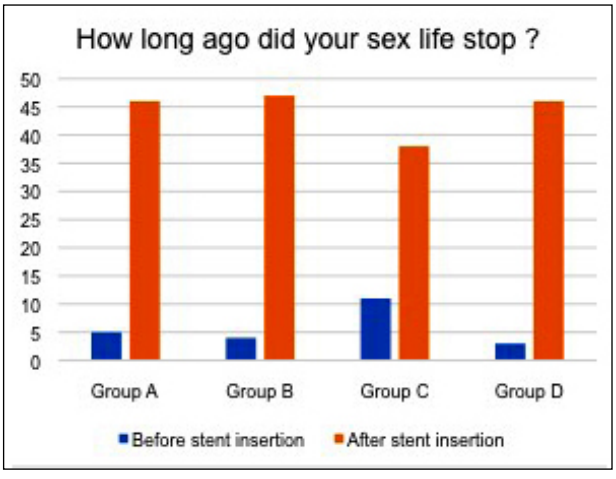


Figure 3.
Bar chart which shows the percentage of patients who reported that they stopped having an active sex life before (blue) and after (orange) ureteral stenting.
X axis: Groups of patients.
Y axis: Percentage of patients who reported that they stopped having an active sex life before (blue) and after (orange) ureteral stent placement.

Table 4.

Responses to the ureteric stent symptoms Questionnaire 1, one week after placement of the ureteric stent (stent in situ).

		Group A (N = 51, 25.5%) Mean ± SD	Group B (N = 51, 25.5%) Mean ± SD	Group C (N = 49, 24.5%) Mean ± SD	Group D (N = 49, 24.5%) Mean ± SD	P (95% CI)
U1-U11. Urinary Index Score (UIS) (Mean ± SD)		23.06 ± 2.6	23.02 ± 2.8	23.4 ± 2.6	23.6 ± 2.5	0.61 +
P1. Do you experience body pain or discomfort in association with the stent? (N %)	No	34 (66.6)	35 (68.6)	33 (67.3)	33 (67.3)	0.99 ++
	Yes	17 (33.4)	16 (31.4)	16 (32.7)	16 (32.7)	
P2. Site(s) where you experience pain or discomfort in association	Kidney Front	17/17 (100)	16/16 (100)	16/16 (100)	16/16 (100)	N/A
with the stent typically (N %)	Groin Area	16/17 (94.1)	15/16 (93.8)	15/16 (93.8)	14/16 (87.5)	0.88 ++
	Bladder Area	1/17	1/16	2/16	0	0.51 ++
	Kidney Back	14/17 (82.4)	11/16 (68.8)	5/16 (31.3)	10/16 (62.5)	0.04 ++
P3. Sum of the VAS scores for all sites of pain (Mean ± SD)		7.2 ± 0.4	7.3 ± 0.6	7.4 ± 0.8	6.9 ± 0.8	0.2 +
P3-P9. Pain Index Score (Mean ± SD)		20.47 ± 1.5	20.25 ± 2.3	19.3 ± 2.4	19.8 ± 2.6	0.45 +
G1-G6. General Health Index Score (Mean ± SD)		10.5 ± 3.1	10.4 ± 2.9	10.8 ± 3.1	9.6 ± 2.1	0.17 +
W1. Status of employment (N %)	Full time	16 (31.4)	18 (35.25)	14 (28.6)	15 (30.6)	0.53 ++
	Part time	19 (37.2)	16 (31.4)	16 (32.7)	15 (30.6)	0.42 ++
	Retired on health ground	0	0	0	0 (2)	0.67 ++
	Retired for other reason	2 (3.9)	1 (1.95)	0	1	0.8 ++
	Student	0	0	0	0	N/A
	Unemployed, looking for work	14 (27.5)	16 (31.4)	19 (38.7)	18 (36.8)	0.67 ++
W2. How many days did the symptoms associated with the stent keep you in bed all or most of the day (Mean ± SD)		2.45 ± 1.7	2.29 ± 1.5	2.18 ± 1.8	2.36 ± 1.4	0.85 +
W3. How many half days or more did you cut down your routine activities because of the symptoms associated with the stent (Mean ± SD)		2.56 ± 1.7	2.73 ± 1.1	2.49 ± 1.5	2.61 ± 1.8	0.37 +
W4. Type of employment (N %)	Employee	15 (29.4)	17 (33.3)	18 (36.7)	15 (30.6)	0.6 ++
	Employer	9 (17.6)	12 (23.6)	9 (18.3)	10 (20.4)	
	Self Employed	27 (53)	22 (43.1)	22 (45)	24 (49)	
W5-W7. Quality of work for those who are in active paid jobs (Mean ± SD)		6.8 ± 1.6	6.9 ± 1.7	6.7 ± 1.4	6.4 ± 1.5	0.6 +
S1. Do you have an active sex life?	No	51 (100)	51 (100)	49 (100)	49 (100)	N/A
S2. i) If no sex life, how long ago did this stop? (N %)	After insertion of the stent	46 (90.2)	47 (92.2)	38 (77.6)	46 (93.9)	0.04 ++
	Before insertion of the stent	5 (9.8)	4 (7.8)	11 (22.4)	3 (6.1)	
	Because of the problems associated with the stent	0	0	0	0	
ii) Why did this stop? (N %)	Did not attempt any sexual activity	46/51 (90.2)	47/51 (92.2)	38/49 (77.6)	46/49 (93.9)	0.04 ++
	Some other reason - not to do with the symptoms of the stent	5/51 (9.8)	4/51 (7.8)	11/49 (22.4)	3/49 (6.1)	
S3-S4. Quality of sex (Mean ± SD)		N/A	N/A	N/A	N/A	N/A
A1. How many times have you felt you may be suffering from a urinary tract infection	Never	49 (96.1)	43 (84.3)	46 (93.4)	43 (87.8)	0.16 ++
(e.g. running temperature, feeling unwell and pain while passing urine)? (N %)	Occasionally	2 (3.9)	8 (15.7)	3 (6.6)	6 (12.2)	
	Sometimes	0	0	0	0	
	Most of the time	0	0	0	0	
	All of the time	0	0	0	0	
A2. Have you needed to take antibiotics as a result of insertion of the stent? (N %)	Not at all	51 (100)	51 (100)	49 (100)	49 (100)	N/A
	One course	0	0	0	0	
	Two Courses	0	0	0	0	
	Three or more courses	0	0	0	0	
A3. Have you needed to seek help of a health professional (such as GP, nurse)	Never	51	51	49	49	N/A
due to any problem associated with the stent? (N %)	Once	0	0	0	0	
	Twice	0	0	0	0	
	Three or more times	0	0	0	0	
A4. Have you needed to visit the hospital due to any problem associated	Never	51 (100)	49 (96.1)	48 (97.9)	49 (100)	0.44 ++
with the stent? (N %)	Once	0	1 (1.95)	0	0	
	Twice	0	0	1 (2.1)	0	
	Three or more times	0	1 (1.95)	0	0	
GQ. Global Quality of life with the stent in situ:	Delighted	0	1	1	1	0.37 ++
In the future, if you were advised to have another stent inserted,	Pleased	21	16	19	19	
how would you feel about it? (N %)	Mostly satisfied	9	20	15	20	
	Mixed feelings	18	12	13	8	
	Mostly dissatisfied	3	1	0	1	
	Unhappy	0	1	1	0	
	Terrible	0	0	0	0	

+ One Way ANOVA test; ++ Pearson Chi Square test; N/A: Not Applicable; SD: Standard Deviation; VAS: Visual Analogue.

Table 5.
Responses to the ureteric stent symptoms Questionnaire 1, four (4) weeks after ureteric stent placement.

		Group A (N = 51, 25.5%) Mean ± SD	Group B (N = 51, 25.5%) Mean ± SD	Group C (N = 49, 24.5%) Mean ± SD	Group D (N = 49, 24.5%) Mean ± SD	P (95% CI)
U1-U11. Urinary Index Score (UIS) (Mean ± SD)		18.5 ± 2.3	18.6 ± 2.3	18.7 ± 2.5	18.4 ± 2.7	0.87 +
P1. Do you experience body pain or discomfort in association with the stent? (N %)	No	34 (66.7)	35 (68.6)	34 (69.4)	33 (67.3)	0.99 ++
	Yes	17 (33.3)	16 (31.4)	15 (30.6)	16 (32.7)	
P2. Site(s) where you experience pain or discomfort in association with the stent typically (N %)	Kidney Front	11/17 (64.7)	16/16 (100)	14/15 (93.3)	16/16 (100)	0.04++
	Groin Area	12/17 (70.6)	6/16 (37.5)	4/15 (26.7)	7/16 (43.8)	0.1 ++
	Bladder Area	1/17 (5.9)	1/16 (6.3)	1/15 (6.7)	0 (0)	0.8 ++
	Kidney Back	12/17 (70.6)	6/17 (35.3)	4/15 (26.7)	7/16 (43.8)	0.1 ++
P3. Sum of the VAS scores for all sites of pain (Mean ± SD)		5.7 ± 0.8	5.5 ± 0.9	5.6 ± 0.9	5.8 ± 0.8	0.78 +
P3-P9. Pain Index Score (Mean ± SD)		15.5 ± 2.1	14.8 ± 1.8	14.7 ± 2.3	15.1 ± 2.1	0.7 +
G1-G6. General Health Index Score (Mean ± SD)		8.7 ± 1.9	8.6 ± 1.7	8.9 ± 2.3	8 ± 1.1	0.07 +
W1. Status of employment (N %)	Full time	16 (31.4)	18 (35.25)	14 (28.6)	15 (30.6)	0.53 ++
	Part time	19 (37.2)	16 (31.4)	16 (32.7)	15 (30.6)	0.42 ++
	Retired on health ground	0	0	0	0 (2)	0.67 ++
	Retired for other reason	2 (3.9)	1 (1.95)	0	1	0.8 ++
	Student	0	0	0	0	N/A
	Unemployed, looking for work	14 (27.5)	16 (31.4)	19 (38.7)	18 (36.8)	0.67 ++
W2. How many days did the symptoms associated with the stent keep you in bed all or most of the day (Mean ± SD)		1.75 ± 1.2	1.73 ± 1.2	1.76 ± 1.4	1.65 ± 1.01	0.98 +
W3. How many half days or more did you cut down your routine activities because of the symptoms associated with the stent (Mean ± SD)		1.47 ± 1.2	1.58 ± 1.19	1.81 ± 1.24	1.71 ± 1	0.48 +
W4. Type of employment (N %)	Employee	15 (29.4)	17 (33.3)	18 (36.7)	15 (30.6)	0.6 ++
	Employer	9 (17.6)	12 (23.6)	9 (18.3)	10 (20.4)	
	Self Employed	27 (53)	22 (43.1)	22 (45)	24 (49)	
W5-W7. Quality of work for those who are in active paid jobs (Mean ± SD)		6.8 ± 1.6	6.9 ± 1.7	6.7 ± 1.4	6.4 ± 1.5	0.6 +
S1. Do you have an active sex life?	No	47 (92.2)	48 (94.2)	45 (91.8)	47 (95.9)	N/A
	Yes	4 (7.8)	3 (5.8)	4 (8.2)	2 (4.1)	
S2. i) If no sex life, how long ago did this stop? (N %)	After insertion of the stent	42/47 (89.4)	44/48 (91.7)	34/45 (75.6)	44/47 (93.6)	0.03 ++
	Before insertion of the stent	5/47 (10.6)	4/48 (8.3)	11/45 (24.4)	3/47 (6.4)	
ii) Why did this stop? (N %)	Did not attempt any sexual activity	42/47 (89.4)	44/48 (91.7)	35/45 (77.8)	43/47 (91.5)	0.04 ++
	Some other reason – not to do with the symptoms of the stent	5/47 (10.6)	5/48 (8.3)	10/45 (22.2)	4/47 (8.5)	
S3-S4. Quality of sex (Mean ± SD)		4.3 ± 0.9	4 ± 1	2.7 ± 0.9	3.3 ± 0.6	0.16 +
A1. How many times have you felt you may be suffering from a urinary tract infection (e.g. running temperature, feeling unwell and pain while passing urine)? (N %)	Never	49/51 (96.1)	44/51 (86.3)	46/49 (93.9)	44/49 (89.8)	0.29 ++
	Occasionally	2/51 (3.9)	7/51 (13.7)	3/49 (6.1)	5/49 (10.2)	
A2. Have you needed to take antibiotics as a result of insertion of the stent? (N %)	One course	51 (100)	51 (100)	49 (100)	49 (100)	N/A
A3. Have you needed to seek help of a health professional (such as GP, nurse) due to any problem associated with the stent? (N %)	Never	51	51	49	49	N/A
	Once	0 (0)	1 (2)	0 (0)	(0)	
A4. Have you needed to visit the hospital due to any problem associated with the stent? (N %)	Never	51 (100)	49 (96.1)	48 (97.8)	49 (100)	0.44 ++
	Once	0 (0)	2 (3.9)	1 (2.2)	(0)	
GQ. Global Quality of life with the stent in situ: In the future, if you were advised to have another stent inserted, how would you feel about it? (N %)	Delighted	0 (0)	1 (2)	1 (2.1)	1 (2.1)	0.06 ++
	Pleased	21 (41,2)	16 (31.4)	19 (38.8)	19 (38.8)	
	Mostly satisfied	9 (17.6)	20 (39.2)	19 (38.8)	23 (46.9)	
	Mixed feelings	19 (37.3)	14 (27.4)	9 (18.2)	6 (12.2)	
	Mostly dissatisfied	2 (3.9)	0	0	0	
	Unhappy	0	0	1 (2.1)	0	
	Terrible					

+ One Way ANOVA test; ++ Pearson Chi Square test; N/A: Not Applicable; SD: Standard Deviation; VAS: Visual Analogue.

Responses to the Ureteric Stent Symptoms Questionnaire at week 4 after placement of the ureteric stent (stent in situ)

The results regarding the patients' responses at the fourth week after ureteral stent placement are presented in Table 5. In general, no statistically significant differences were observed between the 4 groups in terms of urinary symptoms, pain severity, general health status, occupational activity, and additional problems that may be related to the ureteral stent. However, a statistically significant difference was observed in the location of pain. Specifically, 64.7% of Group A patients reported pain in the kidney front area which was lower compared to the percentages of patients in the other groups (Group B: 100%, Group C: 93.3%, Group D: 100%, p = 0.04) (Figure 4). In addition, differences were also present regarding the patients' sex life. As

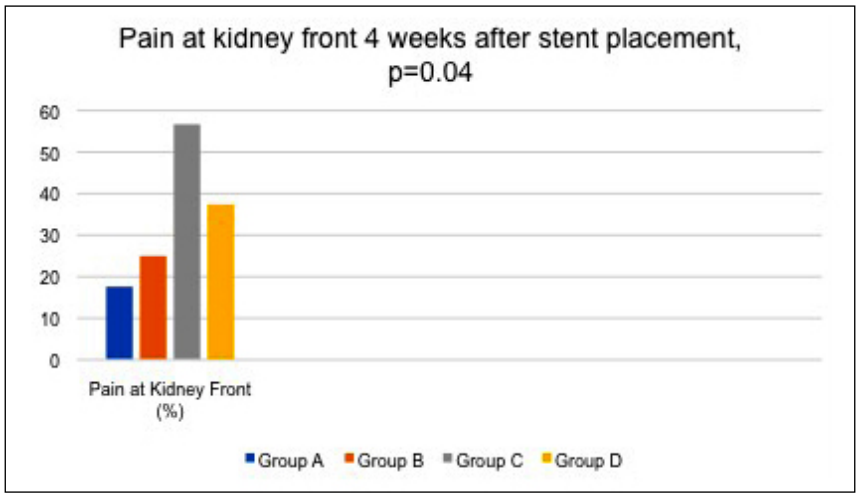


Figure 4.
Bar chart where pain is present in the kidney front area four weeks after placement of the ureteral stent.
X axis: Groups of patients.
Y axis: Percentage of patients who reported pain in the kidney front area.

Table 6.

		Group A (N = 51, 25.5%) Mean ± SD	Group B (N = 51, 25.5%) Mean ± SD	Group C (N = 49, 24.5%) Mean ± SD	Group D (N = 49, 24.5%) Mean ± SD	P-value
U1-U11. Urinary Index Score (UIS) (Mean ± SD)		14.4 ± 1.7	14.4 ± 1.8	14.1 ± 1.6	14.5 ± 1.8	0.68 +
P1. Do you experience body pain or discomfort in association with the stent? (N %)	No	38 (74)	39 (76.5)	36 (73.5)	36 (73.5)	0.98 ++
	Yes	13 (26)	12 (23.5)	13 (26.5)	13 (26.5)	
P2. Site(s) where you experience pain or discomfort in association with the stent typically (N %)	Kidney Front	11 (84.6)	7 (58.3)	11 (84.6)	10 (76.9)	0.57++
	Groin Area	7 (53.8)	9 (75)	10 (76.9)	9 (69.2)	0.85 ++
	Bladder Area	1 (7.6)	1 (8.3)	1 (7.6)	0 (0)	0.81 ++
	Kidney Back	12 (92.3)	6 (50)	5 (38.5)	7 (53.8)	0.25 ++
P3. Sum of the VAS scores for all sites of pain (Mean ± SD)		5.6 ± 0.7	5.6 ± 1.1	5.6 ± 0.9	5.7 ± 0.8	0.96 +
P3-P9. Pain Index Score (Mean ± SD)		3.8 ± 6.7	3.4 ± 6.3	3.8 ± 6.4	4.1 ± 6.9	0.97 +
G1-G6. General Health Index Score (Mean ± SD)		7.1. ± 1.2	7.1 ± 1.1	7.1 ± 1.2	6.8 ± 0.8	0.57 +
W1. Status of employment (N %)	Full time	16 (31.4)	18 (35.25)	14 (28.6)	15 (30.6)	0.53 ++
	Part time	19 (37.2)	16 (31.4)	16 (32.7)	15 (30.6)	0.42 ++
	Retired on health ground	0	0	0	0 (2)	0.67 ++
	Retired for other reason	2 (3.9)	1 (1.95)	0	1	0.8 ++
	Student	0	0	0	0	N/A
	Unemployed, looking for work	14 (27.5)	16 (31.4)	19 (38.7)	18 (36.8)	0.67 ++
W2. Following removal of the stent, how many days did the symptoms associated with the kidney problem keep you in bed all or most of the day (Mean ± SD)		0 (0)	0 (0)	0 (0)	0 (0)	N/A
W3. Following removal of the stent, how many half days or more did you cut down your routine activities because of the symptoms associated with the kidney problem (Mean ± SD)		0 (0)	0 (0)	0 (0)	0 (0)	N/A
W4. Type of employment (N %)	Employee	15 (29.4)	17 (33.3)	18 (36.7)	15 (30.6)	0.6 ++
	Employer	9 (17.6)	12 (23.6)	9 (18.3)	10 (20.4)	
	Self Employed	27 (53)	22 (43.1)	22 (45)	24 (49)	
W5-W7. Quality of work for those who are in active paid jobs (Mean ± SD)		3.5 ± 0.5	3.6 ± 0.5	3.5 ± 0.6	3.5 ± 0.5	0.86 +
S1. Do you have an active sex life?	No	5 (9.8)	4 (7.8)	7 (14.3)	3 (5.9)	0.55 ++
	Yes	46 (90.2)	47 (92.2)	42 (85.7)	46 (93.8)	
S2. i) If no sex life, how long ago did this stop? (N %)	After insertion of the stent	0 (0)	0 (0)	0 (0)	0 (0)	N/A
	Before insertion of the stent	5/5 (100)	4/4 (100)	7/7 (100)	3/3 (100)	
ii) Why did this stop? (N %)	Did not attempt any sexual activity	0 (0)	0 (0)	0 (0)	0 (0)	N/A
	Some other reason - not to do with the symptoms of the stent	5/5 (100)	4/4 (100)	7/7 (100)	3/3 (100)	
S3-S4. Quality of sex (Mean ± SD)		2.52 ± 0.5	2.51 ± 0.5	2.4 ± 0.5	2.3 ± 0.6	0.29 +
GQ. Global Quality of life with the stent in situ: In the future, if you were advised to have another stent inserted, how would you feel about it? (N %)	Delighted	3 (5.8)	0	3 (6.1)	0	0.12 ++
	Pleased	9 (17.6)	20 (39.3)	15 (30.6)	21 (42.8)	
	Mostly satisfied	35 (68.6)	30 (58.8)	26 (53.1)	26 (53.1)	
	Mixed feelings	4 (8)	1 (1.9)	3 (6.1)	2 (4.1)	
	Mostly dissatisfied	0	0	1 (2.05)	0	
	Unhappy	0	0	1 (2.05)	0	
	Terrible	0	0	0	0	

+ One Way ANOVA test; ++ Pearson Chi Square test; N/A: Not Applicable; SD: Standard Deviation; VAS: Visual Analogue.

Table 7a.
Dependent variables.

Independent variables	UIS_t1	UIS_t2	UIS_t3	PIS_t1	PIS_t2	PIS_t3	GH_t1	GH_t2	GH_t3
Ureteric Stent Group	0.170, p = 0.8	-0.035, p = 0.8	-0.004, p = 0.9	-0.336, p = 0.2	0.047, p = 0.8	-0.177, p = 0.7	-0.131, p = 0.5	-0.091, p = 0.5	-0.068, p = 0.4
Age	-0.003, p = 0.8	-0.007, p = 0.6	-0.002, p = 0.8	0,001, p = 0.9	0.011, p = 0.5	-0.038, p = 0.2	0.018, p = 0.2	0.01, p = 0.3	0.004, p = 0.4
Weight	-0.014, p = 0.6	-0.047, p = 0.06	-0.015, p = 0.4	0.021, p = 0.6	0.011, p = 0.7	-0.012, p = 0.8	0.027, p = 0.4	0.01, p = 0.6	-0.001, p = 0.9
Height	-0.004, p = 0.9	0.023, p = 0.47	0.002, p = 0.9	0.047, p = 0.3	0.015, p = 0.7	0.047, p = 0.56	-0.049, p = 0.2	-0.035, p = 0.1	-0.004, p = 0.7
BMI	0.001, p = 0.8	0.004, p = 0.15	0.002, p = 0.4	0.003, p = 0.6	0.001, p = 0.9	0.007, p = 0.4	-0.005, p = 0.1	-0.002, p = 0.3	-0.001, p = 0.6

** Multiple Linear regression analysis. P-values are shown. UIS: Urinary Index Score; PIS: Pain Index Score; GH: General Health; t1: one week after stent placement; t2: four weeks after stent placement; t3: four week after stent removal.*

Table 7b.

Independent variables	QW_t1	QW_t2	QW_t3	QS_t2	QS_t3
Ureteric Stent Group	-0.14, p = 0.3	-0.076, p = 0.4	-0.011, p = 0.8	-0.521, p = 0.09	-0.069, p = 0.07
Age	-0.002, p = 0.8	-0.004, p = 0.6	0.001, p = 0.7	-0.182, p = 0.1	0.001, p = 0.7
Weight	0.021, p = 0.2	0.009, p = 0.5	0.003, p = 0.7	-0.06, p = 0.2	-0.002, p = 0.7
Height	-0.007, p = 0.7	-0.008, p = 0.6	0.005, p = 0.5	0.096, p = 0.1	0.007, p = 0.4
BMI	-0.001, p = 0.5	-0.001, p = 0.4	0.001, p = 0.7	0.007, p = 0.2	-0.001, p = 0.4

** Multiple Linear regression analysis.P-values are shown.*
QW: Quality of Work; QS: Quality of sex; t1: one week after stent placement; t2: four weeks after stent placement; t3: four week after stent removal.

in the questionnaire completed at week 1 after stent placement, Group C patients reported that they had stopped being sexually active before stent placement, at a higher rate of 24.4% compared to the rates of the other groups (Group A: 10.6%, Group B: 8.3%, Group D: 6.4%, p = 0.03). The difference in rates with those of the first week is due to the fact that a small number of patients achieved active sexual activity at week 4 (Group A: 7.8%, Group B: 5.8%, Group C: 8.2%, Group D: 4.1%, p = 0.83).

Responses to the Ureteric Stent Symptoms Questionnaire at week 4 after removal of the ureteric stent (post stent)

At 4 weeks after ureteral stent removal, no statistically significant difference was observed between ureteral catheter groups. Almost all domains have returned to normal in all patients groups.

In multivariate analysis, no statistically significant differences were found between the effects of ureteral catheter group, age, weight, height and BMI variables on *urinary index score* (UIS), *pain index score* (PIS), *general health* (GH), *quality of work* (QW) and *quality of sex* (QS) scores (Tables 7a, b)

Discussion

Aside from other purposes not covered in this text, the use of ureteral stenting acts as a preventive strategy against renal obstruction caused by leftover stone pieces, edema, hematoma, and the potential leakage of urine (9). Potential factors that may contribute to the development of *stent-related symptoms* (SRS) encompass various aspects, such as the irritation in the trigonal and renal regions due to the presence of the ureteral stent, vesicorenal reflux facilitated by the stent, as well as considerations regarding stent size, length, and position within the bladder or kidney. Furthermore, the choice of materials utilized for the stent can also exert an influence on its performance and efficacy. The source of patient discomfort primarily stems from various factors, including the extended ureteral stent intravesical segment, suboptimal double-j stent drainage, ureteral stent displacement or migration, and the rigidity of the ureteral stent (10).

Urinary reflux, characterized by the retrograde flow of urine up the stent, is a prevalent phenomenon observed in cases where intravesical pressures are elevated during voiding. This particular condition has been identified as the underlying cause in approximately 25% of instances involving moderate colic-like flank pain that was closely associated with stents. Elevated intravesical pressure exerts its impact on the renal system by inducing an elevation in intrarenal pressure. This rise in pressure within the kidney subsequently results in kidney distension, a condition characterized by the expansion or enlargement of the renal organ. Additionally, individuals experiencing elevated intrarenal pressure may also encounter flank pain, a discomfort localized in the region between the lower ribcage and the pelvis. The phenomenon was commonly referred to as "*water hammer*", that is a prevalent term in the medical field. Persistent irritation of the mucosal lining of the bladder may result in enduring discomfort despite the removal of the stent.

The alterations in the bladder mucosa are frequently encountered during cystoscopic examinations, particularly when indwelling catheters are retained for prolonged periods (11).

The presence of microscopic hematuria is commonly observed throughout the duration of ureteral stent placement, while macroscopic hematuria is frequently noted but typically self-resolves following stent insertion (11).

Stent migration, encrustation, stone formation, and fragmentation are recognized as potential complications that may arise subsequent to the implantation of a stent. Stent occlusion, a commonly encountered occurrence, necessitates expeditious replacement of the double-j stent for resolution (12). Moreover, it has been observed that a considerable proportion of individuals who have been implanted with indwelling stents, reaching up to 86% according to existing literature (13), experience suboptimal occupational functioning and diminished sexual gratification as additional complications. Females exhibit a higher propensity to present with the perception of an alien entity within the urinary bladder, primarily attributable to the distressing sensations it elicits (11).

The potential influence of stent diameter on ureteral stent symptoms remains inconclusive. The available evidence does not support the notion that employing a stent of larger diameter is associated with elevated levels of discomfort, hematuria, or symptoms pertaining to lower urinary tract obstruction. The propensity for proximal stent migration is heightened in the context of smaller diameter stents (4.8 Fr) when juxtaposed with their 6 Fr counterparts, thereby establishing them as a notable risk factor. The risk of complications in stent placement is influenced by various factors, including the duration of indwelling, the length of the stent, and the specific site of stent implantation (11).

According to our study, there was only statistical difference in the pain characteristics among the different ureteral stents, specifically during the first week a significant proportion of patients belonging to Group A, specifically 82.4%, experienced discomfort in the Kidney Back region. This percentage was notably higher when compared to the corresponding figures for patients in the other groups, with Group B reporting 68.8% and Group D reporting 62.5% and with Group C exhibiting the lowest percentage, with only 31.3% of patients reporting pain in the Kidney Back region. This disparity in percentages was found to be statistically significant, as indicated by a p-value of 0.04. During the fourth week of stent in situ, there were no statistically significant variations observed among the four groups with regards to urinary symptoms, severity of pain, overall health status, occupational activity, and other potential complications associated with the ureteral stent. A notable disparity was observed in the spatial distribution of pain, which yielded statistical significance. A significant proportion of patients belonging to Group A, namely 64.7%, experienced discomfort in the anterior region of the kidney. Remarkably, this percentage was found to be considerably lower when compared to the corresponding figures in the other groups, with Group B reporting 100%, Group C reporting 93.3%, and Group D reporting 100% pain occurrence. The statistical analysis revealed a noteworthy p-value of 0.04, indicating a significant difference among the groups. However, during the fourth week after stent removal there were no significant differences between the groups since all the preoperative parameters returned to normal.

Based on the studies conducted by *Bolat et al.* and *Sighinolfi et al.*, it has been observed that the introduction of a double-j stent is closely linked to the occurrence of sexual dysfunction in nearly all individuals, irrespective of their gender (14, 15). In our prospective observational study, Group C patients reported that they had stopped being sexually active before stent placement, at a higher rate of 24.4% compared to the rates of the other groups (Group A: 10.6%, Group B: 8.3%, Group D: 6.4%, p = 0.03). In the fourth week of stent in situ some patients managed active sexual activity (Group A: 7.8%, Group B: 5.8%, Group C: 8.2%, Group D: 4.1%, p = 0.83). The fourth week after stent removal the sexual activity returned back to normal.

Despite the optimal positioning and appropriate sizing of the stent, patients may still encounter urinary symptoms and pain that are correlated with the existence of the stent (11). In a recent study conducted by *Al-Kandari et al.*, the investigation focused on evaluating the potential influence of upper coil placement on the manifestation of stent-related complaints. The study findings revealed that the positioning of the upper coil did not yield any discernible impact on the occurrence of such complaints. However, it has been postulated that the translocation of the bladder coil across the body's midline elicits augmented sensations of urgency and discomfort during micturition (16). Several investigations carried out by *Inn et al.*, *Ho et al.*, and *Taguchi et al.* have yielded compelling findings suggesting a significant association between the insertion of a double-j stent coil into the urinary bladder, particularly on the contralateral side of the body, and the exacerbation of urinary symptoms and heightened pain levels (17-19). In a recent investigation carried out by *Abt et al.*, it was determined that the precise positioning of the stent within the bladder does not yield any discernible effects on the symptoms induced by a ureteral stent (19). In our cohort, all the double-j stents were positioned so they will not cross the midline.

The present study is subject to certain limitations, primarily stemming from its non-randomized trial design.

Conclusions

The potential influence of ureteral stent physical properties on stent-related symptoms remains inconclusive, despite numerous trials dedicated to identifying the optimal ureteral stent. In light of the limited availability of robust empirical data, a definitive conclusion cannot be ascertained at this time. The prioritization of establishing a benchmark for the quantification and documentation of the physical characteristics of stents is of utmost importance as the preliminary stage of forthcoming investigations.

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