

Should the Double-J Stent Be Removed Endoscopically after a Ureteroscopic Stone Surgery?

Üreteroroskopik Taş Cerrahisinden Sonra Double-J Stent Endoskopik Yolla Çıkarılmalı mı?

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What's known on the subject? and What does the study add?

Urologists mostly prefer to use Double-J (JJ) stents to provide better postoperative comfort for their patients without an extraction string. Our findings showed that removal of the JJ stent with its extraction string with lower treatment costs and complications does not adversely affect surgical outcomes, and has higher patient comfort.

Abstract

Objective: Ureterorenoscopic stone surgery (USS) is the primary method of ureteral stone treatment. Double-J (JJ) stenting is an integral part of a USS, and most urologists prefer to use it without an extraction string. The probable reason for such preference could be the lack of reliable and sufficient data on JJ stent use with an extraction string.

Materials and Methods: A total of 177 patients who underwent USS were divided into four groups: Group 1 men (JJ stent was manually removed), group 2 men (JJ stent was cystoscopically removed), group 3 women (JJ stent was manually removed), and group 4 women (JJ stent was cystoscopically removed). We investigated the impact of two different JJ stent removal techniques on pain perception, lower urinary tract symptoms (LUTS), depressive symptomatology, complications, and cost.

Results: Compared to groups 1 and 3, the mean surgery times were higher in groups 2 and 4 ($p=0.001$). Preoperative LUTS scores were similar in all groups ($p>0.05$). Postoperative pain scores in groups 3 and 4 were similar ($p=0.06$), but they were lower in group 1 than in group 2 ($p=0.004$). Postoperative Beck depression inventory scores were lower in groups 1 and 3 ($p<0.02$). The total cost of USS was 28.5% higher in groups 2 and 4 compared to groups 1 and 3.

Conclusion: It is concluded that JJ stent removal with an extraction string is a reliable method with low treatment costs that does not adversely affect surgical outcomes.

Keywords: Cost effectivity, Double-J stent, Extraction string, Ureterorenoscopy, Pain

Öz

Amaç: Üreterorenoskopik taş cerrahisi, üreter taşı tedavisinin temel yöntemidir. Double-J (JJ) stent, taş cerrahisinin ayrılmaz bir parçasıdır ve çoğu ürolog ipsiz JJ stent kullanmayı tercih etmektedir. Bu tercih, büyük olasılıkla, ipli JJ stent kullanımı hakkında güvenilir ve yeterli veri bulunmamasından kaynaklanmaktadır.

Gereç ve Yöntem: Üreterorenoskopik taş cerrahisi uygulanan toplam 177 hasta grup 1 erkeklere (ipli JJ stent, manuel olarak çıkarıldı), grup 2 erkek (ipsiz JJ stent sistoskopik olarak çıkarıldı), grup 3 kadınlara (ipli JJ stent, manuel olarak çıkarıldı) ve grup 4 kadınlara (ipsiz JJ stent sistoskopik olarak çıkarıldı) sınıflandırıldı. İki farklı JJ stent çıkarma tekniğinin ağrı algısı, alt idrar yolu semptomları (AÜSS), depresif semptomlar, komplikasyonlar ve maliyet üzerindeki etkisini araştırdık.

Bulgular: Grup 1 ve 3 ile karşılaştırıldığında, ortalama ameliyat süresi grup 2 ve 4'te daha yüksekti ($p=0,001$). Preoperatif AÜSS skorları tüm gruplarda benzerdi ($p>0,05$). Postoperatif 3. ve 4. gruplardaki ağrı skorları benzerdi ($p=0,06$), ancak grup 1'de grup 2'den düşüktü ($p=0,004$). Postoperatif Beck depresyon envanteri skorları 1. ve 3. gruplarda daha düşüktü ($p<0,02$). Üreterorenoskopik taş cerrahisinin toplam maliyeti grup 1 ve 3'e kıyasla grup 2 ve 4'te %28,5 daha yüksek olarak saptandı.

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Sonuç: JJ stentin ipli şekilde manuel olarak çıkarılmasının düşük tedavi maliyetleriyle güvenilir bir yöntem olduğu sonucuna ulaştık. JJ stentlerin ipli kullanımı cerrahi sonuçları olumsuz yönde etkilememektedir.

Anahtar Kelimeler: Maliyet etkinliği, Double-J stent, Ekstraksiyon ipi, Üreterorenoskopi, Ağrı

Introduction

Stone incidence varies depending on geographical, climatic, ethnic, dietary, and genetic factors with a prevalence rate of 1-14% (1). Medical expulsive treatment (MET), shock wave lithotripsy (SWL), and ureterorenoscopic stone surgery (USS) are the primary methods used in ureteral stone treatment. The evolution of smart and advanced technological instruments has led to a higher preference for endoscopic surgery for the removal of ureteral stones (2). The USS is one of the most investigated surgical techniques in terms of its efficacy and complications and Double-J (JJ) stenting is an integral part of this technique. JJ stents are placed in 60-80% of patients after ureteral or renal stone surgery to prevent urinary obstruction (3). Urologists tend to use JJ stents without extraction strings, despite their benefits, due to their anticipation of risks such as infection, string irritation, or dislocation of the JJ stent, and possibly due to the lack of data on the use of JJ stents with extraction string (4).

The cost of ureteral stone treatment continues to increase national health expenditures significantly. At the beginning of the 1980s, the financial burden associated with urinary stones was reported to be less than \$900 million in the United States. This figure increased to \$5.3 billion in 2014 (5). In addition to the direct cost of ureteral stone surgery, almost one in seven patients are readmitted to the hospital due to complications and face further indirect costs (6). The costs of endoscopic ureteral laser surgery have been reported to be \$1,425 per case (7) and \$926-\$3,520 (8-10) in the United States and European countries, respectively. According to the repayment policy of the Turkish Social Security Institution, the official cost of endoscopic ureteral stone treatment is \$154.9 for a JJ stentless procedure and an additional \$45.1 for stent removal.

Despite the revolution in JJ stent technology, stent-related morbidity is still the primary concern, as the ideal stent has not been produced yet. The lack of published studies providing sufficient data and the continued use of JJ stents without extraction strings by urologists encouraged us to conduct the present study.

The removal of the JJ stent with or without an extraction string may have an impact on postoperative outcomes and treatment costs. In this study, we aimed to investigate the impact of two different JJ stent removal techniques on pain perception, depressive symptomatology, complications, and cost.

Materials and Methods

This retrospective study was conducted between January and October 2018 using a two-center and two-arm design, which was approved by the Ethics Committee of the Zonguldak Bülent Ecevit University (12/10/2018-33479383). A written consent form was obtained from all participants.

Inclusion criteria for JJ stent with and without extraction string

Adult men and women with the unilateral ureteral stone disease who had failed MET and could not pass the stone with SWL.

Exclusion criteria

Patients with an untreated urinary tract infection, uncorrected bleeding diathesis, bilateral ureteral stones, urogenital tumors, a neurogenic bladder, pregnancy, urogenital malformations (i.e., horseshoe kidney or pelvic kidney), renal insufficiency, renal transplantation, or pregnancy were excluded. Pediatric patients and participants who were taking antidepressant therapy for a psychogenic disorder were also excluded.

Study design

Of the 196 patients, 177 were included in this study. Nineteen patients were excluded due to incomplete data. Random sampling was performed by tossing up a coin. Of the 131 men included in the study, 40 were identified as group 1 (JJ stents were manually removed), and the remaining 91 as group 2 (JJ stents were cystoscopically removed). Out of the 46 women included in the study, 19 were identified as group 3 (JJ stents were manually removed) and 27 as group 4 (JJ stents were cystoscopically removed). The patients were given antispasmodic drugs when needed for stent-related irritative symptoms and pain control.

JJ stent insertion and removal techniques

After ureteral stone surgery, 4.7 French JJ stents were cystoscopically placed under the guidance of fluoroscopy, and thus, the distal end of the extraction strings exited the external urethral meatus and it was secured to the radix penis or mons pubis in groups 1 and 3, respectively (Figure 1a, b).

JJ stents without extraction strings were cystoscopically placed into ureters under the guidance of fluoroscopy in groups 2 and 4 following the USS. The patients in groups 1 and 3 were warned and educated about hygienic practices to take care of their distal extraction strings, and their JJ stents were manually removed.

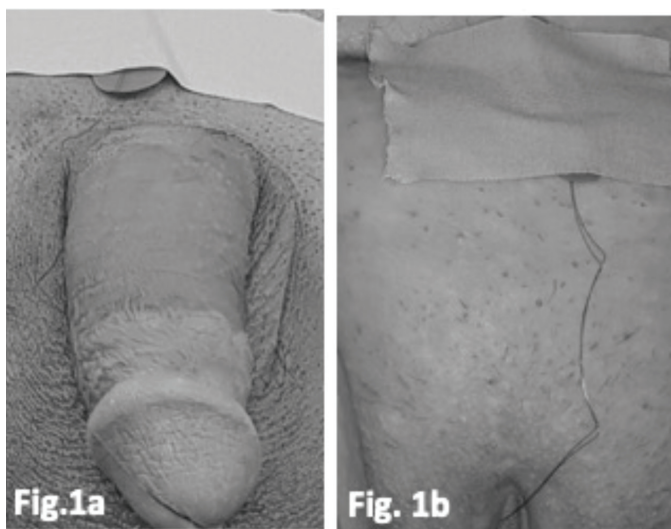


Figure 1. a, b. Distal end of the extraction strings were secured to the radix penis or mons pubis

The JJ stents were endoscopically removed in patients in groups 2 and 4 under sterile conditions using local anesthesia.

Primary outcome measures

1. Men and women with LUTS
2. Pain perception during JJ stent removal
3. Cost of intervention

Secondary outcome measures

1. Depressive symptoms
2. Complications

Measurement tools

In men, LUTS were evaluated using the Turkish validated international prostate symptom score (IPSS) and was based on the answer to seven questions concerning urinary symptoms. The questions allowed the patient to choose one out of six answers indicating the severity of a particular symptom. Each answer was assigned a point from 0 to 5, and the total score was from 0 (asymptomatic) to 35 (the worst). Total scores were grouped into three categories: mild (symptom score ≤ 7), moderate (symptom score within the range of 8–19), or severe (symptom score ≥ 20) (8).

Pain perception level due to ureteral colic was identified using an 11-point numeric rating scale (NRS) score (0= no pain, 10= unbearable pain) (9). Post-operative NRS scores were recorded as the perceived pain during the removal of JJ stents in the groups.

Micturition changes in women and men were evaluated using Turkish validated international consultation on incontinence questionnaire-female lower urinary tract symptoms (ICIQ-

FLUTS) and male lower urinary tract symptoms (ICIQ-MLUTS) questionnaires that assess the prevalence of 13 urinary symptoms and their impact on daily life (10). Eleven symptoms were rated using a score from 0 ("never") to 4 ("all the time"). The daytime frequency was measured using a score from 0 ("1-6 times") to 4 (" ≥ 13 times"). Nocturia was measured using a score from 0 ("0 times") to 4 (" ≥ 4 times"). Impact on the daily life of each symptom was scored on a scale from 0 ("not at all") to 10 ("a great deal").

Depressive symptoms of the participants in each group were assessed using the Beck depression inventory (BDI), which is one of the most commonly used tools for the self-rated measurement of emotional, cognitive, somatic, and motivational components (11). BDI scores were classified as none (<13 pts), minimal-moderate (14–19), moderate-severe (20–29), and severe (30–63).

Preoperative urine cultures were obtained from all participants regardless of their grouping. Non-contrast enhanced computerized tomography scans localized the stones in patients and revealed the sizes of the stones. Because the JJ might affect stent-related symptoms, it was confirmed that the distal end of the JJ stent did not cross the midline using the postoperative kidney-ureter-bladder (KUB) X-ray.

All the aforementioned questionnaires were then applied to all participants included in the study before grouping. Following the initial evaluation, men and women were divided into four groups: group 1 (men whose JJ stents with extraction strings were manually removed by a urologist without an additional endoscopic procedure, $n=40$); group 2 (men whose JJ stents without extraction strings were removed with an additional cystoscopy, $n=91$); group 3 (women whose JJ stents with extraction strings were removed manually without an additional cystoscopy, $n=19$); and group 4 (women whose JJ stents without extraction strings were removed with an additional cystoscopy, $n=27$). On the day of JJ stent removal, all patients were invited to the clinic for reassessment using the aforementioned instruments.

Treatment costs for both removal techniques

According to the repayment price policy of the Turkish Social Security Institution, the official cost of an endoscopic ureteral stone treatment is \$154.9 per patient. For a JJ stent without an extraction string placed after the surgery, the cystoscopic removal of the JJ stent costs an additional \$44.1 (Table 1).

Statistical Analysis

Data were analyzed using the Statistical Package for the Social Science (SPSS 21.0 for Windows; SPSS Inc., Chicago, Illinois, USA) and presented as mean \pm standard deviation (SD) and frequency (%). A comparison of preoperative and postoperative data was performed using an independent sample test and a

Table 1. Demographic and clinical variables of men in the groups

	Group 1	Group 2	p-value
Patients n, (%)	40 (30.5)	91 (69.5)	-
Age (years, mean ± SD)	44.5±12.3	46.4±13.5	0.33
BMI* (kg/m ²)	27.6±3.4	27.3±3.0	0.77
Comorbidity (n, %)			0.62
0	37 (92.5)	79 (86.8)	
1	2 (5)	9 (9.9)	
2	1 (2.5)	3 (3.3)	
≥3	-	-	
Marital status (n, %)			-
Married	39 (97.5)	83 (91.2)	
Single	1 (2.5)	7 (7.7)	
Divorced	-	1 (1.1)	
Stone burden (mm ² , mean ± SD)	78.1±55.8	82.2±60.4	0.17
Stone location (n, %)			-
Upper ureter	9 (22.5)	39 (42.9)	
Middle ureter	7 (17.5)	30 (32.9)	
Lower ureter	24 (60.0)	22 (24.2)	
Previous shock wave lithotripsy (n, %)			0.14
Yes	1 (2.5)	3 (3.3)	
No	39 (97.5)	88 (96.7)	
Treatment cost per patient (USD**)	154.9	199	-
Stent stay period (days, mean ± SD), (min-max)	6.4±3.9 (5-11)	13.6±11.2 (8-25)	0.02
Surgery time (min, mean ± SD)	43.7±12.1	58.0±15.4	0.001
Complications (n, %)			0.91
Urinary infection requiring antibiotic treatment	1 (2.5)	2 (2.2)	
JJ stent displacement	1 (2.5)	-	
String irritation	1 (2.5)	-	

*BMI: Body mass index, **USD: United States Dollar, JJ: Double-J

paired sample test for men and the Mann-Whitney U test for women. A value of $p < 0.05$ was considered as significant.

Results

The demographic data of groups 1 to 4 such as the mean age, gender, body mass index (BMI), comorbidities, marital status, location and burden of the stone, and history of previous SWL are summarized in Tables 1 and 2. For men and women, the mean ages, BMI, history of previous SWL, and comorbidities were similar ($p > 0.05$). JJ stent insertion with extraction string rates were 30.5% in men, 41.3% in women, and 33.3% in total. The mean surgery times were significantly higher in groups 2 and 4 compared to those in groups 1 and 3 ($p = 0.001$), although the stone sizes were similar ($p > 0.05$) (Tables 1, 2).

The mean preoperative and postoperative IPSS scores were 9.7 ± 7.0 and 8.5 ± 7.5 in group 1 ($p = 0.71$) and 8.9 ± 5.7 and 10.9 ± 6.3 in group 2 ($p = 0.001$), respectively. Groups 1 and 2 showed similar mean postoperative IPSS scores ($p > 0.05$) (Table 3).

The mean preoperative and postoperative voiding, storage, and incontinence subdomains of the MLUTS and MLUTS impact on

daily life scores were similar in groups 1 and 2 ($p > 0.05$). For group 2, only the mean storage subdomain of MLUTS increased ($p = 0.001$), whereas the other subdomains were similar ($p > 0.05$). Preoperative MLUTS and MLUTS impact on daily life scores were similar between groups 1 and 2, as in the postoperative period ($p > 0.05$) (Table 3). The mean preoperative and postoperative voiding, storage, and incontinence subdomains of the FLUTS and FLUTS impact on daily life scores were similar in groups 3 and 4 ($p > 0.05$) (Table 4).

The mean postoperative NRS scores were 2.3 ± 1.5 and 4.0 ± 2.5 in groups 1 and 2, respectively ($p = 0.004$) (Table 3). For women, the mean postoperative NRS scores were 3.0 ± 2.8 and 4.2 ± 2.3 in groups 3 and 4, respectively ($p = 0.06$). The mean postoperative NRS score was significantly lower in group 1 than in group 2 ($p = 0.004$) (Table 4).

The mean preoperative and postoperative BDI scores were 10.5 ± 6.8 and 6.6 ± 5.7 in Group 1 ($p = 0.04$); 12.3 ± 9.7 and 10.8 ± 8.3 in Group 2 ($p = 0.20$) (Table 3); 12.7 ± 7.4 and 7.0 ± 3.5 ($p = 0.02$) in Group 3; and 14.6 ± 9.4 and 14.0 ± 8.4 in Group 4 ($p = 0.86$), respectively (Table 4). Groups 1 and 2, and groups 3 and 4 had similar preoperative BDI scores ($p > 0.05$). The mean postoperative BDI score was significantly lower in group 1 than

	Group 3 (n=19)	Group 4 (n=27)	p-value
Age (years, mean ± SD)	48.7±15.9	51.3±15.4	0.52
BMI* (kg/m ²)	28.2±4.3	28.7±3.6	0.21
Comorbidity (n, %)			0.66
0	15 (78.9)	21 (77.7)	
1	2 (10.5)	4 (14.8)	
2	2 (10.5)	1 (3.7)	
≥3	-	1 (3.7)	
Marital status (n, %)			-
Married	17 (89.5)	24 (89.9)	
Single	2 (10.5)	3 (11.1)	
Divorced	-	-	
Stone burden (mm ² , mean ± SD)	77.9±49.0	84.4±57.0	0.09
Stone location (n, %)			-
Upper ureter	4 (21.1)	16 (59.3)	
Middle ureter	5 (26.3)	3 (11.1)	
Lower ureter	10 (56.6)	8 (29.6)	
Previous shock wave lithotripsy (n, %)			0.43
Yes	1(5.3)	4 (14.8)	
No	18 (94.7)	23 (85.2)	
Treatment cost per patient (USD**)	154.9	199	-
Surgery time (min, mean ± SD)	37.5±13.0	53.5±15.6	0.001
Stent stay period (days, mean ± SD), (min-max)	5.7±2.8 (3-8)	11.6±8.2 (8-23)	0.01
Complications (n, %)			0.82
Urinary infection requiring hospitalization	2 (10.5)	2 (7.4)	
Incontinence due to JJ stent displacement	1 (5.2)	-	
String irritation	1 (5.2)	-	
External meatal erosion	1 (5.2)	-	

*BMI: Body mass index, **USD: United states dollar

	Group 1 (n=40)			Group 2 (n=91)			Group 1 vs group 2	Group 1 vs group 2
	Preoperative	Postoperative	p-value	Preoperative	Postoperative	p-value	(Preoperative) p-value	(Postoperative) p-value
IPSS*	9.7±7.0	8.5±7.5	0.71	8.9±5.7	10.9±6.3	0.001	0.51	0.10
M-LUTS**								
Voiding	6.3±3.4	7.0±5.8	0.31	5.9±4.1	5.8±4.3	0.44	0.63	0.34
Storage	4.0±2.8	5.4±5.1	0.26	3.6±2.8	4.5±3.5	0.001	0.64	0.43
Postmicturition	2.9±1.9	3.0±1.8	0.36	2.6±1.7	2.8±1.7	0.14	0.50	0.62
M-LUTS BOTHER								
Voiding	18.4±11.7	15.8±14.1	0.81	13.7±12.0	13.2±13.0	0.14	0.08	0.44
Storage	13.5±10.8	19.2±15.7	0.17	13.5±11.6	13.0±12.8	0.001	0.54	0.10
Postmicturition	7.8±6.3	6.1±5.9	0.73	7.2±6.7	6.1±5.4	0.48	0.52	0.68
NRS***	-	2.3±1.5	-	-	4.0±2.5	-	-	0.004
BDI [†]	10.5±6.8	6.6±5.7	0.04	12.3±9.7	10.8±8.3	0.20	0.35	0.02

*IPSS: International prostate symptom index, **M-LUTS: Male lower urinary tract symptom, *NRS: Numerical rating scale, †BDI: Beck depression inventory

in group 2 (p=0.02). Similarly, the mean postoperative BDI score was significantly lower in group 3 than in group 4 (p=0.004).

Postoperative urinary tract infection rates were 5.0%, 2.2%, 10.5%, and 7.4% in groups 1, 2, 3, and 4, respectively. Other complications are listed in Tables 1 and 2.

Discussion

JJ stenting is frequently applied after USS to provide urinary drainage (4). Unless removed, JJ stents may cause LUTS predominantly due to irritation of trigone rich in neurogenic innervation (12-14). Although the IPSS questionnaire was

Table 4. Preoperative and postoperative changes in women

	Group 3 (n=19)			Group 4 (n=27)			Group 3 vs group 4	Group 3 vs group 4
	Preoperative	Postoperative	p-value	Preoperative	Postoperative	p-value	(Preoperative) p-value	(Postoperative) p-value
F-LUTS**								
Voiding	6.8±4.5	4.9±3.5	0.58	6.0±4.2	6.2±3.9	0.30	0.75	0.22
Storage	4.8±3.6	5.0±3.9	0.31	4.4±2.4	3.0±1.7	0.42	0.49	0.15
Postmicturition	5.5±4.0	4.0±2.1	0.56	3.1±2.4	7.1±6.2	0.99	0.16	0.33
F-LUTS BOTHER								
Voiding	15.6±15.1	12.3±11.5	0.68	14.5±11.3	14.2±11.4	0.47	0.74	0.33
Storage	11.6±10.2	9.8±8.9	0.95	10.5±8.0	9.6±6.7	0.20	0.94	0.74
Postmicturition	13.5±11.8	8.8±5.4	0.47	10.4±8.6	16.8±13.7	0.20	0.55	0.32
NRS*** score	-	3.0±2.8	-	-	4.2±2.3	-	-	0.06
BDI& score	12.7±7.4	7.0±3.5	0.02	14.6±9.4	14.0±8.4	0.86	0.84	0.004

F-LUTS: Female lower urinary tract symptoms, *NRS: Numeric rating scale, #BDI: Beck depression Inventory

initially considered for questioning prostate-related symptoms, today it is used to evaluate several pathologies. Urologists are familiar with the IPSS questionnaire because it is easy to use. However, the ICIQ-MLUTS questionnaire provides more comprehensive data for all LUTS subdomains such as voiding, storage, and postmicturition (15). We investigated the impact of JJ stenting on postoperative LUTS using the IPSS and the ICIQ-MLUTS questionnaires in men and observed no significant differences between groups 1 and 2. As expected, postoperative IPSS and only the storage subdomain score of the ICIQ-MLUTS increased in group 2 compared to preoperative levels (p=0.001). This finding can be explained by the trigonal irritation of the JJ stent due to a relatively longer JJ stent dwell-time than group 1 (Table 1). A shorter JJ stent indwell time was associated with mild complications only, and a higher complication rate was reported as JJ stenting time increased (16). The daily workload for clinicians and the need for an additional session for cystoscopic stent removal in group 2 were the main causes of longer JJ stenting periods. Group 1 patients had a shorter JJ dwell-time because they had the option to immediately remove their stents during outpatient admission, a finding consistent with previous reports (17). Although an increased rate of a urinary infection may be expected in patients whose JJ stents were inserted with extraction string, similar infection rates were reported (18). In consistent with previous reports, no significant difference was observed in the risk of infection both in men and women in the present study (p>0.05). Both an irritation secondary to extraction string and an incomplete accidental stent dislodgement were observed only in one patient each. No additional intervention was required for these patients, and they were told to remove their JJ stents slowly by pulling off the string. Our opinion is that, although the number of patients was very low, JJ stenting with extraction string may not be suitable for patients with ureteral perforation, higher upper urinary infection, and after endopyelotomy.

In women, similar findings were found in terms of ICIQ-FLUTS scores (Table 4). Both females and males reported an increase in postoperative LUTS scores, and the use of JJ stents with extraction strings did not cause this increase.

The patients' expectations of pain and the occurrence of pain during stent removal remain to be the primary factors affecting their future decisions to receive another ureteral stone surgery (19). Using the NRS, we found a significantly lower postoperative pain score in group 1 compared to group 2 (p=0.004). This finding was consistent with previous reports (4). Although the difference in mean postoperative NRS scores between groups 3 and 4 was not statistically significant, this finding could be explained by the fact that the number of cases was relatively lower for female patients than for male patients and also the shorter length of the urethra in women than in men (p=0.06).

JJ stents should be removed as early as possible to minimize LUTS. Despite their best efforts, urologists may forget to remove the JJ stents, which may result in major complications such as encrustation, fragmentation, urinary obstruction, or even renal failure (20). Moreover, removal of a complicated JJ stent could result in a 7-fold increase in treatment costs (21). Using JJ stents with extraction strings eliminates all these risks.

Emotional stress in patients may increase during the removal of a JJ stent with an additional cystoscopy. Patients usually expect postoperative JJ stent removal to be a painful procedure, possibly due to their previous experiences relating to urinary stone disease. A majority of the patients stated that cystoscopic removal of the JJ stent would be a painful procedure. Indeed, at the beginning of the study, we observed that participants in groups 1 and 3 were happy with the information that their JJ stents would be manually removed. To prove this, we measured depressive symptoms for each groups pre- and postoperatively and found significantly lower postoperative BDI scores in groups 1 and 3.

Although the repayment and pricing policies of different insurance systems vary among countries, an additional endoscopic procedure is one of the main factors worldwide that raises treatment costs after ureteroscopic surgery. The total cost of the surgery was 28.5 % higher in groups 2 and 4 compared to groups 1 and 3 in the study. According to the Turkish Social Security Institution, the official cost of endoscopic ureteral stone treatment is approximately \$200 per patient with the additional cost of cystoscopic JJ stent removal included. In a report, the cost of treatment was reported to be \$243 and \$185 for cystoscopic and manual removal, respectively (22). A combined 10,500 patients underwent USS in the United Kingdom in 2014, which was 86% higher compared to the number of USS patients in 2007, possibly due to increased prevalence of metabolic syndrome (23). The presence of overweight status, one of the components of metabolic syndrome, supports the increasing prevalence of stone disease over the globe. In this respect, it is foreseeable that a considerable part of the world's population will be candidates for USS due to ureter stones. Today, JJ stents are used in approximately 80% of the USS patients, but only 1/3 of the stents are placed with extraction strings. In parallel to the prevalence of urolithiasis reaching 16%, there is a significant increase in annual USS (24). The present study clearly showed that the use of JJ stents with extraction strings could reduce the cost of treatment by 28.5% per patient.

Regardless of groupings, JJ stents were safely removed with its extraction strings in the outpatient setting. In group 1, one patient had a urinary infection requiring hospitalization, and two patients had external meatal hyperemia due to stent displacement for one patient and string irritation for the other patient. Only two patients had urinary infections requiring hospitalization, one had incontinence due to stent displacement, and one had meatal erosion due to string irritation in group 3. These are minor complications that can easily be managed (Tables 1, 2).

This study has shifted our projection in favor of using JJ stents with extraction strings, and our findings support that the use of the JJ stents with extraction strings does not adversely affect the patients' comfort.

Conclusion

Urologists mostly prefer to use JJ stents to provide better postoperative comfort to their patients. The decision on the use of a JJ stent is usually based on the preference of urologists rather than the patient and is generally placed and removed without an extraction string. The lack of sufficient data is the main reason for the removal of a JJ stent without an extraction string in urology practice. Our findings showed that removal of the JJ stent with its extraction string is a reliable method with

a lower treatment cost, higher patient comfort, and acceptable minor complications. Using JJ stents with extraction strings does not adversely affect surgical outcomes.

Ethics

Ethics Committee Approval: This retrospective study was conducted between January and October 2018 using a two-center and two-arm design, which was approved by the Ethics Committee of the Zonguldak Bülent Ecevit University (12/10/2018-33479383).

Informed Consent: A written consent form was obtained from all participants.

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Authorship Contributions

Surgical and Medical Practices: Ö.Ç., M.S.B., K.Ö., Concept: Ö.Ç., M.S.B., Design: Ö.Ç., M.S.B., Data Collection or Processing: Ö.Ç., M.S.B., Analysis or Interpretation: Ö.Ç., M.S.B., Literature Search: Ö.Ç., M.S.B., Writing: Ö.Ç., M.S.B.

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