ORİJİNAL ARAŞTIRMA ORIGINAL RESEARCH

DOI: 10.5336/urology.2021-86492

The Effect of Passive Ureteral Dilatation on the Incidence of Ureteral Stricture in Retrograde Intrarenal Surgery of Renal Stone: Retrospective Observational Study

Böbrek Taşı Nedeniyle Retrograd İntrarenal Cerrahi Yapılan Hastalarda Pasif Üreteral Dilatasyonun Üreteral Darlık İnsidansına Etkisi: Retrospektif Gözlemsel Çalışma

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ABSTRACT Objective: To investigate the effect of passive dilatation (PD) on ureteral stricture (US) rates after retrograde intrarenal surgery (RIRS), and to determine the factors that predict US. **Material and Methods:** Patients who underwent RIRS (Group 1) and patients who could undergo RIRS after PD (Group 2) were compared in terms of demographic data, clinical characteristics, perioperative and postoperative complications. The primary end point was US rate at postoperative 1 year. The predictive factors for US was assessed with logistic regression analysis. **Results:** US was determined in 12 (4.61%) and in 1 (0.67%) patients for Group 1 and 2, respectively. When the study population was grouped according to the US, the rate of PD was observed to be lower (p=0.037), and stone volume, surgical duration were observed to be higher in the US group, statistically (p<0.001 and p=0.034 respectively). The rate of PD, stone volume and surgical duration were detected as predictive factors for US. The cut-off value of stone volume for US was 2,408 mm^3 in receiver-operating characteristic curve analysis. Above the cut-off value, it was observed that the surgical duration was higher in cases with US, and there was no difference between the groups in terms of PD statistically. **Conclusion:** We conclude that PD is protective against US. However it was observed that PD was not protective in patients with stone volume higher than the cut off value, and the most important risk factor for US was found to be prolonged surgical duration.

Keywords: Retrograde intrarenal surgery; passive dilatation; ureteral stent; ureteral stricture

ÖZET Amaç: Bu çalışmanın amacı, böbrek taşı tedavisi için retrograd intrarenal cerrahi (RİRC) yapılan hastalarda pasif dilatasyonun (PD) üreteral darlık (ÜD) insidansına olan etkisini ve ÜD gelişimini predikte eden faktörleri araştırmaktır. **Gereç ve Yöntemler:** PD uygulamaya gerek kalmadan RİRC uygulanan hastalar (Grup 1) ile PD sonrası RİRC uygulanabilen hastalar (Grup 2); demografik veriler, klinik özellikler, perioperatif ve postoperatif komplikasyonlar açısından karşılaştırıldı. Çalışmanın birincil sonlanım noktası, postop 1. yıl ÜD saptanma oranı olarak belirlendi. ÜD gelişimini predikte eden faktörler lojistik regresyon analizi kullanılarak belirlendi. **Bulgular:** ÜD 1. grupta 12 (%4,61) hastada, 2. grupta 1 (%0,67) hastada saptanmıştır. Çalışma popülasyonu, ÜD gelişimi açısından gruplandırıldığında ise ÜD grubunda PD oranı daha düşük (p=0,037), ortalama taş hacmi ve cerrahi süresi daha yüksek saptandı (p<0,001 ve p=0,034). PD, taş hacmi ve cerrahi süre ÜD için prediktif faktörler olarak saptandı. ÜD gelişimi için taş volümü kestirim değeri alıcı işletim karakteristiği eğrisi analizinde 2.408 mm^3 olarak saptandı. Taş volümü saptanan kestirim değerinin üzerinde olan olgularda yapılan analizde, operasyon süresinin ÜD gelişen olgularda daha yüksek olduğu, PD açısından gruplar arasında fark olmadığı izlenmiştir. **Sonuç:** PD'nin ÜD gelişimi açısından koruyucu bir faktör olabileceği sonucuna varılmıştır. Bununla birlikte, yüksek taş hacmine sahip hastalarda, PD'nin koruyucu bir faktör olmadığı görülmüş, en önemli risk faktörünün uzamış operasyon süresi olduğu saptanmıştır.

Anahtar Kelimeler: Retrograd intrarenal cerrahi; pasif dilatasyon; üreteral stent; üreteral darlık

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Peer review under responsibility of Journal of Reconstructive Urology.

Received: 03 Oct 2021 ***Received in revised form:*** 17 Apr 2022 ***Accepted:*** 23 Apr 2022 ***Available online***: 27 Apr 2022

Urolithiasis is the third most frequently encountered urinary tract disease and a significant health problem with high morbidity, high treatment costs and the potential to lead to end-stage renal disease.[1,2] Endourological treatment methods take essential place in the most recent European Association of Urology guidelines since they have become more popular during the last years.[3]

The most popular minimally invasive treatment options for renal stones are percutaneous nephrolithotomy (PNL) and retrograde intrarenal surgery (RIRS).[3] The treatment decision is made according to the location and size of the stone. Although PNL is the gold standard method for stones larger than 2 cm, RIRS can also be considered as a treatment alternative in those who do not accept PNL.[3-5]

The increasing popularity of RIRS can be attributed to high stone-free rates, low complication rates and only a few contraindications. The development of thinner ureteroscopes with higher image quality and flexibility contributed to this popularity.[6]

Anatomical abnormalities, ureteral strictures (US) and tortuosity, and prior ureteroscopy history can make the ureteroscopic stone surgery difficult. It has been reported that the ureteroscope could not be introduced through the target ureteral orifice in 8-10% of the cases.[7-11]

Even though dilatation of the ureteral orifice via balloon or coaxial dilatators is routinely performed before introducing ureteroscope or ureteral access sheath (UAS), they may increase the risk of ureteral injury. Also, some authors denoted that brutal mechanical dilatation increased the risk of recurrent ureteral stricture even in the cases without apparent intraoperative or perioperative ureteral injury.[7,8,11,12]

Ureteral stenting is another method that urologists implement for passive dilatation (PD) when ureteral access cannot be achieved by mechanical dilatation. The ureteral orifice is expected to dilate and permit the access of the ureteroscope after this procedure.[13-15]

At our center, we perform PD with ureteral stenting without attempting mechanical dilatation in the cases that ureteroscope cannot be advanced through the ureteral orifice. We perform RIRS in these cases a few weeks after PD procedure. Although this is a common approach among urologists, the rate of the US in patients who undergo RIRS following a PD period has not been researched. In this study, our purpose was to interrogate the effects of PD on operative data, stone-free rates, postoperative early complications and US rates in patients who underwent RIRS for treatment of renal stones smaller than 2 cm after insertion of UAS. Also, we aimed to reveal the predictive factors for the US.

MATERIAL AND METHODS

Our study has been approved by the ethical review commitee of Dr. Sadi Konuk Training and Research Hospital (date: December 3, 2018, no: 2018-22), and has therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments. The data of patients who underwent RIRS for renal stones smaller than 2 cm between January 2015 and January 2019 were retrospectively analyzed. These patients were consented with written documents. Patients who underwent RIRS without the need for PD (Group 1), and patients who could undergo RIRS after PD with double J stent (DJS) insertion (Group 2) constituted the target population. Patients who underwent RIRS during a renal colic episode or as an adjunct to concurrent shock wave lithotripsy or PNL procedure, patients who had an acute renal failure or who had a renal stone larger than 2 cm were excluded. Patients with congenital urinary tract abnormalities, US detected by preoperative intravenous urography (IVU) or hydronephrosis were also excluded. Thus, all study participants had non-obstructing stones, and none of them had impacted stones.

Two patient groups were compared in terms of demographic characteristics, stone volume [length (mm) x width (mm) x diameter (mm)/2], stone number, location, density (Hounsfield Unit-HU), surgical parameters, postoperative outcomes and complications including US.

All study participants underwent kidney-ureter-bladder graphy on the postoperative first day, and patients with residual fragments smaller than 4 mm were considered as stone-free. The stone-free status of the patients with non-opaque renal stones was assessed by non-contrast computerized tomography (CT) during the postoperative first month. Long-term radiological follow-up of the study participants was performed by urinary ultrasonography (USG). A CT scan was performed in cases with hydronephrosis detected in USG or ipsilateral flank pain with the suspicion of residual stones. Patients with hydronephrosis in the absence of residual stones were evaluated with IVU for diagnosing or excluding the US. In patients diagnosed with US in IVU, before the treatment with endoscopic or open surgery, diagnostic ureteroscopy and retrograde ureteropyelography (UPGR) were performed to evaluate the stenosis area with direct visualization in each patient.

In order to analyze the predictive factors for US, the entire study group was divided into 2 groups based on the presence or absence of postoperative US. These 2 groups were compared in terms of patient gender, age, body mass index (BMI), preoperative history of PD, stone volume, density (HU), number and location of stones and surgery duration. The cut-off value for stone volume was determined by the receiver-operating curve (ROC) analysis. Patients with stone volumes higher than the cut-off value and developed US were compared with the other patients in terms of the preoperative history of PD and duration of surgery.

SURGICAL TECHNIQUE

Three endourologists performed all surgical procedures. Patients were operated, provided that their urine cultures were negative. All procedures were performed in the lithotomy position under general anesthesia. A 14F (Plasti-med, İstanbul, Türkiye) UAS was introduced to the target ureter over a 0.035-inch polytetrafluoroethylene-coated sensor guidewire (Boston Scientific, Marlborough, Massachusetts) under fluoroscopic guidance following ureteroscopy (URS) performed by 7F Karl Storz semirigid ureterorenoscope. A flexible ureteroscope (Storz Flex-X2, Storz Flex XC, Tuttlingen, Germany) was advanced through the UAS, and the renal stone was fragmented by 200 µm holmium YAG laser. The laser settings were adjusted as per the endourologist's preference. Basket catheter or grasping forceps was not used for stone extraction; the stone fragments were left in situ after fragmentation of the stone to clinically insignificant stone fragments. All patients were stented with 4.8F DJS at the end of the procedure. Two weeks after the procedure, DJS was removed via a flexible cystoscope. In the cases that we could not introduce the ureteroscope or the UAS to the target ureter, we did not perform active mechanical dilatation due to the risks related to this procedure. In these cases, we performed UPGR by introducing the tip of the 12F dual-lumen UAS (BI-FLEX EVOTM, ROCAMED, Monaco) over a guidewire into the distal ureter. The reason why we use a 12F UAS instead of an open end ureteral catheter is to see the tip of the UAS was in the distal ureter while advancing it with the help of scopy over the guidewire and to perform UPGR without the need to remove the guidewire.

A 4.8F DJS was advanced over a guidewire after UPGR in these cases with so-called "tense ureters" who do not have US or hydronephrosis. These patients underwent RIRS 2-6 weeks after this procedure. The DJS was removed by a grasping forceps inserted through a 22F cystoscope, and UPGR was performed. In cases with free flow of contrast dye, URS was done. In the case that there was no resistance in the ureter against the ureteroscope, a 14F UAS was introduced following URS and RIRS was performed as described above. However, re-stenting was performed in the case that the target ureter did not permit access. Ureterorenoscopy was performed at the end of the procedure for inspection of the ureteral mucosa in all cases where UAS could not be advanced smoothly over the guidewire. All ureteral mucosal tears higher than Grade 1 as per mucosal lesion scale (i.e., Grades 2-5) were recorded (Table 1).[16] The DJS was removed 3 weeks after the procedure in patients with high-grade mucosal tears (i.e., Grades 3-5).

STATISTICAL ANALYSIS

Normally distributed continuous variables were expressed as mean±standard deviation (SD). Continuous variables that did not show a normal distribution were expressed as median and interquartile range (1st and 3rd, respectively). Categorical data were presented as numbers and percentages. The distribution

TABLE 1: Post-ureteroscopic Lesion Scale.

Stage 0	No lesion	Uncomplicated URS
Stage 1	Superficial mucosal lesion and/or significant mucosal edema/hematoma	(no grading according to the Dindo-modified Clavien classification of
Stage 2	Submucosal lesion (Figure 1)	surgical complications)
Stage 3	Perforation with less than 50% partial transsection	Complicated URS
Stage 4	More than 50% partial transsection	(Grade 3a or b according to the Dindo-modified Clavien classification of
Stage 5	Complete transsection	surgical complications)

URS: Ureteroscopy.

normality of continuous variables was evaluated using the Shapiro-Wilk test. The means of 2 independent groups were compared with the independent t-test. The frequencies of categorical variables were compared using Pearson chi-square or Fisher Freeman Halton Exact test. Multivariate logistic regression analysis was done for the determination of the factors predicting US. The cut-off value of stone volume for the development of US was detected by the ROC curve analysis. The p value was considered significant when it was lower than 0.05.

RESULTS

Four hundred nine patients were included in this study. Among these patients, 266 (65.03%) were male, while 143 (34.97%) were female. Group 1 consisted of 260 (63.57%) patients who underwent RIRS at the first attempt, and 149 patients (36.43%) who underwent PD with ureteral stenting before RIRS constituted Group 2 (Table 2). Re-stenting was performed in 21 (14.09%) of 149 patients because UAS could not be inserted in the second session. In the 3rd session, UAS was implanted in all patients. Comparison of these 2 groups in terms of demographic characteristics, stone volume, number, location, duration of surgery, hospital stay and stone-free rates did not reveal any statistical significance (Table 2). The mean time interval between ureteral stenting for PD and re-attempt for RIRS was calculated as 22.5±10.5 days.

Comparison of the patient groups regarding complications revealed that 2 groups did not differ in terms of postoperative early-term complications, including bleeding, mucosal tears, ureteral perforation, fever, sepsis and renal colic (Table 3). The rate of the US was calculated as 3.17% in the entire cohort. US was determined in 12 (4.61%) and in 1 (0.67%) patients for Group 1 and 2, respectively (p=0.037) (Table 3).

Thirteen patients who developed US (i.e.. US group) were compared with the patients who did not develop this complication (i.e., non-US group) (Table 4). Comparison of these groups did not reveal any significant difference regarding gender, age, BMI, stone density, number and location.

Mean stone volume, surgical duration, lenght of hospital stay was significantly higher, and the rate of PD was significantly lower in the US group (Table 4). The rate of PD, stone volume and surgical duration were detected as significant predictive factors for US in multivariate analysis (Table 5).

Logistic regression analysis was also utilized for developing a model for predicting US:

US= 1/[1 + exp(-10.186 + 0.063 (surgical duration) + (-2.543)(PD) + 0.0007 (stone volume)

The statistical significance of the logistic regression model was observed as $p<0.001$.

The ROC curve analysis of patients revealed that the cut-off value of stone volume for development of US was 2,408 mm^3. The sensitivity or specificity was determined as 87.61% and 83.39% at this level ($p<0.001$; area under the curve=0.882; sedimentation equilibrium=0.053; %95 confidence interval=0.778-0.987) (Figure 1). The mean duration of surgery was calculated as 110±7.5 and 83.3±10.8 minutes in patients with stone volume higher than the cut-off value and lower than the cut-off value, respectively ($p<0.001$) (Table 6). It was detected in the subgroup analysis that the presence of a DJS before RIRS was not protective against the US in patients with stone

TABLE 2: Comparison of demographic data, stone characteristics, surgical data between 2 groups.

Variables	Non-PD group (n=260)	PD group (n=149)	p value
Age (y), median (IQR)	42 (18-72)	39 (19-76)	0.098
Gender, n (%)			
Male	172 (66.15)	94 (63.08)	0.531
Female	88 (33.85)	55 (36.92)	
BMI (kg/m^2), median (IQR)	25.7 (20.3-35.8)	25.1 (18.7-31.2)	0.313
Stone volume (mm^3), mean±SD	1385±953	1220±970	0.096
Stone density (HU), median (IQR)	854 (387-1550)	780 (420-1480)	0.732
Stone number, mean±SD	1.32±(0.61)	1.37±0.63	0.469
Stone localization, n (%)			
Ureteropelvic junction	46 (17.70)	21 (14.10)	0.716
Renal pelvis	91 (35.0)	50 (33.55)	
Inferior calyx	74 (28.46)	46 (30.87)	
Middle calyx	29 (11.15)	22 (14.76)	
Superior calyx	20 (7.69)	10 (6.72)	
Surgical duration (minimum), median (IQR)	68 (44-114)	66 (40-105)	0.062
Stone free rate, n (%)	213 (81.92)	128 (85.90)	0.298
LOS (day), mean±SD	1.23±0.84	1.21±0.81	0.887

PD: Passive dilatation; SD: Standart deviation; IQR: Interquartile range; BMI: Body mass index; HU: Hounsfield unit; LOS: Lenght of hospital stay.

TABLE 3: Comparison of groups in terms of complications.

Complication	Non-PD group (n=260)	PD group (n=149)	p value
Bleeding, n (%)	7 (2.69)	5 (3.35)	0.764
Mucosal injury, n (%)	11 (4.23)	6 (4.02)	0.921
Ureteral perforation, n (%)	2 (0.76)	2 (1.34)	0.624
Fever, n (%)	5 (1.92)	7 (4.69)	0.132
Sepsis, n (%)	6 (2.30)	5 (3.35)	0.539
Renal colic, n (%)	7 (2.69)	7 (4.69)	0.283
Ureteral stricture, n (%)	12 (4.61)	1 (0.67)	0.037

PD: Passive dilatation.

volume higher than 2,408 mm^3 (p=0.099) (Table 6). The surgical duration was significantly longer in patients with a stone volume larger than 2,408 mm^3 who develop US (p<0.001) (Table 6).

Interrogation of the stricture locations revealed that 10 (76.93%) of the patients with the US had distal ureteral, and 3 (23.07%) of them had middle US. Two of the patients with the distal US underwent ureteroneocystostomy (UNC), while 1 patient with the distal US necessitated psoas hitch and UNC procedures. One patient with the middle US underwent ureteroureterostomy, and the remaining nine patients with US were treated by endourological interventions.

DISCUSSION

The iatrogenic ureteral injury resulting from the ureteroscopic procedures performed to treat renal or ureteral stones are relatively uncommon.[17] In these cases, various complications ranging from simple mucosal tears to catastrophic ureteral avulsions may occur.[18] In URS procedures, the US incidence is reported to be in the range of 0.5-2.5%.[19] The ureter may be injured during the advancement of a semirigid ureteroscope through the ureteral lumen. Exposure of the ureteral wall to the energy used for stone fragmentation is another mechanism of ureteral injury. Also, it can be damaged during ureteral dilatation procedures. Besides, the UAS can injure the ureteral mucosa or cause ischemia, and pave the way for the subsequent US.

Since the mean diameter of a non-stented ureter is reported to be 9-10F in radiology or cadaveric anatomy studies, it can be anticipated that the successful access rate would be lower with the UAS,

TABLE 4: Comparison of US group with non-US group in terms of demographic data, stone characteristics, surgical data.

Variables	Non-US group (n=396)	US group (n=13)	p value
Age (y), median (IQR)	37 (18-74)	36.5 (22-76)	0.333
Gender, n (%)			
Male	259 (65.41)	6 (46.16)	0.236
Female	137 (34.59)	7 (53.84)	
Passive dilatation, n (%)	148 (37.37)	1 (7.69)	0.037
BMI (kg/m²), mean±SD	25.7±2.27	24.7±2.01	0.615
Stone volume (mm³), mean±SD	1295±942	2801±834	<0.001
Stone density (HU), mean±SD	830±253	868±330	0.748
Stone number, mean±SD	1.34±0.62	1.25±0.46	0.518
Stone localization, n (%)			
Ureteropelvic junction	65 (16.41)	2 (15.39)	0.052
Renal pelvis	140 (35.35)	1 (7.70)	
Inferior calyx	116 (29.30)	4 (30.76)	
Middle calyx	47 (11.7)	4 (30.76)	
Superior calyx	28 (7.07)	2 (15.9)	
Surgical duration (min), mean±SD	67.0±13.3	72.1±11.9	0.034
LOS (day), median (IQR)	1 (1-8)	1 (1-5)	0.024

US: Ureteral stricture; SD: Standart deviation; IQR: Interquartile range; BMI: Body mass index; HU: Hounsfield unit; LOS: Lenght of hospital stay.

TABLE 5: Multivariate logistic regression analysis of potential predictors for US.

	OR	95% CI	p value
Passive dilatation	0.779	1.027-1.333	0.041
Stone volume	0.537	0.998-1.002	0.038
Surgical duration	0.055	1.687-1.802	0.037
LOS	0.593	0.636-0.712	0.286

US: Ureteral stricture; OR: Odds ratio; CI: Confidence interval; LOS: Lenght of stay.

In the case that access cannot be achieved to the target ureter via ureteroscope, some authors suggest dilating the ureter by a Nottingham dilatator or balloon dilatator and proceeding with the actual surgery in the same session.[22] In contrast, others recommend DJS insertion with or without mechanical dilatation of the ureteral orifice (i.e., PD).[22] The latter group of authors bases their approach on the hypothesis that balloon dilatation increases the risk of subsequent US which has an outer diameter of 14F. In a prospective trial that assessed the successful access rates with 14F UAS, a failure rate of 22% was reported despite the performance of sequential ureteral dilatations.[20] The rate of our study (36.43%) was observed to be higher when compared to the literature. This data can be attributed to the fact that sequential ureteral dilatation was not performed in our study, contrary to the practice in the literature.

It was reported that utilization of UAS during RIRS shortened the duration of surgery, decreased the costs, reduced the intra-renal pressure, facilitated subsequent ureteral access, and increased the postoperative stone-free rates.[21]

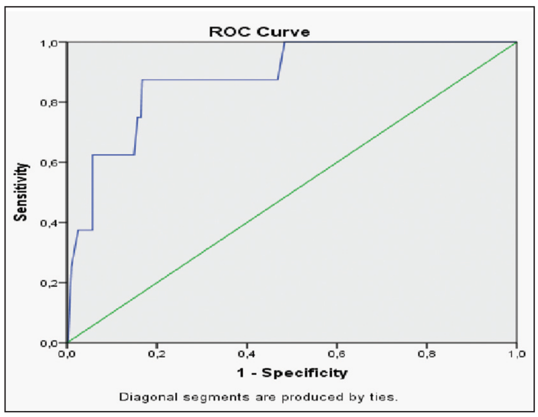

FIGURE 1: ROC curve for stone volume in predicting ureteral stricture (p<0.001; AUC=0.882; SE=0.053; %95 CI=0.778-0.987). ROC: Receiver-operating characteristic; AUC: Area under the curve; SE: Sedimentation equilibrium; CI: Confidence interval.

TABLE 6: Comparison of presence of DJS and mean operation time between US and non-US groups in patients with stone volumes higher than the cut-off value.

Stone volume >2,408 mm^3	Non-US group (n=91)	US group (n=11)	p value
Preop DJS, n (%)			
Positive	32 (35.17)	1 (9.1)	0.099
Negative	59 (64.83)	10 (90.9)	
Surgical duration (minimum), mean±SD	83.3±10.8	110±7.5	<0.001

US: Ureteral stricture; OR: Odds ratio; CI: Confidence interval; LOS: Lenght of stay.

due to mechanical tension and ischemic ureteral injury.[22] On the other hand, coaxial dilatation can lead to linear shearing stress, and this stress can be more traumatic for the ureter than the progressive radial force introduced by the balloon dilatation procedure.[22]

The PD duration suggested in various reports in the literature vary between 2 days and 65 day.[23-26] In our study, the duration of PD was calculated as 22.5±10.5 days.

In a retrospective study investigating the impact of UAS on the US rates, the US rate was determined as 1.4% while it was calculated as 1.8% in a prospective cohort.[27,28] In our study, the US rate was 0.67% in patients who were previously stented and underwent RIRS with UAS insertion. The US incidence was calculated as 4.61% in the other group, and the difference was statistically significant. The US rate was calculated as 3.17% in the entire study group. The difference between our US rate and the rates reported in the other studies may be due to the differences in sample sizes. Traxer et al. stated in their prospective report that the presence of a previously-inserted DJS was the strongest predictive factor for the avoidance of high-grade ureteral injury during UAS insertion.[29] In another prospective study investigating the risk of ureteral injury and the subsequent US related to UAS insertion with a mean follow-up period of 35.8 months, the authors did not find an association between high-grade ureteral injury and US.[28] Patients with stents were excluded from this study. Even though the presence of a DJS was not determined as a protective factor for ureteral injuries in our study, the presence of previously-inserted DJS was found to be significantly lower in the US group it should be considered that easy placement of the UAS does not eliminate the risk of ureteral injury. Besides, the mucosal tear is not the sole pathophysiological mechanism leading to US.[30,31] Even though the UAS does not directly cause injury, it can impair the blood flow of the ureteral wall significantly and cause ureteral ischemia if it is large for the diameter of the ureter.[29,30] Removal of the UAS after completion of stone fragmentation initiates reperfusion of the ureter. Formation of free oxygen radicals and associated ischemia-reperfusion injury can lead to significant ureteral damage. The severity of the injury and duration of the procedure is directly proportional to this UAS-related ureteral injury model.[30] Sorokin et al. analyzed 118 patients who underwent RIRS and reported that stone volume is the primary determinant of the duration of surgery.[32] This finding indicates that the longer the UAS stays in the ureter, the higher is the risk of ureteral ischemia and the subsequent US. In our study, the mean stone volume was larger in the patients with US, and in line with this finding, the mean duration of surgery was also significantly higher. Our results indicated that the duration of surgery and US risk were both higher in patients with stone volumes larger than 2,408 mm^3. Besides, presence of a previously-inserted DJS did not rise as a protective factor against US in these patients. As per our analysis, the predictive factor for the US was the duration of surgery.

In our study, mean hospital stay was found to be higher in US patients at the level of statistical significance. The reason for this situation may be the fact that as Whitehurst et al. mentioned in their studies higher stone volume and, accordingly, longer operative times may cause infectious complications more frequently.[33]

In addition to the results of the study, it should be taken into account that it also has some limiting factors. First, three endourologists performed the operations. Thus, the operator-dependent parameters can be biased. However, it can be said that the experience level of all endourologists is similar, and all of them complied with the study protocol, which dictated switching to PD when the target ureter did not permit the access of UAS. Second, the definition of "tense ureter" was subjective. The stricture of the intramural segment of the distal ureter may not be detected in UPGR. Therefore, cases with stricture in the distal ureter might be inadvertently included in this study, and they may lead to selection bias. Third, the formula used for calculating stone volumes may not reflect the actual stone size since some stones may have irregular shapes, and calculation of the actual volume of these stones necessitates specific software that is very complicated for radiologists to use. Interestingly, several studies utilized the formula we used, which accepts every stone as ellipsoid.[33] Another one of the limiting factors of the study is that it reflected the experience of a single center.

CONCLUSION

We conclude that the presence of a previously-inserted DJS is protective against the post-RIRS US. We suggest that the presence of DJS preoperatively, stone volume, and surgery duration are the significant predictive factors of US formation. Also, we conclude that the presence of DJS is not protective against the development of the US in patients with a stone volume larger than 2,408 mm^3. We suggest DJS insertion without performing active dilatation techniques in cases with tense ureters and the performance of RIRS after a PD period.

Source of Finance

During this study, no financial or spiritual support was received neither from any pharmaceutical company that has a direct connection with the research subject, nor from a company that provides or produces medical instruments and materials which may negatively affect the evaluation process of this study.

Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *Ali İhsan Taşçı;* ***Design:*** *Feyzi Arda Atar;* ***Control/Supervision:*** *Ali İhsan Taşçı;* ***Data Collection and/or Processing:*** *Fatih Akkaş;* ***Analysis and/or Interpretation:*** *Fatih Akkaş;* ***Literature Review:*** *Fatih Akkaş;* ***Writing the Article:*** *Fatih Akkaş;* ***Critical Review:*** *Feyzi Arda Atar;* ***References and Fundings:*** *Ali İhsan Taşçı;* ***Materials:*** *Fatih Akkaş.*

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