Failure of endoscopic management of ureteral strictures is due to ureteroscopic lithotripsy as a cause and longer length of stricture

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Abstract

Background

Ureteroscopic lithotripsy is a common treatment for middle and lower ureteral stones. Although effective and minimally invasive, this technique might cause significant complications, including postoperative ureteral strictures, which occur in 1–4% of patients after ordinary ureteroscopic lithotripsy and in 7.8–24% when lithotripsy is performed for impacted stones. The main purpose of the management of ureteral strictures is to improve hydronephrosis and protect renal function. However, factors that influence the success rate of the endoscopic management of US (e.g., the cause and length of stricture, the duration of hydronephrosis, surgical management technique, and the number of placed ureteral stents) are controversial. The aim of this study was to investigate factors determining the outcomes of endoscopic management for stone-related ureteral stricture.

Methods

This multi-center case series study was performed at one of the highest-volume centers and the affiliated institutions in Japan. Data of patients who underwent endoscopic surgery for ureteral stricture from January 2016 to March 2019 were retrospectively analyzed. Laser incision and/or balloon dilation were performed for management; single or double stents were placed at the end of the surgery. Treatment success was defined as improvement in hydronephrosis status.

Results

Nineteen patients were treated for stone-related ureteral stricture. Hydronephrosis successfully improved in 12 patients (63.2%). All seven patients with failed endoscopic management had ureteroscopic lithotripsy-related stricture, whereas 3/12 (25.0%) and 7/12 (58.3%) patients with ureteroscopic lithotripsy-related stricture and impacted stone-related stricture, respectively, underwent successful endoscopic treatment ($P = 0.004$). Stricture length > 15 mm was observed in five patients (71.4%) with failed management, two patients (16.6%) with successful management ($P = 0.046$), 7/10 patients (70.0%) with ureteroscopic lithotripsy-related stricture, and 1/7 patients (14.3%) with impacted stone-related stricture ($P = 0.049$). Among patients with ureteroscopic lithotripsy-related stricture and impacted stone-related stricture, both laser incision and balloon dilation were performed in 5/10 (50.0%) and 2/7 (28.6%) patients ($P = 0.874$) while double stents were placed in 5/10 (50.0%) and 5/7 (57.1%) patients ($P = 0.874$), respectively.

Conclusions

Ureteroscopic lithotripsy as a cause and stricture length > 15 mm could strongly affect the success rate of endoscopic management of ureteral stricture. In such cases, reconstructive management should be considered in the early stages.

Background

In recent years, the prevalence of ureteral stones has been consistently increasing in the world due to the effects of the increasing incidence of obesity and changes in dietary habits.^{1,2} Ureteroscopic lithotripsy (URSL) has become a common treatment for middle and lower ureteral stones.^{3,4} Although it is effective and minimally invasive, it could cause significant complications such as intraoperative ureteral injury, bleeding, infection, and postoperative ureteral strictures (US).⁵ US is reported to occur in 1–4% of patients after ordinary URSL; however, it occurs in 7.8–24% of patients when URSL is performed for impacted stones.^{6,7,8} Moreover, there are non-iatrogenic ureteric strictures such as those associated with impacted stones or chronic inflammatory disorders.^{9,10}

The main purpose of the management of US is to improve hydronephrosis and protect renal function.¹¹ Recently, a wide variety of therapeutic options has become available to urologists, such as endoscopic management and open/laparoscopic/robot assisted reconstruction. Laser incision (LI) and balloon dilation (BD) as endoscopic management techniques for benign US has been described in previous reports; Razdan et al. reported that these techniques had a success rate of 74% of 50 patients.⁹ Further, May et al. reported that 27.5% of 40 patients were successfully managed with endoscopic techniques.¹² The factors that influence the success rate of the endoscopic management of US (e.g., the cause and length of stricture, the duration of hydronephrosis, surgical management technique, and the number of placed ureteral stents) are controversial.

To identify the factors associated with the successful endoscopic management of US, we retrospectively investigated 19 patients who underwent endoscopic management for benign US related to ureteral stones and/or their treatments.

Methods

Patients

The present study was approved by the Institutional Review Board of Nagoya City University Hospital. All patients provided informed consent for the use of their data.

Patients diagnosed with benign US between January 2016 and April 2020 were analyzed. These patients underwent LI and/or BD management and one or two ureteral stents or nephrostomy catheter were placed at the end of the surgery at Nagoya City University Hospital and two affiliated institutions. Patients with a solitary kidney, urinary diversion, poorly controlled diabetes, and those who were pregnant were excluded from this study. We obtained patients' demographics, such as sex, age, and BMI from the

medical records. Additionally, the laterality, location, cause, and length of the US as well as the status of hydronephrosis were also captured. The US related to URSL was defined as follows: US without stone impaction, which was related to damage caused by the laser or access sheath during URSL. US related to an impacted stone was defined as follows: US with stone impaction which was observed during prior URSL.

Surgical techniques

All patients were placed under general anesthesia, and the operation was performed in the lithotomy position. Before treatment, the status of the stricture was confirmed using retrograde ureteropyelography. A semi-rigid ureteroscope (Olympus, Tokyo, Japan) was inserted and used to observe the stricture site. Then, we inserted a 0.035-inch guide wire through the stricture site. As the LI procedure, we cut the mucosa and muscular layer of the stricture site using a 200 µm fiber (Cyber Ho, Quanta system, Milan, Italy), including 5 mm before and after, until we could visualize the fat tissue outside of the ureter. The energy setting was 60 W and the incision was conducted using the 'Soft Tissues' mode. For the BD, we dilated the ureteral lumen up to 15 Fr using a balloon catheter (URO MAX Ultra™; Boston Scientific Japan, Tokyo, Japan). One or two double-J ureteral stents (4.7 Fr or 6.0 Fr, INLAY OPTIMA™, BD, Franklin Lakes, NJ and 4.8 Fr, Tria™, Boston Scientific, Marlborough, MA) were placed into the ureter at the end of procedures.

Follow-up

Surgical parameters, including surgical time, postoperative hydronephrosis, and success or failure of treatment were analyzed. Furthermore, we evaluated laboratory tests. Success of treatment was defined as improvement in the status of hydronephrosis examined by either ultrasonography or computed tomography.

Statistical analysis

Non-normally distributed variables are expressed as medians (25%, 75% interquartile range). Categorical variables are presented as frequencies (percentages). Data were analyzed using EZR for R (R project 3.6.3).¹³ To compare the patients with failed or successful management and the factors associated with the cause of US, Fisher's exact test and Mann-Whitney U tests were used. To compare preoperative and postoperative renal function, the Wilcoxon signed-rank test was used. P-values < 0.05 were defined as statistically significant.

Results

A total of 19 patients were identified as having undergone endoscopic treatment for US. The characteristics of the patients are summarized in Table 1. The stricture cause was identified as URSL in 10 patients (52.6%), impacted stone in 7 patients (36.8%), and chronic inflammatory disorders in 2 patients (10.5%). The median length of the stricture was 10 mm, and the median duration of hydronephrosis before surgery was 4.0 months. Preoperative hydronephrosis was Grade 1 in 3 patients

(15.8%), Grade 2 in 5 patients (26.3%), Grade 3 in 5 patients (26.3%) and Grade 4 in 6 patients (31.6%).
 Prestenting before surgery was performed in 5 patients (26.3%).

Table 1
 Preoperative characteristics of patients who underwent endoscopic
 management of ureteral strictures (n = 19)

Factor	n = 19
Sex	
Male	12 (63.2%)
Female	7 (36.8%)
Age (years) ^a	69 [58, 73]
BMI (kg/m ²) ^a	24 [21, 26.9]
Laterality	
Right	11 (57.9%)
Left	8 (42.1%)
Location	
Proximal	7 (36.8%)
Distal	12 (63.2%)
Cause of stricture	
URSL	10 (52.6%)
Impacted stone	7 (36.8%)
chronic inflammatory disorders	2 (10.5%)
Length of stricture	10 [7, 19.5]
Duration of hydronephrosis before surgery (months) ^a	4.0 [2.5, 5.5]
Preoperative hydronephrosis	
Grade 1	3 (15.8%)
Grade 2	5 (26.3%)
Grade 3	5 (26.3%)
Grade 4	6 (31.6%)
Prestenting	5 (26.3%)

BMI, body mass index; URSL, ureteroscopic lithotripsy

^aMedian [25%, 75% interquartile range].

Surgical data are shown in Table 2. Eight patients (42.1%) underwent both LI and BD. Two patients (10.6%) underwent LI alone, and 3 patients (15.8%) underwent BD alone. A single stent was placed in 8 patients (42.1%) and double stents were placed in 9 patients (47.3%). We could perform neither LI nor BD in 3 patients (15.8%); therefore, we placed a ureteral stent in 1 patient (5.3%) and a nephrostomy tube in 1 patient (5.3%). Postoperative hydronephrosis was Grade 0 in 7 patients (36.8%), Grade 1 in 3 patients (15.8%), Grade 2 in 2 patients (10.5%), Grade 3 in 4 patients (21.1%), and Grade 4 in 3 patients (15.8%). The success rate of the treatment was 63.2%.

Table 2
Perioperative details of the endoscopic management of ureteral strictures

Surgical time (min) ^a	71.0 [64.5, 93.5]
Endoscopic management	
Lase incision (LI) and balloon dilation (BD)	8 (42.1%)
LI	2 (10.6%)
BD	3 (15.8%)
Drainage	
Single stent	8 (42.1%)
Double stent	9 (47.3%)
Nephrostomy tube	1 (5.3%)
Duration of follow-up after surgery (months) ^a	8.0 [3.0, 17.0]
Postoperative hydronephrosis	
Grade 0	7 (36.8%)
Grade 1	3 (15.8%)
Grade 2	2 (10.5%)
Grade 3	4 (21.1%)
Grade 4	3 (15.8%)
Success of treatment	12 (63.2%)

LI, laser incision; BD, balloon dilation

^aMedian [25%, 75% interquartile range].

Table 3 shows the data classified as failure or success of the treatment. URSL-related US occurred in 7 and 3 patients in the failure and success groups, respectively ($P = 0.004$). Contrarily, all seven patients with impacted stone-related US were successfully treated with endoscopic management. Five patients (71.4%) had a US longer than 15 mm in the failure group, whereas two patients (16.6%) had a US longer than 15 mm in the success group ($P = 0.045$). In all five patients who underwent presenting, endoscopic management was successful. The median duration of hydronephrosis before surgery was 5.0 months in the failure group and 4.0 months in the success group ($P = 0.898$). Both LI and BD were performed in four patients (57.1%) in the failure group and in four patients (33.3%) in the success group ($P = 0.481$). The median US lengths in the patients treated with both LI and BD in the failure and success groups were 22.5 mm and 10.0 mm, respectively ($P = 0.34$). Double stents were placed in four patients (57.1%) in the failure group and in five patients (41.7%) in the success group ($P = 0.12$). The median US length in the patients who underwent double stent placement in the failure group was 22.5 mm, whereas it was 10.0 mm in the success group ($P = 0.34$).

Table 3

Comparison of factors associated with the success of endoscopic management for ureteral strictures

Factor	Failure (n = 7)	Success (n = 12)	P value
Age (years) ^a	71.5 [58.0, 75.3]	60.0 [58.0, 66.0]	0.253
Sex			
Male	3 (42.9%)	9 (75.0%)	0.326
Female	4 (57.1%)	3 (25.0%)	
BMI (kg/m ²) ^a	25.0 [24.0, 26.9]	23.5 [20.8, 26.5]	0.611
Cause of stricture			
URSL	7 (100%)	3 (25.0%)	0.004
Impacted stone	0 (0.0%)	7 (58.3%)	
chronic inflammatory disorders	0 (0.0%)	2 (16.7%)	
Length of stricture (> 15 mm)	5 (71.4%)	2 (16.6%)	0.045
Prestenting	0 (0.0%)	5 (41.7%)	0.106
Duration of hydronephrosis before surgery (months) ^a	5.0 [3.5, 5.0]	4.0 [2.0, 7.5]	0.898
Endoscopic management			
Lase incision (LI) and balloon dilation (BD)	4 (57.1%)	4 (33.3%)	0.481
LI	0 (0.0%)	2 (16.6%)	
BD	0 (0.0%)	3 (25.0%)	
Drainage			
Single stent	1 (14.3%)	7 (58.3%)	0.12
Double stent	4 (57.1%)	5 (41.7%)	
Nephrostomy tube	1 (14.3%)	0 (0.0%)	
BMI, body mass index; URSL, ureteroscopic lithotripsy; LI, laser incision; BD, balloon dilation			
^a Median [25%, 75% interquartile range].			

Table 4 outlines the causes of strictures. The success rate was 30.0% for URSL-related US, whereas it was 100% for impacted stone-related US (P = 0.01). Four patients (40.0%) were male in the URSL-related US group, whereas seven patients (100%) were male in the stone-related US group (P = 0.035). Seven patients

(70.0%) with URSL-related US had strictures longer than 15 mm in length compared to one patient (14.3%) in the impacted stone-related US group ($P = 0.049$). Both LI and BD were performed in five patients (50.0%) in the URSL-related US group, whereas they were performed in two patients (28.6%) in the impacted stone-related US group ($P = 0.874$). Double stents were placed in five patients (50.0%) in the URSL-related US group and in five patients (57.1%) in the impacted stone-related US group ($P = 0.874$).

Table 4
Comparison of factors associated with the cause of ureteral strictures

Factor	URSL (n = 10)	impacted stone (n = 7)	P value
Successfully treated cases	3 (30.0%)	7 (100%)	0.01
Age (years) ^a	61.5 [57.0, 69.0]	75.0 [67.5, 77.5]	0.063
Sex			
Male	4 (40.0%)	7 (100%)	0.035
Female	6 (60.0%)	0 (0.0%)	
BMI (kg/m ²) ^a	24.5 [21.8, 27.3]	25.0 [23.5, 27.5]	0.659
Length of stricture (> 15 mm)	7 (70.0%)	1 (14.3%)	0.049
Prestenting	2 (20.0%)	2 (28.6%)	1
Duration of hydronephrosis before surgery (months) ^a	4.5 [3.3, 5.0]	4.0 [2.5, 8.0]	0.693
Endoscopic management			
Lase incision (LI) and balloon dilation (BD)	5 (50.0%)	2 (28.6%)	0.874
LI	0 (0.0%)	1 (14.3%)	
BD	1 (10.0%)	1 (14.3%)	
Drainage			
Single stent	3 (30.0%)	3 (42.9%)	0.874
Double stent	5 (50.0%)	5 (57.1%)	
Nephrostomy tube	1 (10.0%)	0 (0.0%)	
URSL, ureteroscopic lithotripsy; BMI, body mass index; LI, laser incision; BD, balloon dilation			
^a Median [25%, 75% interquartile range].			

Renal function is shown in Table 5. The median preoperative and postoperative Creatinine (Cre) levels were 0.90 and 0.86, respectively, and the median estimated glomerular filtration rates (eGFRs) were 60.6 and 60.9, respectively. In the patients with failed endoscopic management, the median preoperative and postoperative Cre were 0.89 and 0.82, while the median eGFRs were 62.1 and 65.2, respectively. In the patients with successful endoscopic management, the median preoperative and postoperative Cre were 0.96 and 0.98, while the median eGFRs were 55.7 and 50.9, respectively. The difference in the data reported in Table 5 are not significant.

Table 5
Overall preoperative and postoperative renal function and renal function after failed and successful endoscopic management

	Preoperation	Postoperation	P value
Cre	0.90 [0.79, 0.95]	0.86 [0.75, 0.98]	0.097
eGFR	60.6 [53.1, 65.5]	60.9 [55.7, 70.8]	0.103
Failure	Preoperation	Postoperation	P value
Cre	0.89 [0.83, 0.93]	0.82 [0.72, 0.93]	0.399
eGFR	62.1 [59.8, 73.8]	65.2 [60.3, 73.0]	0.563
Success	Preoperation	Postoperation	P value
Cre	0.96 [0.78, 1.14]	0.98 [0.82, 1.19]	0.23
eGFR	55.7 [44.4, 58.8]	50.9 [45.9, 57.2]	0.154
Cre, creatinine; eGFR, estimated glomerular filtration rate			
^a Median [25%, 75% interquartile range].			

Discussion

The development and innovation of endourologic tools has enabled urologists to choose endoscopic management techniques, such as endoureterotomy and endoscopic dilation, for patients with US.¹⁴ These techniques are safer and less invasive than open surgical repair; however, success rates vary widely between reports.^{9,15} We would investigate the factors which influence the success rate of the management for US.

Intraoperative ureteral damage during URSL is one of the causes of US.⁶ US caused by ureteral damage is associated with ischemic changes, which results in lower success rates following treatment for US⁷. On the other hand, it is reported that stones embedded in the ureteral mucosa stimulate inflammation, which might result in US.¹⁶ US caused by stones embedded in the ureteral wall does not always involve ischemic changes; therefore, it is likely to be curable with additional treatment.¹¹ Netto et al. reported that

the success rates of BD for non-ischemic and ischemic US were 89% and 29%, respectively.¹⁷ In the current study, 52.6% of the USs were related to URSL; the success rate of the management for URSL-related US was significantly lower compared to that of the management for impacted stone-related US ($P = 0.01$). The US length was significantly longer in the patients with URSL-related US. The ischemic changes in the ureteral wall caused by laser lithotripsy may be associated with the development of a longer stricture. Together, these data suggest that to treat URSL-related US with endoscopic management is challenging.

US length is thought to be an important predictor of the outcome after endoscopic management for US in several reports. Netto et al. reported a lower success rate for the management of USs longer than 10 mm.¹⁷ Thomas et al. reported a poorer outcome of BD for USs longer than 15 mm.¹⁸ Meretyk et al. reported that the 20 mm in length was the most reliable predictor of success rate of LI.¹⁵ The current study demonstrated that more than 70% of patients failed with endoscopic treatment had a US longer than 15 mm. Consistent with previous reports, our study revealed that a length of 15 mm was likely to be an important factor to affect success rate of endoscopic treatment, even if the combination of LI and BD, as well as double stenting were utilized as novel techniques.

Prior studies report that the duration of the US is associated with the success rate for endoscopic management. Byun et al. reported that the duration of US (shorter or longer than 3 months) was an important factor which affected the success rate.¹⁹ On the other hand, Wolf et al. reported that the duration of the US did not significantly affect the success rate of US treatment.²⁰ In the current study, the median duration of hydronephrosis before surgery was not significantly different between the patients with endoscopic treatment failure and success.

The success rate of LI using a holmium YAG laser was reported to be 67-68.4%.^{21,22} Moreover, previous reports demonstrated that the success rate of BD for US was 50–76%.^{23,24} A Holmium YAG laser with both cutting and coagulating functions provides precise incision to a depth of the fat tissue outside of the ureter with effective hemostatic effect.²⁵ However, the laser incision or placement of a ureteral stent do not always sufficiently expand the lumen; therefore, we believe that the combination of LI and BD enables the equally centered expansion of the lumen on the incision line, which prevents restenosis. The current study showed that 57% patients underwent both LI and BD in the failure group; whereas one third of the patients underwent both procedures in the success group. There were no significant differences in the management between the patients with success or failure. However, the median length of US in the patients treated by both LI and BD in the success group of endoscopic management tended to be longer than that in the patients treated by both LI and BD in the failure group, although there was no significant difference. Thus, US length might affect the success rate of the combination of LI and BD as well.

Ureteral stents are preoperatively used for avoiding infection and kidney failure before the management of urolithiasis. They dilate the ureteral lumen and straighten the ureter, which makes it easy to insert a ureteroscope or ureteral access sheath.²⁶ For these reasons, prestenting would also elevate the success

rate of endoscopic management for US. In our study, all five patients with prestenosing had successful endoscopic management.

The placement of two ureteral stents was first reported in cases of malignant obstruction.²⁷ The authors suggested that two stents have more power to stand up to the comprehensive force of the tumor than one thick stent. The use of two ureteral stents has been applied for the management of benign US.^{9,28,29} Some urologists prefer to insert as large of a ureteral stent as possible; however, larger stents cause ischemia of the ureter, which tend to develop restenosis.²⁹ It is reported that two stents slide each other via peristalsis of the ureter, which maintain the expanded lumen.³⁰ This motion may prevent ischemia or pressure necrosis of the ureter, which is believed to result in a better success rate. We found no statistical differences in treatment success rates between the patients with single and double stents. However, the median length of the US in patients in the success group who underwent double stent placement tended to be longer than in patients with double stents in the failure group, though there was no significant difference. Thus, the length of the US might affect the success rate.

Our study is limited by its relatively small number of patients. Moreover, it is difficult to assess which factor is most important for the success rate because we conducted different treatments for each patient. Furthermore, given that identifying the beginning of US development was difficult without close monitoring, we may not have been able to provide an accurate estimate of the US duration. Despite these limitations, we believe that our study findings are useful for improving the management of treatment for stone-related US.

Conclusions

In conclusion, we investigated the outcomes of endoscopic management for stone-related US at our institution. URSL as a cause and longer than 15 mm in length could strongly affect the success rate of the endoscopic management of US. In such cases, reconstructive management for US should be considered in the early stages.

Abbreviations

BD, balloon dilation

BMI, body mass index

Cre, creatinine

eGFR, estimated glomerular filtration rate

LI, laser incision

URSL, ureteroscopic lithotripsy

US, ureteral strictures

Declarations

Ethics approval and consent to participate

The present study was approved by the Institutional Review Board of Nagoya City University Hospital. All patients provided informed consent for the use of their data.

Consent for publication

All patients provided informed consent for the use of their data.

Competing interests

The authors declare that they have no competing interests.

Availability of data and materials

The datasets used analysed during the current study are available from the corresponding author on reasonable request.

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Authors' contributions

TS: Manuscript writing and editing

KT: Project development and manuscript reviewing

SH: Data analyzing

Okada T: Data collection

MI: Data collection

YT: Data collection

RU: Data analyzing

YF: Data analyzing

TH: Statistical analysis

RA: Statistical analysis

Okada A: Data management

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References

1. Curhan GC. Epidemiology of stone disease. *Urol Clin North Am.* 2007;34:287–93.
2. Ando R, Nagaya T, Suzuki S, Takahashi H, Kawai M, Okada A, et al. Kidney stone formation is positively associated with conventional risk factors for coronary heart disease in Japanese men. *J Urol.* 2013;189:1340–6.
3. Preminger GM, Tiselius HG, Assimos DG, Alken P, Buck C, Gallucci M, et al, EAU/AUA Nephrolithiasis Guideline Panel. 2007 Guideline for the management of ureteral calculi. *J Urol.* 2007;178:2418–34.
4. Taguchi K, Cho SY, Ng AC, Usawachintachit M, Tan YK, Deng YL, et al. The Urological Association of Asia clinical guideline for urinary stone disease. *Int J Urol.* 2019;26:688–709.
5. Geavlete P, Georgescu D, Nita G, Mirciulescu V, Cauni V. Complications of 2735 retrograde semirigid ureteroscopy procedures: A single-center experience. *J Endourol.* 2006;20:179–85.
6. Gdor Y, Gabr AH, Faerber GJ, Roberts WW, Wolf JS Jr. Success of laser endoureterotomy of ureteral strictures associated with ureteral stones is related to stone impaction. *J Endourol.* 2008;22:2507–11.
7. Roberts WW, Cadeddu JA, Micali S, Kavoussi LR, Moore RG. Ureteral stricture formation after removal of impacted calculi. *J Urol.* 1998;159:723–6.
8. Fam XI, Singam P, Ho CC, Sridharan R, Hod R, Bahadzor B, et al. Ureteral stricture formation after ureteroscope treatment of impacted calculi: a prospective study. *Korean J Urol.* 2015;56:63–7.
9. Razdan S, Silberstein IK, Bagley DH. Ureteroscopic endoureterotomy. *BJU Int.* 2005;95:94–101.
10. Ramanathan LT, Kumar A, Kapoor R, Bhandari M. Relief of urinary tract obstruction in tuberculosis to improve renal function: Analysis of predictive factors. *Br J Urol.* 1998;81:199–205.
11. Lang EK, Fritzsche PF. Ureteral strictures. In: Lang EK, editor. *Radiology of the Lower Urinary Tract.* Berlin: Springer-Verlag; 1994. pp. 33–40.
12. May PC, Hsi RS, Tran H, Stoller ML, Chew BH, Chi T, et al. The morbidity of ureteral strictures in patients with prior ureteroscopic stone surgery: multi-institutional outcomes. *J Endourol.* 2018;32:309–14.
13. Kanda Y. Investigation of the freely available easy-to-use software ‘EZR’ for medical statistics. *Bone Marrow Transplant.* 2013;48:452–8.
14. Richter F, Irwin RJ, Watson RA, Lang EK. Endourologic management of benign ureteral strictures with and without compromised vascular supply. *Urology.* 2000;55:652–7.

15. Meretyk S, Albala DM, Clayman RV, Denstedt JD, Kavoussi LR. Endoureterotomy for treatment of ureteral strictures. *J Urol*. 1992;147:1502–6.
16. Dretler SP, Young RH. Stone granuloma: a cause of ureteral stricture. *J Urol*. 1993;150:1800–2.
17. Netto Júnior NR, Ferreira U, Lemos GC, Claro JF. Endourological management of ureteral strictures. *J Urol*. 1990;144:631–4.
18. Thomas R. Choosing the ideal candidate for ureteroscopic endoureterotomy. *J Urol*. 1993;149–314.
19. Byun SS, Kim JH, Oh SJ, Kim HH. Simple retrograde dilation for treatment of ureteral strictures: etiology-based analysis. *Yonsei Med J*. 2003;44:273–8.
20. Wolf JS, Soble JJ, Ratliff TL, Clayman RV. Ureteral cell cultures II. Collagen production and response to pharmacologic agents. *J Urol*. 1996;156:2067–72.
21. Singal RK, Denstedt JD, Razvi HA, Chun SS. Holmium: YAG laser endoureterotomy for treatment of ureteral stricture. *Urology*. 1997;50:875–80.
22. Lane BR, Desai MM, Hegarty NJ, Strem SB. Long-term efficacy of holmium laser endoureterotomy for benign ureteral strictures. *Urology*. 2006;67:894–7.
23. Schondorf D, Meierhans-Ruf S, Kiss B, Giannarini G, Thalmann GN, Studer UE, et al. Ureteroileal strictures after urinary diversion with an ileal segment-is there a place for endourological treatment at all? *J Urol*. 2013;190:585–90.
24. Laven BA, O'Connor RC, Gerber GS, Steinberg GD. Long-term results of endoureterotomy and open surgical revision for the management of ureteroenteric strictures after urinary diversion. *J Urol*. 2003;170:1226–30.
25. Johnson DE, Cromeens DM, Price RE. Transurethral incision of the prostate using the holmium:YAG laser. *Lasers Surg Med*. 1992;12:364–9.
26. Shields JM, Bird VG, Graves R, Gómez-Marín O. Impact of preoperative stenting on outcome of ureteroscopic treatment for urinary lithiasis. *J Urol*. 2009;182:2768–74.
27. Liu JS, Hrebinko RL. The use of 2 ipsilateral ureteral stents for relief of ureteral obstruction from extrinsic compression. *J Urol*. 1998;159:179–81.
28. Christman MS, Kalmus A, Casale P. Morbidity and efficacy of ureteroscopic stone treatment in patients with neurogenic bladder. *J Urol*. 2013;190:1479–83.
29. Ibrahim HM, Mohyelden K, Abdel-Bary A, Al-Kandari AM. Single versus double ureteral stent placement after laser endoureterotomy for the management of benign ureteral strictures: A randomized clinical trial. *J Endourol*. 2015;29:1204–9.
30. Isogai M, Hamamoto S, Hasebe K, Iida K, Taguchi K, Ando R, et al. Dual ureteral stent placement after redo laser endoureterotomy to manage persistent ureteral stricture. *IJU Case Rep*. 2020;3:93–5.