Semi-rigid Ureteroscope as a Dilator in Renal Stone Ureteroscopic Treatment

Amy M. Reed MD[1], Eric C. Umbreit MD[2] James K. Aden, ScD[1] and Christopher L. Allam, DO[1]

1. Brooke Army Medical Center
JBSA Fort Sam Houston, TX 78234
2. Eglin Hospital
Eglin AFB, FL 32542

Authors:
Amy M. Reed, MD, Capt, USAF
Urology Clinic, Department of Surgery
Brooke Army Medical Center
3551 Roger Brooke Dr.
JBSA Fort Sam Houston, TX 78234
Telephone: 210-916-4126
Email: Amy.m.reed18.mil@mail.mil

Eric C. Umbreit, MD, Major, USAF
Urology Clinic, Department of Surgery
96 MDG, Eglin AFB
Eglin, FL 32542
Telephone: 850-883-8346
Email: eric.umbreit.1@us.af.mil

James K. Aden, ScD
Statistician, MEDCOM BAMC
Brooke Army Medical Center
3551Roger Brooke Dr.
JBSA Fort Sam Houston, TX 78234
Telephone: 210-916-9102
Email: james.k.aden2.civ@mail.mil

Correspondence:
Christopher L. Allam, DO, Lt. Col, USAF
Urology Clinic, Department of Surgery
Brooke Army Medical Center
3551 Roger Brooke Dr.
JBSA Fort Sam Houston, TX 78234
Telephone: 210-916-6225
Fax: 210-916-5076
Email: Christopher.L.Allam.mil@mail.mil

Conflict of Interest and Source of Funding: The authors declare no conflicts of interest.

Disclaimer: The views expressed herein are those of the authors and do not reflect the official policy or position of Brooke Army Medical Center, the U.S. Army Institute of Surgical

Research, the U.S. Army Medical Department, the U.S. Army Office of the Surgeon General, the Department of the Army, Department of the Air Force or the Department of Defense or the U.S. Government

Abstract:

Introduction: To determine the efficacy and safety of using the semi-rigid ureteroscope as the only ureteral dilator for primary ureteroscopy (URS) in the treatment of renal stones.

Materials & Methods: A retrospective review of primary URS for renal stone disease was performed on consecutive patients treated by a single provider (CLA) from 2013 to 2017. Utilizing wire placement under fluoroscopic guidance and direct visual ureteroscopic dilation with a semi-rigid ureteroscope, primary outcome was successful completion of stone treatment. In addition, perioperative safety was evaluated.

Results: A total of 126 consecutive cases of primary URS using the semi-rigid ureteroscope as the only ureteral dilator were attempted for renal stone treatment. The renal stones were treated in 124 (98.4%) patients without other forms of active ureteral dilation. Two (1.6%) patients required ureteral stent placement for passive dilation despite attempted other dilating techniques. No intraoperative ureteral perforations were identified. Post-operative radiographic follow up was available for 67% patients with a 91% stone free rate and no hydronephrosis or ureteral strictures were detected.

Conclusion: Utilizing direct visual semi-rigid ureteroscopic dilation with a semi-ridged ureteroscope prior to flexible ureteroscopy leads to successful primary ureteroscopy for renal stone treatment in most patients. This technique is an effective, safe and possibly cost-effective method of obtaining ureteral access to facilitate primary URS for renal stone treatment.

Key Words: Ureteroscopy; ureteral dilation; kidney stones; semi-rigid ureteroscope

Introduction

With an increasing prevalence of stone disease at more than 9% of the United States population,[1] minimally invasive surgical management is becoming more widely used by urologists.[2,3] Specifically, ureteroscopy (URS) for ureteral and kidney stones less than 2cm in size has been recognized by the American Urological Association[4] and the European Association of Urologists[5] guidelines as an appropriate first-line treatment option. Technical advances in ureteroscope design, basket devices and laser equipment have all led to improved stone free rates (SFR) during URS depending on stone size and location.[6,7] However, primary URS stone

treatment is often precluded by intrinsic ureteral narrowing or underlying pre-existing ureteral pathology such as stricture which lead to an inability to advance the ureteroscope to the offending calculi.

In recent studies, almost a third of primary URS cases failed because of the inability to advance the ureteroscope within the ureter to the level of the stone.[8] Specifically, between 20-35% of primary URS failed to reach proximal ureteral or renal stones.[9] This will often result in placement of a ureteral stent for passive ureteral dilation and a second URS performed at a later date for definitive stone management.[10,11] In order to circumvent the need for passive dilation with ureteral stents, many urologists will actively dilate the ureter with balloon dilation, sequential dilators or other equipment (i.e. ureteral access sheaths (UAS)) prior to performing URS. These active dilating techniques can decrease the failure rate of primary URS to less than 5%.[12]

The semi-rigid ureteroscope is commonly used for URS especially if stones are located in the lower ureter. There is a paucity of data regarding the use of the semi-rigid ureteroscope as a dilating apparatus to facilitate flexible URS within the kidney. We present a method of performing ureteral dilation with the semi-rigid ureteroscope to facilitate the advancement of a flexible ureteroscope into the kidney for renal stone treatment. The active dilation of the ureter during this technique was accomplished with a semi-rigid ureteroscope in lieu of balloon dilation, sequential dilators or any other ureteral equipment besides a wire. We sought to evaluate the efficacy and safety of our technique and the impact on successful one staged URS for renal stone treatment.

Materials and Methods:

After receiving institutional review board approval, we conducted a multi-institutional retrospective review of consecutive primary URS for the treatment of renal calculi by a single provider (CLA) from 2013 to 2017. Patients were included in the review if it was a primary URS for treatment of renal stones without prior stenting and the semi-rigid ureteroscope was the only ureteral dilator in reaching the renal stone. Patients were excluded if there were any ureteral stones discovered or the renal stone migrated into the ureter. Patients with preoperative ureteral stents were also excluded. A failure of this technique was consider to be the inability to advance the flexible ureteroscope into the kidney after dilating with a semi-rigid ureteroscope or if other forms of active dilation were required to facilitate flexible URS. Patient demographic and clinical data were collected to include age, gender, BMI, stone size, location and laterality. Intraoperative data to include postoperative stenting and complications were extracted from operative dictations. Postoperative follow up imaging was reviewed to evaluate for late complications.

Each case was completed in a similar manner. The ureteral orifice was first intubated with a 0.035 inch sensor wire (Boston Scientific, Quincy, MA), which was passed into the collecting system under fluoroscopic guidance. In all cases, the semi-rigid ureteroscope (Olympus 6.9fr distal to 10.2fr proximal, Center Valley, PA) was then advanced into the bladder. Using a double wire technique, a second wire was passed into the ureter through the semi-rigid ureteroscope. This has been shown to increase the likelihood of accessing the distal ureter, likely related to tenting of the ureteral orifice[13]. The semi-rigid ureteroscope was advanced proximally to the level of the ureteropelvic junction if possible; or as proximal that could be safely passed at the

discretion of the operating surgeon. After the initial advancement of the semi-rigid ureteroscope for active dilation, a flexible ureteroscope (Karl Storz, Tuttlingen, Germany; Flex-X2^{TM}) was advanced over a single sensor wire into the kidney. Most cases were performed without a separate safety wire. The favored technique of stone treatment by the operative surgeon was to dust the stone rather than stone extraction. A retrograde pyelogram was performed at the end of every case and a ureteral stent was placed at the discretion of the operating surgeon.

Our primary outcome was to evaluate the rate of successfully accessing the kidney with a flexible ureteroscope for renal stone treatment with a secondary outcome evaluating immediate or late complications. Categorical data was summarized using percentages. Means and standard deviations or medians and inter-quartile ranges were used as summary statistics for continuous variables.

Results

Between 2013 and 2017, a total of 126 consecutive cases of primary URS for only renal stones were available for review in which this technique was used. Patient demographics and stone characteristics are listed in Table 1. Included in the review were 75 (60%) male patients and 51 (40%) female patients with a median age of 46.3 (36,57) and BMI of 28 (25,30). Sixty-three (50%) cases were right sided and 63 (50%) cases were left sided. The median stone size was 10mm (6,13). Postoperative ureteral stents were left in 76 cases (60%).

All cases were started with using the semi-rigid ureteroscope as the only ureteral dilator. In 98.4% of cases, no other forms of ureteral dilation were required to facilitate flexible URS in treating the renal stones. However, in 2 (1.6%) cases, the flexible ureteroscope following semi-

rigid URS was unsuccessful in accessing the kidney to treat the stone. These patients did go on to have other forms of attempted ureteral dilation with sequential dilators but ultimately remained unsuccessful in advancing the flexible ureteroscope into the kidney. These two patients required placement of a ureteral stent for passive dilation. A retrograde pyelogram following unsuccessful dilation did not reveal any urinary extravasation or indication of injury. There were no ureteral perforations or other reported intraoperative complications for any patient in this study.

Postoperative imaging was available for 85 (67%) patients between 6 and 16 weeks postoperatively. Many of the patients without imaging were military members that were unavailable or had moved from the area during the follow up time. The majority of imaging were renal ultrasounds. There were no cases of hydronephrosis or other evidence of ureteral strictures. Seventy-seven (91%) of the treated patients were stone-free on postoperative imaging.

Discussion

The incidence of urinary calculi is increasing worldwide, and in the United States the incidence is estimated at 9% of the population.[1] As the annual expenditure on urolithiasis has increased to over $5 billion in the United States,[14,15] there has been a parallel increase in minimally invasive surgical management options.[2,3] Despite tremendous technological advances in endoscopic management of urinary stones, a significant amount of patients undergo multiple procedures due to unfavorable ureteral anatomy.[6,7] In up to 35% of proximal ureteral or renal stone cases, primary URS cannot be completed and a ureteral stent is placed for passive dilation.[8,9] While URS on a pre-stented patient can be associated with improved stone free rates and decreased operative time,[16,17] there are risks associated with multiple anesthetics and prolonged ureteral

stenting.[18] In addition, the American Urological Association guidelines recommend against routine stenting prior to URS.[4]

To circumvent the need for pre-stenting, active dilation of the ureter is completed in over 1/3 of all endoscopic cases.[9,12] Historically, balloon dilation has been well described to be safe and effective for primary URS and is reportedly necessary in up to 60% of cases.[19,20] Recently, Mitchell et al. described sequential dilation of the ureter with Lubriglide ureteral dilators with a success rate of primary URS of up to 94% of cases. In their study, 30% (64 of 211) of renal stone treatment required active dilation with ureteral dilators.[21] Other forms of dilation may be performed with double-lumen catheters or UAS and are required in up to 18-26% of endoscopic cases to access the ureter.[22,23] However, these methods of active dilation are not without possible complications, as well as additional costs to the procedure. Even with the use of these ureteral dilation techniques, failure of primary URS may still occur in over 5% of patients.[12,21]

We report our experience using the semi-rigid ureteroscope as the only ureteral dilator during primary URS in the treatment of renal stones. While the semi-rigid ureteroscope is routinely used in the treatment of ureteral stones, there is a paucity of data regarding its use solely as a dilator in renal stone treatment in the absence of ureteral stones. In our study, 126 consecutive patients with only renal stones were treated using our technique of ureteral dilation using a semi-rigid ureteroscope in order to facilitate flexible renoscopy. We were able to successfully advance the flexible ureteroscope into the kidney for treatment in 124 (98.4%) patients. In two patients (1.6%) the semi-rigid ureteroscope would not advance into the mid ureter (pelvic inlet) and both cases ultimately failed other active dilation attempts, requiring stent placement and

secondary URS. No specific patient or stone characteristics were identified in these two failed patients which could aid in preoperatively predicting failures with our technique.

Our results are similar to contemporary studies of other ureteral dilation techniques including a reported almost 95% success rate using both balloon dilation and sequential dilators.[12,19,21] However, unlike balloon or sequential dilating techniques that rely on fluoroscopic guidance for visualization, we are able to directly visualize the ureteroscope advancing within the lumen of the ureter during dilation. There were no cases of ureteral perforation or other intraoperative complications during this study. This technique may offer an additional strategy during primary URS. Many urologists could find this technique easily adaptable due to the ubiquitous use of semi-rigid URS in routine practice for treatment of ureteral stones. In addition, using our technique can visualize any renal stones that may have progressed into the ureter during the interim time from imaging to going to the operating room. The unexpected ureteral stone within the ureter can be impacted into the ureteral wall if active dilation is performed without realization of the ureteral stone. Using the semi-rigid ureteroscope, the entire ureter is evaluated and any unexpected ureteral stones may be treated accordingly as discovered.

Ureteral stents are well known to cause bothersome urinary symptoms in over 80% of patients with two thirds of these patients unable to work while the stent is in place.[18]With a high success rate for primary URS, there is decreased need for prolonged ureteral stenting. This can limit pain and discomfort, allowing earlier return to work and decreasing the risk of ureteral stricture formation. In addition, our technique may offer further financial benefits by decreasing the costs that are associated with other ureteral dilators. At our institution, balloon dilators or UAS are most commonly used for ureteral dilation and are more expensive than the cost of sterilizing the

semi-rigid ureteroscope ($279 and $148, respectively, compared to $30 per sterilization). For an example, the cost of sterilizing a semi-rigid ureteroscope for all 126 cases in our study would be about $3,800. Comparatively, assuming 30% of patients (38 procedures) require active ureteral dilation, the cost of dilating with a UAS ($148) for these patients would be more than $5,600 and over $10,000 for balloon dilation techniques. While this study was not designed to specifically determine cost factors, there is a financial advantage using our procedure over other dilation techniques. In addition, within our military population, this technique may provide less equipment needs overall for stone treatment in a deployed or remote setting. However, this study does not take into account the availability of ureteroscopes at a high volume surgery center, the need for ancillary support staff or the cost to refurbish ureteroscopes. During our study, none of the semi-rigid ureteroscopes required any repair or replacement.

There are some limitations to our study. We are limited by the retrospective nature of the review and the inherent selection bias. All cases were performed by a single fellowship trained endourologist which may limit generalizability. We relied on operative dictations to complete our review which may have limited capture of all data points or underestimated minimal intraoperative trauma. Finally, only 67% of our patients completed postoperative imaging and follow up which may not accurately capture long term data points.

Conclusion

Utilizing direct visual ureteroscopic dilation with a semi-rigid ureteroscope is a feasible, safe and effective method of ureteral dilation prior to flexible URS for renal stones. This readily available equipment lends to widespread adaptability into even low-resource settings. Further prospective studies on this technique are warranted.

References

1. Scales CD, Jr., Smith AC, Hanley JM,et al. Urologic Diseases in America P. Prevalence of kidney stones in the United States. *Eur Urol.* 2012;62(1):160-165.
2. Geraghty RM, Jones P, Somani BK. Worldwide Trends of Urinary Stone Disease Treatment Over the Last Two Decades: A Systematic Review. *J Endourol.* 2017;31(6):547-556.
3. Turney BW, Reynard JM, Noble JG,et al. Trends in urological stone disease. *BJU Int.* 2012;109(7):1082-1087.
4. Surgical Management of stones: American Urological Association/Endourological Society Guideline. https://www.auanet.org/guidelines/surgical-management-of-stones-(aua/endourological-society-guideline-2016). Accessed Accessed July 8, 2017.
5. Turk C PA, Sarica K, et al. European Association Urologists guidelines on interventional treatment for urolithaisis. *Eur Urol* 2016;69:475-482.
6. Matlaga BR, Jansen JP, Meckley LM, et al. Treatment of ureteral and renal stones: a systematic review and meta-analysis of randomized, controlled trials. *J Urol.* 2012;188(1):130-137.
7. Wright AE, Rukin NJ, Somani BK. Ureteroscopy and stones: Current status and future expectations. *World J Nephrol.* 2014;3(4):243-248.
8. Cetti RJ, Biers S, Keoghane SR. The difficult ureter: what is the incidence of pre-stenting? *Ann R Coll Surg Engl.* 2011;93(1):31-33.
9. Fuller TW, Rycyna KJ, Ayyash OM, et al. Defining the Rate of Primary Ureteroscopic Failure in Unstented Patients: A Multi-Institutional Study. *J Endourol.* 2016;30(9):970-974.
10. Hubert KC, Palmer JS. Passive dilation by ureteral stenting before ureteroscopy: eliminating the need for active dilation. *J Urol.* 2005;174(3):1079-1080.
11. Ji C, Gan W, Guo H, et al. A prospective trial on ureteral stenting combined with secondary ureteroscopy after an initial failed procedure. *Urol Res.* 2012;40(5):593-598.
12. Kuntz NJ, Neisius A, Tsivian M, et al. Balloon Dilation of the Ureter: A Contemporary Review of Outcomes and Complications. *J Urol.* 2015;194(2):413-417.
13. Bostanci Y, Ozden E, Atac F, et al. The double wire technique: an alternative method for difficult ureteroscopic access. *Urol Res.* 2012;40(6):783-784.
14. Stamatelou KK, Francis ME, Jones CA, et al. Time trends in reported prevalence of kidney stones in the United States: 1976-1994. *Kidney Int.* 2003;63(5):1817-1823.
15. Antonelli JA, Maalouf NM, Pearle MS, et al. Use of the National Health and Nutrition Examination Survey to calculate the impact of obesity and diabetes on cost and prevalence of urolithiasis in 2030. *Eur Urol.* 2014;66(4):724-729.
16. Chu L, Sternberg KM, Averch TD. Preoperative stenting decreases operative time and reoperative rates of ureteroscopy. *J Endourol.* 2011;25(5):751-754.
17. Kawahara T, Ito H, Terao H, et al. Preoperative stenting for ureteroscopic lithotripsy for a large renal stone. *Int J Urol.* 2012;19(9):881-885.
18. Joshi HB, Stainthorpe A, MacDonagh RP, et al. Indwelling ureteral stents: evaluation of symptoms, quality of life and utility. *J Urol.* 2003;169(3):1065-1069.
19. Garvin TJ, Clayman RV. Balloon dilation of the distal ureter to 24F: an effective method for ureteroscopic stone retrieval. *J Urol.* 1991;146(3):742-745.

20. Baseskioflu B, Sofikerim M, Demirtas A, et al. Is ureteral stenting really necessary after ureteroscopic lithotripsy with balloon dilation of ureteral orifice? A multi-institutional randomized controlled study. *World J Urol.* 2011 Dec;29(6):731-6.
21. Mitchell C, Kuebker J, McCormick B, et al. Lubriglide Sequential Ureteral Dilators((R)): A Safe and Effective Method of Ureteral Dilation. *J Endourol.* 2017;31(6):573-576.
22. Cetti RJ, Biers S, Keoghane SR. The difficult ureter: what is the incidence of pre-stenting? *Ann R Coll Surg Engl.* 2011;93:31-33.
23. Fuller TW, Rycyna KJ, Ayyash PM, et al. Defining the rate of primary ureteroscopic failure in unstented patients: A multi-institutional study. *J Urol.* 2016;30(9):970-974.

Table 1. Patient demographics and stone characteristics

	Total	Successful URS	Failed URS
Patients treated	126	124 (98.4%)	2 (1.6%)
Median Age, (*IQR*)	46 (36,57)	46 (36,57)	34, 49
Gender, *n (%)*			
Male	75 (60)	74 (59)	1(50)
Female	51 (40)	50 (39)	1 (50)
Median BMI, (*IQR*)	28 (25,30)	28(25, 32)	23, 28
Median Stone Size mm, (*IQR*)	10 (6,13)	10 (6,13)	10, 14
Laterality, *n (%)*			
Right	63 (50)	62 (50)	1 (50)
Left	63 (50)	62 (50)	1 (50)
Ureteral Access Sheath (%)	12 (9.5)	12	0
Postoperative Ureteral Stents (%)	76 (60)	74	2