Controversies in ureteroscopy: Wire, basket, and sheath

Emad R. Rizkala, Manoj Monga

Department of Urology, Glickman Urological and Kidney Institute, Cleveland Clinic Foundation, Cleveland, OH 44195, USA

ABSTRACT

In the last one to two decades, flexible ureteroscopy has rapidly expanded its role in the treatment of urologic stone disease. With the frequent and expanded use of flexible ureteroscopy, other ancillary instruments were developed in order to ease and facilitate this technique, such as ureteral access sheaths (UAS) and a variety of wires and baskets. These developments, along with improved surgeon ureteroscopic competence, have often brought into question the need to implement the "traditional technique" of flexible ureteroscopy. In this review, we discuss a brief history of flexible ureteroscopy, its expanded indications, and the controversy surrounding the use of UAS, wires, and baskets.

Key words: Basket, calculus, controversy in urology, flexible ureteroscopy, safety wire, ureter, ureteral access sheath

INTRODUCTION

For centuries, endourology has been on the forefront of minimally invasive procedures, with Philipp Bozzini (1773-1809), a young German army surgeon who developed a sharkskin-covered instrument housing a candle within a metal chimney and a mirror on the inside that reflected light from the candle. Bozzini used this instrument to look into the urethra, among other orifices.[1] This was the early 18th century ancestor of what would be the modern cystoscope. Since that time, endourology has rapidly expanded its role in the treatment of urological disease to the point of limiting the use of certain open procedures, such as anatrophic nephrolithotomy, to only the extremely difficult cases. However, where there is rapid development and new technology, there most likely will be controversies. In this review, we will discuss the controversies of the use of wires, baskets, and ureteral access sheaths (UAS).

For correspondence: Dr. Manoj Monga, Glickman Urological and Kidney Institute, Cleveland Clinic Foundation, 9500 Euclid Avenue, Q10-1, Cleveland, OH 44195 USA.
E-mail: mongam@ccf.org

Access this article online	
Quick Response Code:	Website: www.indianjurol.com
	DOI: 10.4103/0970-1591.117287

BRIEF HISTORY OF FLEXIBLE URETEROSCOPY

The first ureteroscopic procedure was performed by Hugh Hampton Young in 1912 and was later reported in 1929.[2,3] In 1977, Goodman and Lynn, *et al.* independently reported purposeful rigid ureteroscopy.[4] The development of the flexible ureteroscope was only possible after fiberoptics became available. In 1964, Marshall reported the first flexible ureteroscope.[2,5] This was a 9F flexible scope with fiberoptic light transmission and imaging bundles. However, there was no method of deflecting the tip and no working channel for irrigation to provide a clear field. Dr. Marshall's associate passed this flexible ureteroscope through a 26F cystoscope into the distal ureter where a ureteral stone was visualized at 9 cm.[2] It was not until the late 1980s, when flexible, actively deflectable ureteroscopes with an irrigation channel were clinically trialed in a meaningful way. In 1989, Kavoussi and colleagues reported 76 flexible ureteroscopic procedures in 68 patients using four different models.[6] The models ranging in diameter from 9.8F to 12.3F and they were able to access the area of interest in 96% of patients. Diagnostic and therapeutic maneuvers were successful in 84% of the patients treated, thereby demonstrating the usefulness of these instruments.[2] Further development of the flexible ureteroscope centered on reduction of diameter and larger range of deflection. In 1994, Grasso and Bagley reported their early experience with a 7.5-F diameter flexible ureteroscope with a 3.6-F working channel. Ureteral dilation was not necessary in 48% of patients, due to the ureteroscope's relative small diameter.[7]

Digital flexible ureteroscopes have also been recently developed and they have been shown by Zilberman *et al.*, to have improved resolution and color representation, as well as 5.3 times larger image size compared with the standard fiberoptic flexible uretersocope.[8] Other developments in the flexible ureteroscope have been the addition of a second working channel, which was demonstrated by Haberman *et al.*, to provide similar deflection characteristics to the current single-channel scope, as well as increased overall irrigation flow.[9] With this vast improvement of flexible ureteroscopic technology, there has been an expansion in indications for treatment of intrarenal calculi.

Expanded Indications for Intrarenal Calculi

Flexible ureteroscopy now makes possible the treat of patients that had relative, as well absolute contraindications to shockwave lithotripsy and/or percutaneous nephrolithotomy. For example, patients on anticoagulation, pregnant women, and the obese, as well as patients who simply do not wish to be admitted to the hospital, can often undergo these procedures with good outcomes.[10-14] Thus, flexible ureteroscopy has now allowed endourologists to perform procedures safely and effectively, that prior to the advent of this technology, were otherwise unable to.

Traditional Technique

In the so-called "traditional technique" of flexible ureteroscopy, a wire is initially placed into the ureteral orifice cystoscopically and advanced cranially into the renal pelvis under fluoroscopic visualization. Typically, a second wire is placed alongside the initial wire, either cystoscopically or *via* a dual-lumen catheter. This provides two wires; a working wire which is used for passing instruments up the ureter, such as a flexible ureteroscope (by "back loading" it over the wire), and a safety wire, to remain in place throughout the procedure. During a ureteroscopic procedure, such as laser lithotripsy, baskets are commonly implemented in order to retrieve stone fragments. Repetitive ureteroscope removal and reintroduction into the ureteral orifice is required if multiple stone fragments are present. This process can often be time consuming if one wishes to render the patient stone-free.

With the frequent and expanded use of flexible ureteroscopy, other ancillary instruments were developed in order to ease and facilitate this technique, such as UASs and a variety of wires and baskets. These developments, along with improved surgeon ureteroscopic competence, have often brought into question the need to implement this "traditional technique" of flexible ureteroscopy.

The Use of Ureteral Access Sheaths

The UAS was first introduced in 1974 as a means of passing a flexible ureteroscope into the ureter.[15,16] Initial experience with UAS was somewhat bleak with a reported ureteral perforation during placement of the UAS in 19% of 43 cases, published in 1987 by Newman, *et al.*[17] Since this report, UAS quickly fell out of favor. However, in 2001, Preminger and colleagues renewed interest when they reported about a new generation of UAS which had an impregnated wire and hydrophilic coating, making them safer and easier to insert.[18]

Advantages of Ureteral Access Sheaths

There has been multiple proposed advantages of utilizing UAS; however, none of the proposed advantages have been established with level 1 randomized controlled trials. Some of the reported advantages of UAS is ease of access, protection of the ureter, protection of the scope, expeditious stone extraction, higher stone-free rates, low intrarenal pressure, virtual elimination of having to drain the bladder during prolonged ureteroscopy, and decreased cost (as compared to balloon dilation). Also, a significant increase in postoperative symptoms was noted when the balloon was used as a dilator compared to the access sheath.

Kourambas, *et al.*[18] in a study showed that a significant increase in postoperative symptoms was noted when the balloon was used as a dilator compared to the access sheath. Also, there was no significant difference in postoperative symptoms, complication rate or stone-free status in the access sheath and nonaccess sheath groups in patients not requiring ureteral dilatation ($P < 0.05$). Moreover, they showed that operative time and costs in all patients who underwent access sheath dilatation were less than in those in whom the access sheath was not used.

Intrarenal Pressure

A study by Preminger and colleagues illustrated that there is a reduction in intrarenal pressures by 57% to 75% during flexible ureteroscopy when employing a UAS.[19] In a similar study by Rehman *et al.*, it was found that with all of the sheaths tested (35 cm; 10/12F, 12/14F, and 14/16F), intrapelvic pressure remained low (less than 30-cm H_2O), and there was a 35% to 80% increase in irrigant flow versus the control unsheathed ureteroscopy. They also found that the 12/14F access sheath provides for maximum flow of irrigant (and thereby improving visualization) while maintaining a low intrarenal pelvic pressure and that even with an irrigation pressure of 200-cm H_2O, renal pelvic pressure remained below 20-cm H_2O.[20]

Improvement in Ureteroscope Longevity

Pietrow, *et al.*[21] showed that using UASs along with nitinol devices (baskets/graspers), and a small caliber holmium laser fiber (200 μm) increases the ureteroscopes average life to 27.5 separate operative procedures per instrument (range 19-34) prior to being sent for repair compared to the previously published 6 to 15 operative cases.[22] The UAS not only reduces stress on the tip of the ureteroscope during advancement of the instrument through the ureteral orifice, but the sheath also allows for repeated simplified insertion and withdrawal of the scope while removing stone fragments from the upper urinary tract. Also, potential damage to the working channel of the ureteroscope is reduced by not advancing the instrument over a working guide wire during scope insertion.[21] Moreover, improving longevity of ureteroscope can obviously be translated into significant financial savings for the operating room equipment.[21]

Improvement in Stone-free Rates

L'esperance and colleagues[23] studied a total of 256 ureteroscopic procedures for the removal of renal calculi that were performed between 1997 and 2003 (173 with UAS and 83 without). The groups were similar in age, sex, and stone burden (stone size 8.7 mm for UAS group and 7.3 mm for non-UAS group, $P = 0.07$). Of note, for either study group, the authors attempted fragmentation of the stone down to very small sizes, avoiding the need to basket retrieve stones or fragments. The stone-free status was determined at 2 months postoperatively by either intravenous urography (IVU) with tomograms or noncontrast renal computed tomography (CT) in patients with contrast allergies or radiolucent stones only. The lower renal pole represented the most common presenting location. Stone displacement with a ureteroscopic basket for efficient fragmentation was necessary in 34%. The overall stone-free rate (SFR) was 75% for the two groups combined. The SFR in the UAS group and non-UAS group was 79% and 67%, respectively, ($P = 0.042$). Therefore, in addition to facilitating ureteroscopic access, reducing costs, and lowering intrarenal pressures, this study also suggest that UASs improve SFRs.

Disadvantages of Ureteral Access Sheaths

Lallas and colleagues[24] studied the ischemic effects of UAS on the ureter. Using a porcine animal model, ureteral blood flow was measured with a laser Doppler flowmeter. They found that the control group demonstrated little ureteral blood flow variability over the course of 70 minutes. However, the study groups that were dilated with sheaths all showed a decrease in ureteral blood flow after access sheath insertion, with the flow in animals dilated with 12F/14F and 14F/16F sheaths dropping below 50% of baseline. This initial drop in blood flow was followed by a gradual increase from nadir toward baseline values. On average, the 14F/16F group reached nadir more quickly and took longer to restore its ureteral blood flow. Histologically, there was no evidence of ischemic damage in any of the study groups at 72 hours. The authors concluded that compensatory mechanisms of the ureteral wall restore blood flow to near-baseline rates and preserve urothelial integrity, thereby suggesting that use of the UAS remains a safe adjunct to flexible ureteroscopy.

Subsequently, one of the proposed risks of UAS use is increased ureteral stricture formation. However, Delvecchio *et al*.[25] analyzed the long-term incidence of ureteral stricture formation in a series of patients in whom a new-generation UAS was used. Mean clinical follow-up was 11.1 months (range 3.2-27.4), and follow-up imaging was performed within 3 months after ureteroscopy in all patients. The 10/12F access sheath was used in 8 ureteroscopic procedures (11.2%), the 12/14F access sheath in 56 (78.9%), and the 14/16F access sheath in 7 (9.8%). One stricture was identified on follow-up imaging of 71 procedures performed, for an incidence of 1.4% (which is within the range 1-2% ureteral stricture rate with ureteroscopy without the UAS[26-28]). The patient developed the stricture at the ureteropelvic junction after multiple ureteroscopic procedures. The authors did not believe that the UAS was a contributing factor.

Basket Stone Retrieval versus Dusting

Certainly, the stone-free rates that were presented by the well-experienced group[23] quoted earlier are not as high as would be expected considering the great visualization, improved irrigation flow rates, and ease of access facilitated by the use of UAS. One question is can the laser lithotripsy technique and/or the retrieval method effect the SFR? Whether or not to either basket or dust a stone is the question that arises when laser lithotripsy is performed along with flexible ureteroscopy. *Currently, there is no data available to suggest the superiority of one modality over the other*. There is speculation that "dusting the stone" may give rise to lower SFRs since follow-up in many of these studies is CT scan, which will likely over represent stone fragments that are likely too small to cause obstruction or renal colic symptoms and/or are likely to dissolve if appropriate medical treatment is initiated. Proponents of basket retrieval of stone fragments commonly hold the premise that ensuring that all stones fragments are removed is the most sure way of maximizing SFRs.

Is a Safety Wire Necessary?

Initially, safety guide wires were maintained alongside the ureteroscope during stone manipulation to prevent loss of access and allow stent insertion in the event of perforation. However, as endourologists are becoming more efficient and skilled at performing flexible ureteroscopy, certain "dogmas" of traditional flexible ureteroscopy techniques are coming more into question, such as the necessity of using a safety wire. Nakada and colleagues[29] recently published a report in which they did not use a safety wire and merely used the flexible ureteroscope as a sort of "safety wire". Wireless ureteroscopy was defined as ureteroscopy with laser lithotripsy performed for renal calculi without a safety wire in place. They looked at 268 patients who met their study inclusion criteria. Mean stone diameter of the renal calculi treated was 12.0 ± 5.9 mm. Twenty percent of the patients needed ureteral dilation, and 15% of the patients had a UAS placed intraoperatively. The overall complication rate was 2.6% (major: 0.7%, minor: 1.9%). Complications included: Four urinary tract infections, two patients with urosepsis, and one patient with urinary retention. No patients had ureteral perforation or ureteral avulsion. Of note, the authors do state that a "UAS was placed in selected patients with a large stone burden or who needed endoscopic basket retrieval of multiple stone fragments".[29]

Dickstein, *et al.*[30] performed a series in which flexible ureteroscopy was performed on 305 kidneys in 246 consecutive patients with renal or ureteropelvic junction stones, of which 59 cases were bilateral. Cases were subdivided into complicated and uncomplicated. Complicated cases were defined as those having concomitant obstructing ureteral stones requiring intervention, an associated encrusted ureteral stent, or difficult access secondary to a large stone burden (Steinstrasse or staghorn) or aberrant anatomy (pelvic kidney, urethral/ureteral stricture, ileal loop, suprapubic tube, and limb contractures). Two-hundred and seventy cases were uncomplicated and performed without a safety guide wire. No intraoperative complications resulted from the lack of a safety guide wire, including no cases of lost access, ureteral perforation/avulsion, or need for percutaneous nephrostomy tube. Thirty-five cases were complicated, necessitating a safety guide wire. Of these, 16 had concomitant obstructing ureteral stones, five had encrusted ureteral stents, and 14 had difficult access because of large stone burden or aberrant anatomy. The authors concluded that a safety guide wire was not necessary for routine cases of flexible ureteroscopy with laser lithotripsy on renal or UPJ stones.

Grasso and colleagues,[31] studied 460 consecutive upper urinary tract procedures that were performed utilizing the 7.5-F actively deflectable, flexible ureteroscope. A stent was in place or had recently been in place in 108 of the procedures (24%). Two-hundred and twenty-seven procedures were performed in which no guide wire was needed to place the flexible endoscope in the upper urinary tract (i.e., “wireless” ureteroscopy). Ureteral and renal stones and tumors were treated successfully using holmium laser energy and, when necessary, small fragments were removed by basket retrieval, removing the stones to the bladder and accessing the ureter again without having to place a safety wire. Multiple passes were made as needed to extract renal or ureteral stone fragments. The authors state that essential to this maneuver was reducing the stone burden to small (3-mm) fragments. There were no false passages or ureteral perforations secondary to endoscope placement.

From these reports, one can conclude that the common requirements needed for performing flexible ureteroscopy without a safety wire are that no basket retrieval of multiple sizable stone fragments is needed and that the procedure is deemed “uncomplicated”. Although Dickstein, *et al.*[30] have correctly outlined the preoperative definition of what would deem a ureteroscopy uncomplicated, it does not take into account perioperative findings and misadventures that could occur and turn a seemingly “uncomplicated” ureteroscopy into a complicated one. Therefore, in our practice, we always utilize a safety wire.

CONCLUSIONS

Flexible ureteroscopy has certainly progressed to the forefront of the endourologist’s armamentarium in the minimally invasive treatment of complex renal stones. This progress has been the result of technological development of the flexible ureteroscope, as well refinement of endoscopic technique. The “traditional technique” of flexible ureteroscopy has also come into question due to the development and experience with UAS, baskets, and wires. From the above review of the literature, one can simplify these controversies and questions to just one: Is it more beneficial to perform laser lithotripsy of the stone to dust and not perform basket retrieval or should we perform laser lithotripsy to fragments and basket retrieve them? Based on the literature, as well as our own experience, we believe that if one is not planning to basket retrieve the stones, then it is probably not necessary to use a wire or sheath. However, if one wishes to basket retrieve the stone fragments, then it may be prudent to employ a safety wire as well as a UAS.

REFERENCES

1. Engel RM. Philipp Bozzini - the father of endoscopy. J Endourol 2003;17:859-62.
2. Conlin MJ, Marberger M, Bagley DH. Ureteroscopy. Development and instrumentation. Urol Clin North Am 1997;24:25-42.
3. Young HH, Mckay RW. Congenital valvular obstruction of the prostatic urethra. Surg Gynecol Obstet 1929;48:509-35.
4. Goodman TM. Ureteroscopy with pediatric cystoscope in adults. Urology 1977;9:394.
5. Marshall VF. Fiberoptics in urology. J Urol 1964;91:110-4.
6. Kavoussi L, Clayman RV, Basler J. Flexible actively deflectable fiberoptic ureteronephroscopy. J Urol 1989;142:949-54.
7. Grasso M, Bagley D. A 7.5/8.2 F actively deflectable, flexible ureteroscope: A new device for both diagnostic and therapeutic upper urinary tract endoscopy. Urology 1994;43:435-41.
8. Zilberman DE, Lipkin ME, Ferrandino MN, Simmons WN, Mancini JG, Raymundo ME, *et al*. The digital flexible ureteroscope: *In vitro* assessment of optical characteristics. J Endourol 2011;25:519-22.
9. Haberman K, Ortiz-Alvarado O, Chotikawanich E, Monga M. A dual-channel flexible ureteroscope: Evaluation of deflection, flow, illumination, and optics. J Endourol 2011;25:1411-4.
10. Pevzner M, Stisser BC, Luskin J, Yeamans JC, Cheng-Lucey M, Pahira JJ. Alternative management of complex renal stones. Int Urol Nephrol 2011;43:631-8.
11. Wheat JC, Roberts WW, Wolf JS Jr. Multi-session retrograde endoscopic lithotripsy of large renal calculi in obese patients. Can J Urol 2009;16:4915-20.
12. Semins MJ, Trock BJ, Matlaga BR. The safety of ureteroscopy during pregnancy: A systematic review and meta-analysis. J Urol 2009;181:139-43.
13. Hyams ES, Munver R, Bird VG, Uberoi J, Shah O. Flexible ureterorenoscopy and holmium laser lithotripsy for the management of renal stone burdens that measure 2 to 3 cm: A multi-institutional experience. J Endourol 2010;24:1583-8.
14. Turna B, Stein RJ, Smaldone MC, Santos BR, Kefer JC, Jackman SV, *et al*. Safety and efficacy of flexible ureterorenoscopy and holmium: YAG lithotripsy for intrarenal stones in anticoagulated cases. J Urol 2008;179:1415-9.
15. Takayasu H, Aso Y. Recent development for Pyeloureteroscopy: Guide tube method for its introduction into the ureter. J Urol 1974;112:176-8.
16. Stern JM, Yiee J, Park S. Safety and efficacy of ureteral access sheaths.

J Endourol 2007;21:119-23.
17. Newman RC, Hunter PT, Hawkins IF, Finlayson B. The ureteral access system: A review of the immediate results in 43 cases. J Urol 1987;137:380-3.
18. Kourambas J, Byrne RR, Preminger GM. Does a ureteral access sheath facilitate ureteroscopy? J Urol 2001;165:789-93.
19. Auge BK, Pietrow PK, Lallas CD, Raj GV, Santa-Cruz RW, Preminger GM. Ureteral access sheath provides protection against elevated renal pressures during routine flexible ureteroscopic stone manipulation. J Endourol 2004;18:33-6.
20. Rehman J, Monga M, Landman J, Lee DI, Felfela T, Conradie MC, *et al*. Characterization of intrapelvic pressure during ureteropyeloscopy with ureteral access sheaths. Urology 2003;61:713-8.
21. Pietrow PK, Auge BK, Delvecchio FC, Silverstein AD, Weizer AZ, Albala DM, *et al*. Techniques to maximize flexible ureteroscope longevity. Urology 2002;60:784-8.
22. Afane JS, Olweny EO, Bercowsky E, Sundaram CP, Dunn MD, Shalhav AL, *et al*. Flexible ureteroscopes: A single center evaluation of the durability and function of the new endoscopes smaller than 9Fr. J Urol 2000;164:1164-8.
23. L'esperance JO, Ekeruo WO, Scales CD Jr, Marguet CG, Springhart WP, Maloney ME, *et al*. Effect of ureteral access sheath on stone-free rates in patients undergoing ureteroscopic management of renal calculi. Urology 2005;66:252-5.
24. Lallas CD, Auge BK, Raj GV, Santa-Cruz R, Madden JF, Preminger GM. Laser Doppler flowmetric determination of ureteral blood flow after ureteral access sheath placement. J Endourol 2002;16:583-90.
25. Delvecchio FC, Auge BK, Brizuela RM, Weizer AZ, Silverstein AD, Lallas CD, *et al*. Assessment of stricture formation with the ureteral access sheath. Urology 2003;61:518-22.
26. Francesca F, Scattoni V, Nava L, Pompa P, Grasso M, Rigatti P. Failures and complications of transurethral ureteroscopy in 297 cases: Conventional rigid instruments vs. small caliber semirigid ureteroscopes. Eur Urol 1995;28:112-5.
27. Abdel-Razzak OM, Bagley DH. Clinical experience with flexible ureteropyeloscopy. J Urol 1992;148:1788-92.
28. Elashry OM, Elbahnasy AM, Rao GS, Nakada SY, Clayman RV. Flexible ureteroscopy: Washington University experience with the 9.3F and 7.5F flexible ureteroscopes. J Urol 1997;157:2074-80.
29. Patel SR, McLaren ID, Nakada SY. The ureteroscope as a safety wire for ureteronephroscopy. J Endourol 2012;26:351-4.
30. Dickstein RJ, Kreshover JE, Babayan RK, Wang DS. Is a safety wire necessary during routine flexible ureteroscopy? J Endourol 2010;24:1589-92.
31. Johnson GB, Portela D, Grasso M. Advanced ureteroscopy: Wireless and sheathless. J Endourol 2006;20:552-5.

How to cite this article: Rizkala ER, Manoj M. Controversies in ureteroscopy: Wire, basket, and sheath. Indian J Urol 2013;29:244-8.

Source of Support: Nil, **Conflict of Interest:** Dr. Monga is a consultant for Cook Urological, Taris Biomedical, Xenolith, US Urology.