

Retrograde Intra Renal Surgery (RIRS).

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Abstract: Evolution of technique and miniaturization of instruments have changed the management of stone disease. Reduction in the size of endoscopes, improvements in the electronic imaging systems, proliferation of auxiliary equipments, and improvement in endourological skills among urologists make endoscopic management of urolithiasis a treatment of choice. The advent of rigid and flexible ureteroscopes has allowed intraureteral and renal lithotripsy (Ultrasonic, Pneumatic, and Laser) regardless of the size and location of stone. The flexible ureteroscopy is safe and efficacious, even for managing upper tract stones. It is a major leap in endourology in managing urolithiasis and other pathologies in kidney. In this article we will discuss about efficiency, advantages, advances and risks involved in RIRS.

INTRODUCTION

In 1978, a paediatric cystoscope was used to examine a dilated distal ureter in a female¹. The technique has improved dramatically over the past 2 decades, and has evolved into a minimally invasive procedure for the diagnosis and treatment of pathology within the upper urinary tract. Today, the vast majority of intrarenal calculi are accessible and treatable using a retrograde ureterorenoscopic approach. The development of smaller calibre, longer, and more nimble ureteroscopes has driven this revolutionary advance. This progress has resulted in a revolution in the management of urolithiasis and an ever-increasing role in oncology treatment. In this article we present our experience of performing ureterorenoscopy and discuss technique which we think maximises the chances of success, while minimizing the risks of failure and complications.

INDICATIONS

The indications for ureteroscopy fall into two categories, **diagnostic** and **therapeutic**.

Diagnostic indications include evaluating a patient with a radiological filling defect, undiagnosed gross haematuria, or positive cytology of the upper tract, or surveillance of patients with uppertract malignancies that have been treated endoscopically.

Therapeutic indications include removing upper tract stones or other foreign bodies, treating upper tract malignancies, treating strictures or areas of obstruction. Flexible ureteroscopy is emerging as a first-line procedure for increasingly challenging stone cases. For children, including prepubertal children, who have urolithiasis, ureteroscopy is becoming more widely accepted as first-line therapy. This is undoubtedly because of miniaturization of ureteroscopes and ancillary devices, and the introduction of the holmium laser. Advances in ureteroscopic instrumentation have resulted in stone-free rates and complication rates similar to those for adults. Ureteroscopy and holmium laser lithotripsy during pregnancy continues to become a more widely accepted treatment. It is particularly useful and effective if there are one or more of the following present: bifid collecting system, stones in a parallel calyx, stenotic upper pole infundibulum, branched staghorn calculus, or multiple stones in separate locations within the collecting system.

CONTRAINDICATIONS

Patients presenting with ‘high-spiking’ fever and rigors, mental status changes, or other signs of serious infection, would better benefit from a percutaneous nephrostomy. Irrigating pressures within the ureter during endoscopy can lead to pyelovenous and/ or pyelolymphatic back-flow, placing the patient at risk of septicemia. However it is safe in bleeding diathesis and pregnant women where other treatment options are limited.

TYPES OF SCOPES

The first ureteroscopy was performed in 1912 by Hugh Hampton Young in a patient with posterior urethral valves when a rigid cystoscope was advanced into the dilated ureter (Young and McKay, 1929)². Initially, all ureteroscopes were rigid in design and consisted of a rod-lens system with outer diameters ranging from 12 to 13.5 Fr. These endoscopes required routine dilation of the ureter in order to gain access as well as an indwelling stent postoperatively. In 1989 next generation of “semirigid” ureteroscopes was developed and contained fiberoptics rather than a rod-lens system (Fig.1) (Dretler and Cho, 1989)³.



Fig.1. Wolf dual operating channels (DOC) semirigid ureteroscope.

Flexible, actively deflectable ureteroscopes range from 6.75 to 9 Fr in diameter at the tip and offer the distinct advantage of being able to reach the entire urinary system including the lower pole of the kidney. Table 1 lists some of the currently available flexible ureteroscopes. Typical endoscopes offer 120 to 170 degrees of deflection in one direction and 170 to 270 degrees in the other (Ferraro et al, 1999 ; Chiu et al, 2004 ; Johnson and Grasso, 2004)⁴⁻⁶; however, the degree of deflection may be altered with instruments (such as laser fibers) in the working channel that increase the stiffness and resistance to deflection of the endoscope (Poon et al, 1997 ; Landman et al, 2002a ; Parkin et al, 2002)⁷⁻⁹. The extra flexibility of such instruments comes with the disadvantages of inferior image quality compared with semirigid ureteroscopes and frequent repairs for a variety of problems including damaged fiberoptic bundles, perforation of the working channel by accessory instruments, or malfunctioning deflection mechanisms (Afane et al, 2000 ; Pietrow et al, 2002 ; Landman et al, 2003a)¹⁰⁻¹². The flexible ureteroscope is used almost exclusively in cases with upper ureteral stones and renal pathology.

Table-1: Characteristics of Available Flexible Ureteroscopes

	ACMI DUR 8 Elite	ACMI DUK 8	Storz J1274AA	Storz J1278A	Flex-X	Wolf 2325,172 7.5 F	Wolf 2336,072 9.0 F	Olympus UKF-P3
Tip size (Fr)	6.75	6.75	7.5	7.5	7.5	9.0	6.9	
Shaft size (Fr)	8.7-10.1	8.7-10.1	8.6	8.4	8.0-9.0	9.0	8.4	
Working channel (Fr)	3.6	3.6	3.6	3.6	3.6	4.0	3.6	
Working length (cm)	64	65	70	67.5	70	60	70	
Field of view (°)	80	80	90	95	95	60	90	
Active deflection	180/170 - 130 down with dual deflection	180/170	170/120	270/270 (dual deflection)	160/130	160/130	180/180	
Active deflection	Primary and secondary	Primary	Primary	Primary and secondary	Primary	Primary	Primary	

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Data from User et al., 2004 ; Monga et al., 2004 ; Shvarts et al., 2004 ; Parkin et al., 2002¹³⁻¹⁶

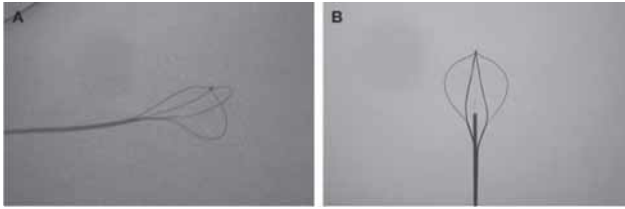


Fig. 2: New stone baskets: (A) Bard Dimension; (B) Microvasive Urology/Boston Scientific Escape.



Fig. 3: Olympus URF-P5 flexible ureteroscope (A) with 5.4F "Evolution tip" (B).



Fig. 4: Gyrus ACMI DUR-D flexible video ureteroscope.

TECHNIQUE

Patient Selection

There are several treatments for urolithiasis, including observation, medical expulsive therapies¹⁷, shock-wave lithotripsy, and percutaneous nephrolithotripsy. Each treatment should be considered with regard to the clinical scenario. Failure of conservative therapy or other considerations, such as occupational requirements (e.g. airline pilots), renal insufficiency, or coexisting infections, can hasten surgical intervention. The preoperative evaluation includes a focused history and physical examination, with particular attention to coagulation disorders and current medications. Laboratory evaluation includes serum creatinine and electrolyte levels, as well as a white blood cell count with differential. Analysis and culture of the urine should reveal no active infection; otherwise, a course of antibiotics should precede intervention. Any abnormalities in the patient's history should be cleared by the appropriate medical services.

Equipment & Techniques

The following list details the authors' preferred equipment and materials for ureterorenoscopy.

- Fluoroscopy (C-arm).
- Ureteroscopes, rigid/flexible.
- Guidewires (a variety).
- 5 fr ureteric catheter.
- Contrast medium.
- Ureteric access sheath.
- Holmium :YAG laser (with laser fibre, 365 or 200 μ m).

- Stone baskets (a variety). (Fig.2)

Rigid ureteroscopes range from 4 F to 13.5 F at the tip and use channels for instruments and/or irrigation ranging from 2.3 F to 5.4 F. Advantages of the rigid scope include the large working channel, greater durability, and excellent visualization. The disadvantages include its rigidity and size, which become apparent while trying to traverse the ureter over the pelvic brim. We prefer the semi-rigid 6 F ureteroscope in the distal ureter, or mid-ureter if accessible. In our practice. Flexible, actively deflectable ureteroscopes range from 6.75 to 9 Fr in diameter (Fig.3) at the tip and offer the distinct advantage of being able to reach the entire urinary system including the lower pole of the kidney, and the working chambers will accommodate 3 F instruments; however, these instruments will adversely affect the deflection of the tip. Nevertheless, with these scopes we can visualize virtually any area of the upper collecting system, most notably the renal pelvis and its various calyces. Furthermore, some flexible ureteroscopes on the market can be used to actively 'double deflect' the tip, allowing access into the most difficult of anatomical areas, but these come at a high price in durability. In the uncomplicated proximal stone or diagnostic procedure, we use the 6.9 F flexible DUR-8 ureteroscope by ACMI (Fig4).

SURGICAL STEPS

Specific Patient Positioning

The patient is placed in a dorsal lithotomy position and all pressure points are padded.

The following steps are used for flexible ureteroscopy

There are three main steps : (1) accessing the ureter; (2) instrumentation of the ureter (3) withdrawing from the ureter.

Ureteric Access

A full cysto-urethroscopy is performed initially. Hydrophilic guidewire is passed into the collecting system under fluoroscopy. Balloon dilatation of the ureteric orifice is done over guidewire.

The ureteric access sheath has recently assumed a greater role in accessing the upper urinary tract, allowing repeated passage of the flexible ureteroscope. It is valuable in minimizing distal ureteric trauma, wear on the ureteroscope and the operative time of the procedure. There is a reported 1.7% stricture rate with the access sheath¹⁸.

Instrumentation

For a proximal ureteric lesion, a ureteric access sheath is placed on guidewire under continuous fluoroscopy.

Care is taken to advance the sheath beyond the iliac vessels and near the area of interest under fluoroscopy. The flexible ureteroscope can then be passed up through the sheath. At this point, renoscopy can proceed under direct visualization and fluoroscopic control, and the objectives of the procedure can be completed. Dilute contrast medium can be injected gently to further define the renal pelvic anatomy and ensure adequate visualization of all calyces (Fig.5).

For urothelial cancers, the objective is to obtain tissue for diagnosis *without* perforation or removal of the full-thickness of the ureteric wall. Gravity irrigation is preferred after access into the ureter, ensuring that the pressure in the collecting system is kept to a minimum. A flat-wire basket is passed superior to the lesion. The cage is opened and carefully withdrawn inferiorly. Once the lesion is within the cage, the basket is closed and the ureteroscope and specimen are removed in its entirety. Care should be taken not to crush the specimen, which is often very friable. The scope is then replaced into the ureter and the base of the lesion cauterized. Holmium:YAG laser is used to fulgurate the area. An indwelling ureteric stent is placed for 7–10 days.



Fig. 5: Deflection of flexible ureteroscope for lower pole access.

STONE-BASKETING

With the ureteroscope in place, the basket is passed superior to the stone under direct vision. There are many and various stone-retrieval devices; the baskets that we most commonly use are the flat-wire basket and the Nitinol TM tip-less basket, although other baskets can be used as the situation dictates. Along with spiral and multiwire baskets, the flat-wire baskets have a tip protruding beyond the cage and are used primarily in the ureter. While working in the renal calyces, tip-less baskets and graspers can avoid trauma to the renal papillae.

The lithotripsy devices that is most effectively used through the flexible ureteroscope is laser. We prefer the holmium:YAG laser, 200 imbfibre with its ability to thermally drill through even the most difficult stones. Disadvantages are the relatively brittle laser fibres, potential for damage or wear on the ureteroscope, and expense.

With the basket engaged, the ureteroscope and stone are removed together, keeping the stone in view at all times to monitor for intussusception of the ureter or lodging of the stone. After removal of stone, the scope is then replaced into the ureter and the collecting system inspected for residual stones or lesions. To facilitate this further, contrast can be instilled into the collecting system and this will also aid in later stent placement. For treating strictures, the flexible ureteroscope is passed alongside the guidewire up to the level of the obstruction. The wire should be directly visualized passing through the true lumen of the stricture. It might be necessary to pass a ureteric catheter superior to the stricture and inject contrast medium to confirm placement into the renal pelvis. The Accusize TM balloon may be used to treat a PUJ stricture or distal ureteric stricture. Laser incisions should be carefully made under direct vision, through the full thickness of the ureteric wall. The surrounding wispy retroperitoneal fat should be seen through the incision. An 8F indwelling ureteric stent is placed for 4–6 weeks.

Concluding the Procedure

The ureteroscope should be withdrawn under direct vision to inspect the mid- and distal ureter on the way out. The ureteric sheath, if present, can be withdrawn simultaneously. The access wire should remain in place with the tip in the renal pelvis.

At this point, a JJ indwelling stent with the 'tail' is placed over the remaining guidewire. Under direct vision, the rigid cystoscope is back-loaded onto the wire and replaced into the bladder. The stent with the tail is passed under direct vision until the distal tip of the stent is 1 or 2 cm outside the orifice, and the guide wire is removed.

COMPLICATIONS

Complications during ureteroscopy have decreased over the past 20 years because of improvements in ureteroscopes, ancillary devices, intracorporeal lithotriptors, and surgical skills. In 1986, Carter and coauthors reported that 8% of patients suffered ureteral perforation or stricture and 3% of patients required a ureteral reimplantation¹⁹. More recent experience has demonstrated that the perforation rate has decreased to between 0% and 4.7% (Harmon et al, 1997)²⁰. Some of intraoperative complications include failure to access (ureter, kidney, or stone), stone

migration into the ureteral wall, failure to fragment the stone, mucosal trauma, ureteral perforation, devastating complication like ureteral avulsion due to use of excessive force during ureteroscopy and inexperience. Post operative minor complaints like hematuria, renal colic (small residual stone fragments, blood clot) pyelonephritis, urinoma can be a problem. Ureteral stricture is one of delayed complication

FUTURE DEVELOPMENT

Digital Era

In line with the high-definition era of laparoscopic surgery, ureterorenoscopy has entered the digital era recently. Humphreys MR et al have demonstrated the beauty of digital ureterorenoscopy²¹. The distal tip objective is a CMOS imaging sensor coupled to a prism, utilising light emitting diodes as the light source, which gives the surgeon superb vision within the pelvicalyceal system.

Further studies will be required to demonstrate whether improved vision with digital imaging in RIRS will be translated into improved outcome.

Robotics

Flexible ureterorenoscopy would exert excessive strain on the surgeon who would need to keep the endoscope in deflection(s) in order to approach the target; and the operation may take hours. Robotics may be the solution to this problem. Desai MM et al have reported their ingenious design of a flexible robotic retrograde renoscopy in swine model²². The potential advantages of Robotic renoscopy compared with conventional manual flexible ureterorenoscopy include an increased range of motion, instrument stability, and improved ergonomics.

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