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REVIEW ARTICLE

Ureteroacopy Management of Upper Ureteral Stone

Osama Mostafa Kamhawy, Lotfy Abdallatif Elbendary, Ahmed M. Eliwa, Tarek Shaker Belhassan Boayad*
Urology Department, Faculty of Medicine, Zagazig University, Egypt.

***Corresponding author:** Tarek Shaker Belhassan Boayad
Email: am6978902@gmail.com

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ABSTRACT

Background: Ureterolithiasis is a common ailment that has a big effect on health around the world. It can be hard to cure large upper ureteric stones, especially those that are bigger than 10 mm. Surgery is often needed. Ureteroscopy, both antegrade and retrograde, has become a way to treat patients, but the results of the surgery vary. This study looks at the results of two different types of surgery for treating big stones in the upper ureter: antegrade flexible ureteroscopy (AFU) and retrograde intrarenal surgery (RIRS). AFU had a lower operative duration than RIRS and a shorter time to break up stones. The AFU group stayed in the hospital for a much less time than the RIRS group. There were no major differences in the stone-free rates at 24 hours or 4 weeks or in the requirement for extra treatments or problems after surgery.

Conclusion: Both AFU and RIRS work well to treat big stones in the upper ureter. AFU had benefits like shorter surgery times, shorter times for breaking up stones, and a quicker recovery, but the differences in stone-free rates and complication profiles were not statistically significant.

Keywords: Ureterolithiasis; Upper ureteric stones; Antegrade flexible ureteroscopy (AFU); Retrograde intrarenal surgery (RIRS); Stone-free rate (SFR).

INTRODUCTION

Millions of people worldwide suffer from ureterolithiasis, a condition that is expensive and heavily burdening the global healthcare system. Additionally, the prevalence and incidence of this condition are rising. Obesity, metabolic syndrome, diabetes mellitus, and cardiovascular disease are linked to ureterolithiasis [1]. Extremely intense flank pain that radiates to the groin is a common symptom of the illness. The agony comes on quickly and unexpectedly. After a conclusion, episodes frequently return. Patients with ureterolithiasis usually want to move frequently, which is symptomatic of colicky pain, in contrast to those with an acute abdomen who prefer to stay motionless. Acute ureterolithiasis is frequently linked to nausea and vomiting. When stones get close to the bladder, lower urinary tract symptoms may appear [2,3].

The size, shape, and placement of the stone and the ureteral anatomy of the patient typically dictate stone passage. The majority of stones that are 5 mm or less in diameter pass on their own, however calculi that have not moved after 4 to 6 weeks or stones larger than 7 mm may require surgery. The two methods most frequently used to remove ureteral stones are extracorporeal shockwave lithotripsy, which fractures stones into easily passable microscopic fragments, and ureteroscopy, which typically involves laser lithotripsy and stone basketing [4].

Patients with large upper ureteral calculi have a number of treatment options, such as extracorporeal shockwave lithotripsy with stenting, retrograde, antegrade, laparoscopic, and ureterolithotomy. Long hospital stays, scarring, infection and blood transfusions are examples of consequences that are still unknown [5]. Due to severe ureteritis, patients with impacted calculi, persistent calculus and infections have difficulties with pushback and double-J stenting, necessitating numerous SWL treatments and having a high failure rate [6].

Using the natural urine channel, ureteroscopy is a less intrusive treatment for upper ureteral calculi. Calculus pushback and fragments are possible, but it also necessitates high skill and costly tools [7,8]. A minimally invasive procedure called antegrade ureteroscopy uses a percutaneous renal tract to reach the ureter. It breaks the calculus with intracorporeal lithotripsy, may remove secondary lower caliceal calculi, and employs either a ureteroscope or a nephroscope. It is susceptible to PCNL-related issues, though [9–12].

The purpose of this research is to compare the results of antegrade flexible ureteroacopy and retrograde intrarenal surgery in order to enhance the endoscopic treatment of large upper ureteric stones larger than 10 mm.

Preoperative prediction of stone impaction

Preoperative stone impaction prediction may be helpful for preoperative planning, surgical technique selection, and patient counseling. A number of definitions of impacted ureteral stones have been put forth, but there are still a number of obstacles to overcome: it is unclear how long the stones should stay in the same position, it is unknown whether guidewires or ureteral stents will pass through until the day of surgery (apart from patients who have had pre-stenting), and contrast study is necessary to visualize the ureter distal to stones. Thus, recent research has tried to use preoperative NCCT or ultrasound imaging to predict stone impaction. [13, 14]. Risk factors for stone impaction include a history of ipsilateral therapy, severe hydronephrosis, and growing stone size. First of all, because there is little chance of spontaneous passage, big stones typically remain in the ureter for a long time. Additionally, they might increase the strain on the ureteral wall, which could result in fibrosis, edema, and ureteral ischemia as well as perhaps stone impaction. Impacted stones can induce severe hydronephrosis by obstructing the flow of urine into the bladder. Although the precise explanation of the elevated incidence rate of stone impaction linked to ipsilateral treatment history is unknown, inflammation or damage from prior treatment may be the culprit. Increased ureteral wall inflammation from prior SWL may affect the stone impaction process [13–15].

Furthermore, the process of stone impaction may be exacerbated by intraoperative ureteral injuries brought on by a guide wire, ureteroscope or other instruments during URSL. On the other hand, an increase in the thickness of the ureter surrounding the stones has been the most often utilized predictor of stone impaction in recent years. According to Sarica et al. [15]

UWT is the greatest ureteral wall thickness at the location of the ureteral stone on axial NCCT images. Poor SWL results were found to be independently correlated with increasing UWT (optimal cutoff value: 3.55 mm) [15–16]. UWV was previously described by Yamashita et al. [16] as the ureteral wall's volume measured from the upper to lower edges on NCCT. Poor SWL results were independently predicted by rising UWV in addition to UWT. Increasing UWT and UWV were thought to be indicative of the thickening of the surrounding ureteral wall brought on by stone impaction in these investigations. Based on the actual endoscopic findings, the relationship between preoperative ureteral wall-related variables and stone impaction has also been investigated. According to Yoshida et al. [17] in patients undergoing URSL, high UWT was linked to poor endoscopic findings such as ureteral edema, polyps, and stone fixation in addition to stone impaction, which is defined as the inability of the guidewire to pass on the first try (optimal cutoff value: 3.49 mm) [16–17]. Thus, a high UWT results in a poor endoscopic stone-free rate and lengthy operating periods. Using preoperative NCCT images, Chandhoke et al. [18]

prospectively evaluated four ureteral thickness parameters: peri-calculus ureteral thickness surface area, ureteral thickness above, around, and below the calculus. In patients who had URSL, they assessed the relationship between these characteristics and endoscopic stone impaction, which was assessed by surgeons using a 10-point Likert scale. Impaction of ureteral stones was linked to all four of these factors. A nomogram for predicting ureteral stone impaction—defined as the inability to pass a guidewire on the first try—was created and verified by Wang et al. [14].

This made use of several preoperative variables, such as UWT, degree of hydronephrosis, age, and ipsilateral treatment history. Although different studies have different definitions of stone impaction and different methods for evaluating ureteral thickening, these ureteral thickness characteristics appear to be helpful for predicting stone impaction before surgery [17–18]. A number of additional potential predictors have been identified in addition to ureteral thickness measures.

According to Tran et al. [19] surgeons whose patients had URSL regarded high HU values >27 HU as being related with stone impaction and possibly reflecting ureteral edema or inflammation. According to Abat et al. [20]. patients with stone impaction had a larger upper-to-lower ureter diameter ratio (upper diameter/lower diameter) than patients without. 11. By using Doppler ultrasonography to evaluate the ureteral jet flow, Erdogan et al. [21] demonstrated a strong correlation between low ureteral jet flow and stone impaction. Numerous researchers have created grading systems or formulas that incorporate these new potential variables. ISF is a new formula developed by Ozbir et al. [22] to predict stone impaction. UWT 9 HU below/HU above 9 (1 + Grade of hydronephrosis) was the formula used. The best cutoff value of ISF, according to receiver operating characteristic curve analysis, was 15.15 (area under the curve 0.958, sensitivity 91.0%, and specificity 91.0%).

Erdogen et al. [21] created a brand-new scoring system that takes into account a number of variables, such as ureteral jet flow, ureteral HU value behind the stone, and UWT. At a cutoff value of 11.5, the scoring system was able to predict stone impaction with excellent sensitivity (89%) and specificity (91%). However, more research is required because the value of these new potential predictors, formulas, and scoring systems has not yet been publicly documented [21].

Safe and effective endoscopic treatment of impacted ureteral stone

SWL is thought to be ineffective for impacted ureteral stones due to ureteral edema, polyps, and stone fixation. The invasiveness of these surgeries cannot be overlooked, even though open or laparoscopic ureterolithotomy is still a therapy option in certain situations, such as those involving large impacted proximal ureteral stones and unsuccessful endoscopic procedures. Endoscopic treatment has emerged as the primary treatment option for ureteral impacted stones as a result of recent developments in endourological methods. There are currently several endoscopic treatment options accessible, such as antegrade URSL, PCNL, and retrograde URSL. This section covers safe and efficient endoscopic techniques, as well as the findings of recent studies and our routine clinical practice [22-24].

Flexible Ureteroscopes:

Digital flexible ureteroscopy

Better viewing with high clarity equal to 10 times the pixel resolution of conventional fiberoptic endoscopes is possible when fiberoptics are replaced with digital imaging endoscopes. These endoscopes don't require a separate camera head or light wire because they come with an integrated light source and distal digital chip-based camera. A larger outer endoscope diameter is necessary for the digital chip camera, which affects access. The digital processing of colored light, especially red light, and issues with chip stability during laser lithotripsy, when the digital images are disrupted by the acoustic percussions generated [25, 26]. By using a charge-coupled device (CCD) image sensor or complementary metal oxide semiconductor (CMOS), which enables pixel conversion of incoming light photons, including color accuracy, into electrical charge and eventually to a digital form, distal video chip sensor technology operates as a miniature camera. Fiberoptic endoscopes have 3,500 pixels, whereas CCD and CMOS semiconductors can provide images with a resolution of up to 40,000 pixels in their viewing area [27].

Disposable flexible ureteroscopy

In 1987, Bagley developed the first disposable flexible ureteroscopy to reach the upper urinary system. Recently, a range of single-use flexible ureteroscopes that are now commercially available have highlighted the innovative technological breakthrough in the expanding field of endourology. In their analysis of 466 patients, Davis et al. [31] found that single-use FURS have equal efficiency, and that their selective use in low-volume clinics may reduce the cost of repairing the reusable scopes [28-31]. Deininger et al. [32] One reusable ureteroscopy (FlexXc, Karl Storz, Tuttlingen, Germany) and two single-use ureteroscopes (LithoVue, Boston Scientific Corporation, Marlborough, Massachusetts, USA; Pusen Uscope UE3011, Pusan Medical Technology, Guangdong, China) were compared in a lab study. Although the light output from both single use ureteroscopes was significantly lower, the reusable one seemed to have better optical and technical qualities. It's interesting to note that the Pusen Uscope had the highest intrarenal pressure, which could potentially impact patient safety. Emiliani et al. [33] tested the Pusen Uscope in ten clinical operations and found that during the procedures, picture quality, deflection, and mobility decreased [32, 33].

LithoVue (Boston Scientific) seemed to be on par with traditional scopes in a human cadaveric model when it came to visibility and manipulation of the upper urinary system. In a related recent study, LithoVue was compared to two commonly used reusable digital ureteroscopes (Olympus and Karl Storz) in a lab setting. In terms of standard technological features, the disposable LithoVue was comparable to the reusable digital scopes, and appropriate use of it may also indicate cost effectiveness [34, 35].

Robotic flexible ureteroscopy

In light of earlier advancements and discoveries, a human surgeon is still operating in an ergonomically unfavorable posture, primarily in time-consuming interferences with long lasing times and high radiation exposure. The ergonomic shortcomings of conventional flexible ureteroscopy may be addressed by the development of a robotic instrument in the era of advancing endourology [36-38]. Avicenna Roboflex, an efficient healthcare facility (ELMED, Ankara, Turkey), was able to articulate the benefits of ergonomics and serve as a secure platform. An ergonomic console, an integrated flat-screen, and a joystick for controlling the scope—which is held by the robotic arm manipulator—make up the system. Micro-motors that move the handpiece's steering lever cause the deflection. Additionally, the robotic arm allows for forward and backward motions as well as horizontal rotation [39, 40].

Description of flexible ureteroscopes

The illumination system, mechanical system, optical bundles, and working channel irrigation system are the four primary components of all contemporary FURS, albeit there are some minor variations between the various endoscopes. The control body, insertion tube, and actively deflecting tip are the other three components that make up this endoscope [41].

The tube is mostly composed of a nitinol shaft with fibers that pass through the endoscope. Their working lengths vary from 54 to 70 cm, and their shaft diameter rises proximally. The diameter of the proximal shaft is between 7.2 and 11 Fr. It includes the illumination system, optical bundle, operational irrigation channel, and deflecting mechanism and spans from the control body to the deflecting tip [41].

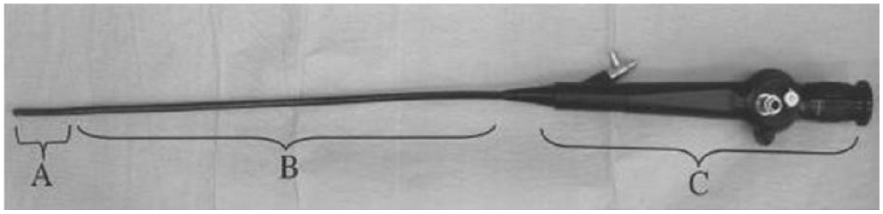

Figure 1: Three divisions of flexible endoscope. A, actively deflecting tip, B, insertion tube and C, control body (189). [41].

The tip's diameter falls between 4.9 and 11 Fr. The current ureteroscope's tip has the light bundle tip, which is mostly divided at the sides, the opening of the working channel, and the delicate optics or video camera sensor chip to record images [42].

Typically, the field of view is 100°, the depth of view is 2–50 mm, and the view is forward. The broad upper section of the endoscope, known as the control body, contains the objective lens or video system, the deflection lever, the entryway for the operational irrigation port, and, in the case of a fiber optic endoscope, the light cable [43].

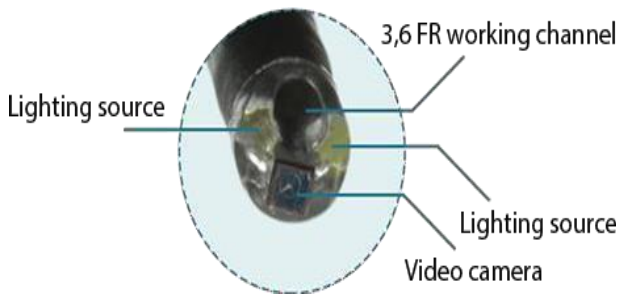

Figure 2: WiScope® Single-Use Digital Flexible Ureteroscope tip. [43].

The deflecting tip

Active curving of the tip is typically possible within the distal 3 cm of the insertion tube. The deflecting mechanical system, which includes a thumb-controlled lever in the control body that is engaged by thumb flexion, controls the active movement of the FURS tip [43].

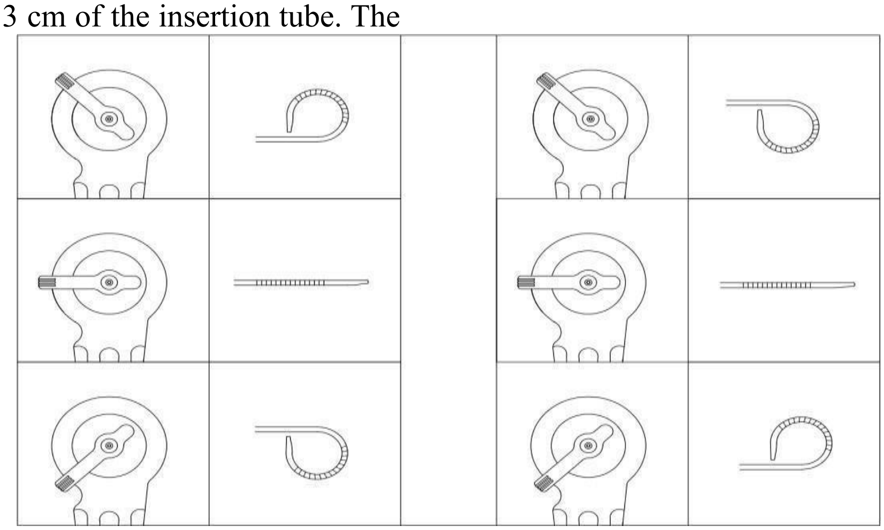

Figure 3: Standard Deflection Models and Reverse Deflection Model . [43].

Figure 4: WiScope® Single-Use Digital FURS OUT-100 deflecting tip . [43].

Figure 5: Area of secondary passive deflection . [43].

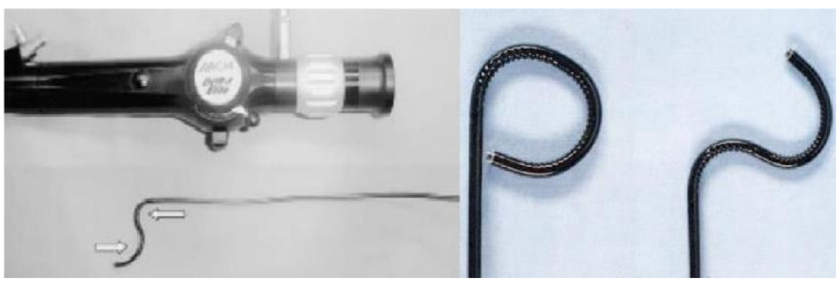

Figure 6: ACMI DUR-8E with primary active (left arrow) and secondary active (right arrow) deflection . [43].

The optical system

Fiberoptic light fibers, which are made of molten glass and covered with an extra layer of glass with a modified refractive index to improve internal reflection and light transmission, are used in the design of the optical system. To provide a well-lit distribution with a more aligned working channel, the distal light bundle separates. Additionally, to provide a wide field of view and appropriate image intensification, tiny lenses are positioned both proximally and distally [44].

Mechanical system

The distal tip can be curved in a single plane by manipulating the lever, which will deflect the tip through many wires that are connected to the lever and run the length of the endoscope. The endoscope tip deflects downward when the thumb lever is deflected downward. This was selected since the majority of deflection attempts aim to direct the tip into the kidney's mid- to lower calyces. Down is down was regarded as a logical diversion [45].

There is "intuitive" or "logic" active deflection in the Storz, Wolf, and ACMI FURS. On the other hand, the Olympus scope is "counterintuitive" or "unlogic" in that the tip moves downward while the lever is deflected upward. The ureteroscope's distal tip can articulate in two directions up to 275 degrees [46]. The passive deflection area of the majority of contemporary flexible endoscopes is situated roughly 5 cm close to the active deflection area. Compared to the rest of the uretroscope, it is more flexible.

In turn, this enables the ureteroscope to acquire a full circle, allowing the tip of the endoscope to look into a lower calyx by deflecting the distal shaft of the URS of the superior section of the renal pelvis [43].

A FURS with two active tip deflection segments was developed by ACMI Corporation. The secondary active deflection is positioned many centimeters proximal to the primary deflection, which provides a 130 degree one-way downward deflection, while the active primary deflection provides 170 and 180 degrees of up and down deflection. The angle of deflection changes depending on the FURS accessory [47].

Durability of the flexible ureteroscope

The main elements influencing the longevity and effectiveness of FURS are the surgeon's experience, the number of surgeries performed, the procedure's complications, and the sterilization technique. While White and Moran claimed that extensive FURS repairs were necessary after just 12 procedures, Afane et al. [48] observed that FURS required major repairs after 15 procedures or 13 hours of operating, and that active deflection deteriorated at a rate of 2% to 28% each usage [48,49].

Traxer et al. [50] have evaluated the maximum active upward and downward deflection, irrigation flow, and number of broken optical fibers through 50 FURS processes using the Karl Storz URS. In their final method, they found that the irrigation flow at 100 cm H20 decreased from 50 ml to 40 ml, the maximal upward deflection initially deteriorated from 270 degrees to 208, and the maximal downward deflection decreased from 270 to 133 degrees. They also realized that when a skilled urologist utilized the most recent generation of FURS, the need for repair was less frequent.

Pietrow et al. [51] investigated methods to make the 7.5 Fr FURS more durable. They believed that using modern scope attachments, such as nitinol baskets, a 200 µm holmium laser fiber and an access sheath could increase the longevity.

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