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Retrograde Intrarenal Surgery (RIRS): Hiking the "Urinary Tract" in Nigeria

John Edoka Raphael*, Okigbeye Danagogo

Urology Division, University of Port Harcourt Teaching Hospital, Port Harcourt, Rivers State, Nigeria
*Corresponding author: drraphaeljohn@gmail.com

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Abstract Rain precipitation at the top of a mountain flowing down the valley below is akin to urine formed in the kidneys flowing out through the ureters, bladder and urethra. Flexible ureterorenoscope enables endoscopic "hiking" into the kidney for intrarenal procedures. Lithotripsy is the commonest procedure during retrograde intrarenal surgery (RIRS). This study highlights RIRS with flexible ureterorenoscope and laser lithotripsy for renal calculus and describes our approach in performing this presently uncommonly procedure in our environment. We review our protocol for RIRS, including the clinical, laboratory and CT evaluation of patients presenting with renal stones for RIRS and laser lithotripsy. The counselling method and the preoperative preparation and approach were noted. The equipment and accessories were identified, along with the intraoperative techniques. We then carried out a literature review using Medline, PubMed and Google Scholars search engines and discussed our approach in light of the literature. Retrograde intrarenal surgery offers immense benefits in managing renal calculi. There is a need to improve the capacity of urologists in sub-Saharan Africa in RIRS, which, like mountain hiking, is seldom performed.

Keywords: *Laser lithotripsy, Renal calculi, Mountain hiking, RIRS*

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1. Introduction

Mountain hiking is a recreational activity that involves on-trail or off-trail climbing of mountains and hills. It is popular in the United States, Canada, the UK and Europe and is uncommon among Africans. Hiking up the symbolic mountain bears a semblance to the urinary system as urine, formed in the kidneys, flows out through the ureters, bladder and urethra, akin to rain precipitation at the top of the mountain flowing down the valley and river below. Hiking safely uphill requires special skills and tools without which the exercise can be hazardous. However, the hiker only gets a beautiful view of nature and enjoys an exhilarating experience climbing uphill if only he has the right tools. In retrograde intrarenal surgery (RIRS), flexible ureterorenoscope and other equipment requiring special training are used to visualize the urinary tract. [1] The development started in Western countries where mountain hiking is popular. It entails carrying out procedures in the kidneys ("top of the mountain") using a flexible endoscope. The commonest procedure performed during RIRS is laser lithotripsy. [2]

2. Objectives

To highlight Retrograde Intrarenal Surgery with flexible ureterorenoscope and laser lithotripsy for renal calculus and describe our approach in carrying out the procedure.

3. Methods and Methodology

We review our protocol for carrying out RIRS and laser lithotripsy in our patients with renal stones at Rosivylle Clinic and Urology Centre and University of Port Harcourt Teaching Hospital, Port Harcourt Rivers, Nigeria, from October 2018 to 2022. We considered the history, examination findings, laboratory and imaging evaluations. Their results, including the clinical findings and counselling method, along with the preoperative preparation and approach, were noted. The equipment and accessories for the procedure were identified, along with the intraoperative techniques in carrying out RIRS and laser lithotripsy. We then performed a literature review using Medline, PubMed and Google Scholars search engines. We finally discussed our approach in light of the literature.

4. Results

Figure 1. Obudu Mountain, Obudu, Calabar, Nigeria, showing a partly covered peak

Figure 2. Computerized axial Tomography showing right renal stones

Figure 3. Reusable flexible ureterorenoscope

Figure 4. Semirigid ureteroscope

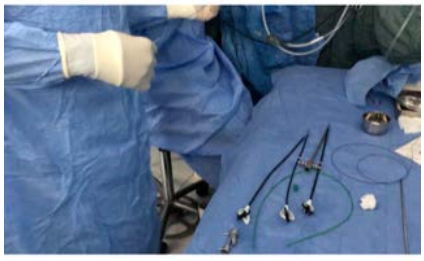

Figure 5. Endoscopic accessories including guide wires, access sheaths and ureteric catheters

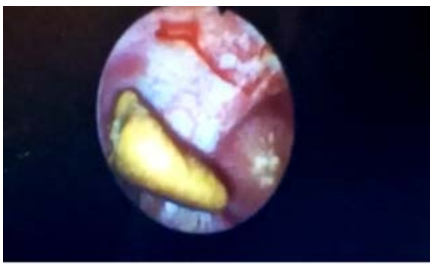

Figure 6. Ureterorenscopic view of renal calculus.

Figure 7. Laser fibre was introduced and targeted on calculus before lithotripsy

Figure 8. Retrograde intrarenal surgery with laser lithotripsy using the dusting mode associated with stone “dust.”

5. Discussion

Retrograde intrarenal surgery (RIRS) involves utilizing flexible endoscopes to carry out surgical procedures within the kidney. It is presently the commonest route used to perform intrarenal procedures. [1] Just as recreational mountain hiking affords the hiker a beautiful view of the mountain, RIRS allows close up and panoramic visualization of the entire urinary tract, including the calyceal system. Most renal calculi in developed Western countries are managed by endoscopically accessing the kidneys (“top of the mountain” where precipitation starts) using a flexible endoscope [1,2].

5.1. Historical Background

The development of RIRS is closely tied historically to several technological advances and the evolution of flexible ureteroscopy (fURS). Marshall first carried out fURS in 1964. [3] He described the passage of a 9F endoscope into the ureter to visualize an impacted ureteral calculus. In 1971 Takagi et al. [4] and Takayasu et al., [5] reported the first successful fURS in humans. Some years later, Bagley et al. [6] published their first clinical

outcomes of using a fURS for diagnostic and therapeutic applications. Today, developments in the optical system in fURS provides better image quality with flexible ureteroscopes that are much lighter in weight and designed to provide improved surgeon's ergonomics. [7]

5.2. Indications

The indications for fURS were initially only for diagnosing diseases in the ureters and pelvicalyceal system. Streem et al. [8] first described the use of ureterorenoscopy to evaluate upper tract filling defects. In 1990, Bagley and Rivas [9] reported diagnosing and treating upper urinary tract filling defects using a fURS. Abdel-Razzak et al., [10] first described upper urinary tract tissues biopsy in 1994, through a small working channel in a fURS before Bagley and Erhard [11] reported in 1995 the first clinical application in the therapeutic use of holmium: YAG laser for ureteric stone. Finally, in 1998, Bagley, [12] published the first ureteroscopic laser treatment of upper urinary tract tumours, which was accomplished using holmium: YAG laser and neodymium-doped YAG laser. RIRS can be used for stones smaller than 2 cm as a first-line treatment option besides shock wave lithotripsy and can be an alternative to PCNL for stones in the lower calyx and those greater than 2 cm. The relatively lower morbidity of RIRS has allowed it to be used increasingly.

The indications for ureteroscopy and RIRS have evolved over the years with the evolution of endoscopic technology. They can be used for most stones but are indicated in the presence of anatomic abnormalities such as in patient tha have a long lower pole calyx, narrow infundibulum, co-existing renal and ureteric calculi, bilateral renal stones, multiple stones, nephrocalcinosis, bleeding disorders; patients like pilot requiring 100% stone clearance, renal and ureteral malformations, obese patients and those with musculoskeletal deformities in addition to patients requiring multiple surgeries. [1,2]

5.3. Preoperative Evaluation

In our practice, an effort is made to get a precise diagnosis. All our patients perform a CT scan with urography to accurately identify the size and number of the stones, the hardness measured by the Hounsfield unit, the location, the anatomy of the collecting system; the degree of function and the status of the contralateral kidney. These were all noted. Comorbidities such as diabetes, hypertension respiratory disorders are controlled before surgery. A full blood count is carried out to exclude septicaemia, and it is treated if present before surgery. The surgery is described to the patient, and informed consent about the nature of the procedure and the outcomes, along with the complications, are all explained to the patient. Active urinary tract infection is treated, and the urine is sterilized before RIRS.

5.4. Intraoperative Technique

We routinely administer antibiotic prophylaxis using either a quinolone, meropenem or ticarcillin tazobactam, even though there are controversies with its use. [2,13] The sensitivity of cultured bacteria serves as a guide to the antibiotic we used.

5.5. Anaesthesia

For our retrograde intrarenal surgery, we use general anaesthesia with endotracheal intubation with paralysis routinely. Regional anaesthesia like the spinal and epidural block is associated with pain and poor cooperation from the patient, which is very important to prevent trauma. However, Zeng et al. [13] compared patients who had undergone combined spinal and epidural anaesthesia with general anaesthesia (GA) and found that they had a similar outcome with no conversion to the GA. They also noted that the efficiency and safety were identical between the two groups, while the cost was significantly lower in patients with regional anaesthesia. [14] General anaesthesia with muscle relaxation and the skilful cessation of ventilation by anaesthesiologist is essential during laser firing and stone fragmentation.

5.6. Surgical Technique

The instruments and equipment for RIRS that we utilize during our procedure include a reusable fibre-optic and flexible digital ureterorenoscope; semi-rigid ureteroscope (Figure 3 and Figure 4), rigid cystoscope, C-Arm fluoroscopy, guidewires, ureteric catheters, ureteral dilatators and ureteral access sheath. Others include stone baskets, irrigation pumps and urograffin contrast agents. We use the semi-rigid ureteroscope to examine the ureters for ureteric stones, check for ureteral relaxation, and assess the calibre of the lumen. (Figure 3, Figure 4 and Figure 5)

The guidewire (GW) is an indispensable device in RIRS for ensuring direct access to the collecting system or ureter, decreasing loss of orientation in the ureter to prevent intraoperative complications such as ureteral injury and perforation. It also facilitates the insertion of a ureteral stent in cases of failed retrograde ureteroscopic procedures. However, the use of a safety GW increases the resistance to the passage of the ureteroscope. [15]

A ureteral access sheath (UAS) has many advantages, including easy re-entry of the fURS into the collecting system, preventing increased intrarenal pressure, maintaining visualization in the surgical field to facilitate saline irrigation, and using it as a possible substitute for a safety GW. [16,17] Various sizes are available for clinical UAS ranging from 9.5/11.5 to 14/16 Fr in diameter and from 20 to 55 cm in length. The selection of an appropriately sized UAS is essential for the negotiation of the renal collecting system. [17] Traxer et al. [18] evaluated the incidence and severity of ureteral injury due to the use of UAS during RIRS in a series of 359 patients treated in two different centres. They found a rate of 46.5% for ureteral wall injury, while a rate of 13% was observed for severe injuries, including injuries to the muscular layer of the ureter. Risk factors for severe injuries were identified as age, male sex and absence of preoperative stent.

Denstedt et al. [19] first described holmium: YAG laser system for lithotripsy in 1995, and since then, it has become the gold standard for upper urinary stone

management. We use laser fibres with different core sizes, including 200, 365 and 550µm. [19] Our laser system allows for the adjustment of the pulse energy and frequency. We perform fragmentation using a lower frequency (5–15 Hz) and higher energy setting from 0.6–1.2 J and dusting using a high frequency 20-25Hz and low energy setting between 0.2–0.5 J depending on the clinical situation and stone hardness. [20] The dusting mode is associated with less stone retropulsion, less fibre degradation, and more excellent stone dust. [21] Stone fragmentation involves the creation of fragments that can be extracted through the UAS with a basket. In contrast, stone dusting creates tiny particles of <2 mm that can be spontaneously passed with no basketing. [22] A proposed definition of stone dust are particles of <250 µm small enough to spontaneous float under 40 cmH2O irrigation pressure, mean sedimentation time of <2 seconds through 10 cm of saline solution, and total suitability for aspiration through a 3.6-Fr working channel. [23] Stone dusting is the choice of most endourologist, and it is ours because it is associated with higher stone-free rates and shorter operating times. [24,25,26] (Figure 6, Figure 7 and Figure 8)

Our choice of irrigation fluid is normal saline or boiled cooled water using a manual pump. Another option involves the use of a foot pump. However, in an in vitro evaluation of two different active systems (foot and hand pumps), the hand pump was found to cause less migration of the fragments, but both were equally effective. [27] The foot pump, however, provides clearer vision. [28]

The procedure is performed after anaesthesia in the dorsal lithotomy position. The bladder is entered with a cystoscope or a semi-rigid ureterorenoscopy. Guidewires, ureteral stents or dilatators can be used to enter the ureter. The guidewire is sent to the ureter and kidney under fluoroscopic guidance. A second guidewire can be passed via a cystoscope or a dual lumen catheter. We place an 8F urethral catheter in the bladder for drainage. In our practice, after the guidewire is passed, we carry out a semirigid ureteroscopy to evaluate for pathologies and coincidental ureteric stones, strictures and also to dilate the ureter. Next, we pass a ureteral access sheath under fluoroscopic guidance. The flexible ureterorenoscope is then introduced through the access sheath into the kidney. The UAS aid evacuation of calculi from the kidney. It also reduces intrarenal pressure and the risk of bacteraemia. [29] Some studies have indicated that UAS decreases the operation time, protects the flexible ureteroscope and increases the stone-free rates. [30,31] However, it should be borne in mind that the placement of a UAS can cause a decrease in ureteral blood flow, leading to ureteral ischemia or direct ureteric injury during the procedure. [18,32]

The collecting system is then methodically inspected, and if a lower calyceal stone is present, it is repositioned into the superior calyx with a basket. The laser fibre is then introduced into the ureterorenoscope and advanced into the kidney. We routinely use the “dusting mode” but convert to the “hard stone mode” for hard stones and evacuate the fragments using a stone basket through the access sheath. The calculi are fragmented until clinically insignificant stones are left. Stone samples are obtained for analysis. We use normal saline for irrigation with a hand-held manual pump. After evacuating the fragments, we remove the access sheath under vision. Factors determining if we pass a DJ stent include the stone volume, ureteric stenosis and strictures. We retain the DJ stent longer in patients with larger stones volumes to aid stone clearance and healing in severe stricture or ureteric trauma. [33]

The benefits of RIRS are enormous, and making the RIRS with laser lithotripsy available in resource-scarce developing countries will improve the outcome of the management of urolithiasis in developing countries like Nigeria.

6. Conclusion

Retrograde intrarenal surgery offers immense benefits in managing renal calculi. There is a need to improve Sub-Saharan Africa's capacity, where RIRS is seldom performed like mountain hiking. Achieving this will require both institutional and government support to urologists by providing training opportunities and equipment. This will help bridge the gap in stone management between the developed countries and resource-scarce nations like Nigeria.

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